DENTAL MEDICINE

Comparative evaluation of dental caries experience using CAST index and WHO criteria among 5 and 15-year-old schoolchildren

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Abstract

Background. CAST (Caries Assessment Spectrum and Treatment) index is a relatively new caries assessment tool that hierarchically describes the entire caries spectrum. Its comparability with WHO (World Health Organization) criteria in different populations and age groups needs to be investigated.

Objective. The objective of this study was to assess caries among 5 and 15-year-old schoolchildren using the CAST index and WHO criteria and to compare both indices on the basis of caries experience and examination time.

Methods. A cross-sectional study was conducted among 553 schoolchildren aged 5 and 15 years in the North zone of Bengaluru city, India. Examiners underwent training and calibration for performing the CAST index. The first examination was performed using the CAST index followed by a second examination using the WHO criteria 2013, after some days. Time taken for examination was also recorded.

Results. The study sample consisted of 279 five-year-old and 274 fifteen-year-old schoolchildren. The difference in caries experience among 5 and 15-year-old children assessed using the CAST index (52%, 45.6%) and WHO criteria (42.3%, 24.5%) were found to be statistically significant ($p < 0.05$). The average examination time was longer for the CAST index (93.77±24.77 seconds and 105.04±9.49 seconds) when compared to WHO criteria (61.05±15.91 seconds and 58.72±9.42 seconds) for primary and permanent dentition ($p < 0.05$).

Conclusion. Though the CAST index took a longer examination time, the information obtained was more precise and facilitated researchers in treatment planning encompassing prevention of initial lesions, restoration, and rehabilitation.

Keywords: CAST index, WHO criteria, dental caries, children

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Introduction

Dental caries is one of the most prevalent chronic diseases affecting the human race. A variety of tools have been used for the assessment of caries experience in field studies. The most widely used being the Decayed, Missing and Filled Teeth (DMFT) index, recommended by the World Health Organization gives a description of the status of the disease in an individual considering both past and present caries [1]. Though it has been criticized for its limitations over the years, it is still being used for assessment and comparison of caries experience of populations around the world [2]. One of the limitations is its inability to differentiate the enamel and dentine carious lesions and therefore it does not contribute to the planning of specific treatment [3]. Moreover, DMFT has low sensitivity in detecting minor shifts in caries progression. Another disadvantage is that DMFT gives equal weight to missing, untreated decay, and permanently restored teeth, hence individuals with the same DMFT may have different dental health status [4].

The late 20th century witnessed the development of various new indices such as Filled and Sound teeth (FS-T), Tissue health index (T-health), International Caries Detection and Assessment System (ICDAS), and PUFA (pulp-ulcer-fistula-abscess) which were put forth in an attempt to address these limitations. But none of these indices have overcome all the limitations of DMFT [5]. Recent advancements in the prevention and treatment of initial carious lesions necessitate the assessment of dental caries in an early non cavitated stage at both enamel and dentine level [6]. With this background a new caries assessment instrument termed Caries Assessment Spectrum and Treatment (CAST) was introduced by Frencken et al. in 2011. It describes caries in a hierarchical way, the complete range of carious conditions, from the absence of carious lesions, to the presence of caries protection (sealant) and caries treatment (restoration), lesions in enamel and dentine, lesions penetrating the pulp and tissue surrounding the tooth (abscess/fistulae), and loss of teeth [7]. CAST has already been validated extensively from in-vitro and in vivo studies which have proven its high specificity, sensitivity, and reliability in epidemiological surveys [8-10].

CAST is relatively a new caries assessment tool and hence its comparability with the WHO criteria in different populations and different age groups needs to be investigated [11]. To date, only a few studies have compared WHO criteria for DMFT with the CAST index based on mean dmf (decayed, missing and filled) /DMF scores, caries prevalence, and this evidence appears to be poor [11,12]. 5 and 15 years are the index age groups recommended by WHO for the global monitoring of caries for international comparison and monitoring of disease trends for primary and permanent teeth [13]. Therefore, the aim of this study was to compare the CAST index and WHO criteria on the basis of caries experience and examination time among 5 and 15-year-old schoolchildren.

Methods

A cross-sectional study was conducted among schoolchildren aged 5 and 15 years of Bengaluru city, India to compare the dental caries experience using the CAST index and WHO criteria. Ethical clearance was obtained from the Ethics Review Board of M S Ramaiah Dental College and Hospital, Bengaluru with approval number MSRDC/EC/2014-15/21 on 14/11/2014. Strobe Guidelines were followed while designing this cross-sectional study. Permission was taken from the respective school authorities. Based on the published literature, the prevalence of dental caries in 5 and 15-year-old children in Bengaluru city were found to be 40% and 45.8% respectively [14]. With a relative precision of 15%, power 90%, and 5% level of significance the minimum sample size was calculated to be n = 256 for 5-year-old children and 202 for 15-year-old children.

All the required and relevant information about the number and location of the government and private schools in the north zone of Bengaluru city were obtained from the Department of Public Instruction, Government of Karnataka website [15,16]. From the list so obtained, 150 schools were shortlisted based on the availability of 5 or 15-year-old children. Schools that had fewer than 30 students aged 5 and 15 years were excluded. One school was randomly selected using the lottery method and approached for permission prior to the study. Children undergoing orthodontic treatment and those with mixed dentition were excluded. The selection of schools was continued in a similar way till the required sample size was achieved. A total of five schools was included in this study.

Examiner training and calibration

The principal investigator (examiner 1) and examiner 2 underwent training in the Department of Public Health Dentistry under appropriate guidance. The training comprised of a theoretical explanation using PowerPoint presentations about the CAST index and WHO criteria 2013 and a practical session in which extracted teeth were examined and scored by each examiner. Individual scores were compared, and, in case of a difference, examiners and the professor discussed the scores until the agreement was reached. If two or more surfaces of the same tooth was presented with different caries scores, e.g. a restoration in one surface and an enamel lesion in another or an enamel lesion in one surface and a distinct cavity in another, both scores were recorded. After the training session, a calibration exercise was carried out on twenty subjects of the same age as those included in the study. Inter and intra examiner agreement was assessed by using Kappa statistics in primary and permanent dentition at surface level. The Kappa test provides a better evaluation of disagreement among examiners during calibration processes since it is a measurement of adjusted agreement by taking into consideration the ratio of chance agreement. According to Cohen, kappa value between 0.61 - 0.80 indicates substantial, and 0.81 - 1.00 as almost perfect agreement [17]. Both examiners obtained good kappa coefficient values that ranged from 0.70 – 1.00 for the CAST index and 0.90 – 1.00 for WHO criteria.

Dental examination

The examinations were carried out in a well-illuminated classroom/assembly hall by two trained and calibrated examiners. Informed consent was obtained from the subjects' parents prior to the study. Dental examination of the subjects was carried out under natural light. Torchlight was used when needed. The subjects were examined by making them sit on a chair, with his or her neck extended, and the examiner seated opposite to them.

The study was conducted in two phases. The first examination was performed using the CAST index mentioned in table I [7].

Table I. Description of CAST codes.

Characteristics	Code	Description
Sound	**0**	No visible evidence of a distinct carious lesion is present
Sealant	**1**	Pits and /or Fissures are at least partially covered with a sealant material
Restoration	**2**	A cavity is restored with an (in)direct restorative material
Enamel	**3**	Distinct visual change in enamel only. A clear caries related discoloration is visible, with or without localized enamel breakdown.
Dentine	**4**	Internal caries related discoloration in dentine. The discolored dentine is visible through enamel, which may or may not exhibit a visible localized breakdown of enamel.
	5	Distinct cavitation into dentine. The pulp chamber is intact.
Pulp	**6**	Involvement of the pulp chamber. Distinct cavitation reaching the pulp chamber or only root fragments are present.
Abscess / fistula	**7**	A pus containing swelling or a pus releasing sinus tract related to a tooth with pulpal involvement.
Lost	**8**	The tooth has been removed because of dental caries.
Other	**9**	Does not correspond to any of the other descriptions

Dental caries status was assessed using a No 5 plane mouth mirror and a Community Periodontal Index (CPI) probe. As recommended for the application of the CAST index, the tooth surface was not air-dried [5,7]. Cotton rolls and CPI probes were used to remove dental plaque present on the teeth surfaces. When necessary, excess saliva was removed with cotton rolls or gauzes as air drying was not recommended for the application of CAST. After 2-7 days, a second examination was performed using WHO criteria 2013. Each examiner was accompanied by a trained assistant for recording the proforma and the indices. The duration of examination was measured using a stopwatch by trained assistants from the moment the examiner gave verbal instruction to 'start' until the examiner concluded the examination and called out 'finished'. To avoid examiner fatigue, examinations were restricted to 25 children per day. Re-examination was performed by the examiners after every 7th child to ensure consistency in recording indices. The subjects were then informed about their oral health status and appropriate referrals were given for preventive and curative dental services.

Statistical analysis

Statistical Program for Social Sciences (SPSS) version 16 was used for statistical analysis of data. On subjecting the data to the normality tests – Shapiro Wilk, the distribution of data was found to be non-normal ($p < 0.05$). Descriptive data were analyzed and derived in terms of mean, standard deviation, and percentages. Distribution of CAST index codes and WHO scores were presented in terms of frequency and percentages at both tooth and surface levels. If two or more surfaces of the same tooth were presented with different caries scores, both codes were recorded and only the higher score was considered in the analysis. Table II presents the codes that were used for calculating the caries experience using CAST index and WHO criteria. Mc Nemar test was used to compare the caries experience assessed by the CAST index and WHO criteria. The mean examination time taken for recording the CAST index and WHO criteria were compared using Wilcoxon signed rank test. The level of significance was fixed at $p < 0.05$.

Table II. Caries experience calculation according to CAST index and WHO criteria.

	CAST index	WHO criteria
Decayed	Code 3-7	Code B, C or 1,2
Missing	Code 8	Code E or 4
Filled	Code 2	Code D or 3
Caries experience	Codes 2-8	Codes B-E/1-4

Results

The subjects comprised 279 five-year-old and 274 fifteen-year-old schoolchildren. Figure 1 shows the frequency distribution of five and fifteen-year-old subjects based on the categorization by CAST codes. Among the 5-year-old children, 144 (51.6%) had healthy dentition denoted by codes 0, 1, and 2. The reversible premorbidity stage (code 3) was reported in 61 (21.9%) children. We found that 140 (50.2%) children had dentition with morbidity (codes 4 and 5); and 41 (14.7%) with serious morbidity (codes 6 and 7). Only one child (0.4%) reported dentition with mortality (code 8). In 15-year-old children, 163 (59.4%) had healthy dentition denoted by codes 0, 1, and 2. The reversible premorbidity stage (code 3) was reported in 72 (26.3%) children. 59 (21.5%) children had dentition with morbidity (codes 4 and 5); and 25 (9.2%) with serious morbidity (codes 6 and 7). Dentition with mortality (code 8) was reported in 5 (1.9%) children.

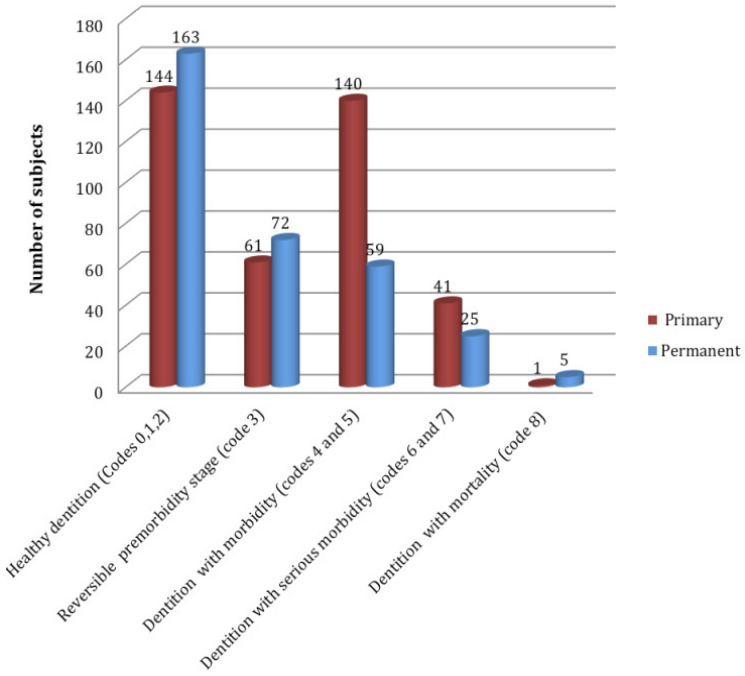

Figure 1. Distribution of 5 and 15-year-old subjects based on the categorization by CAST codes.

Table III. Distribution of CAST codes tooth-wise in primary and permanent dentition.

CAST codes	Dentition		Treatment option
	Primary	Permanent	
3	110 (1.97%)	138 (1.79%)	Preventive care/ Pit and fissure sealant
4	51 (0.95%)	38 (0.5%)	Restoration
5	324 (5.80%)	49 (0.63%)	Restoration
6	123 (2.20%)	39 (0.50%)	Endodontic treatment/ Pulpectomy / Extraction
7	2 (0.04%)	1 (0.01%)	Endodontic treatment/ Pulpectomy/ Extraction
8	1(0.01%)	6 (0.08%)	Space maintainer / Prosthodontic treatment

Table IV. Caries experience in two age groups according to CAST index and WHO criteria.

Age	Caries experience		p value
	CAST index (Codes 2, 3-8)	WHO criteria	
5-year-old (n=279)	52% (145)	42.3% (118)	**0.000**[#]
15-year-old (n=274)	45.6% (125)	24.5% (67)	**0.000**[#]

* CAST index compared with WHO criteria (McNemar test) [#]$p < 0.05$

Table III presents the distribution of CAST codes tooth-wise in primary and permanent dentition with treatment options. With regard to the tooth-wise distribution of CAST codes, of the total teeth examined 110 (1.97%) primary and 138 (1.79%) permanent teeth were identified with enamel lesions (CAST code 3) and required preventive care or sealants. CAST code 6, corresponding to pulpal involvement was recorded in 123 (2.20%) primary and 39 (0.50%) permanent teeth and needed endodontic treatment or extraction.

Table IV shows the comparison of caries experience in two age groups according to the CAST index and WHO criteria. Caries experience among 5-year-old children according to the CAST index codes 2, 3-8 was 52%, and for the 15-year-old children, it was 45.6%. According to WHO criteria, caries experience in both the age group was assessed to be 42.3% and 24.5% respectively. The difference in caries experience assessed using CAST and WHO criteria were found to be statistically significant in both age groups ($p < 0.05$). The mean time spent in

applying CAST index and WHO criteria in examining the primary dentition was 93.77±24.77 seconds and 61.05±15.91 seconds respectively. Regarding permanent dentition, the mean examination time in applying CAST index and WHO criteria were calculated to be 105.04±9.49 and 58.72±9.42 seconds respectively. The average examination time was longer for the CAST index when compared with WHO criteria for primary and permanent dentition using Wilcoxon signed rank test ($p < 0.05$).

Discussion

Dental caries is now recognized as a completely reversible and preventable disease of dental hard tissues if diagnosed at an early non cavitated stage [18]. The most widely accepted caries assessment system, the DMFT index has its limitations of not recording the initial carious lesions. The need for developing a caries assessment tool that incorporates all stages of caries was emphasized. With this background, the CAST instrument was developed. So far, few studies have reported the use of CAST index in field settings, and this is probably one of the first studies that have reported the comparison of CAST index with WHO criteria 2013 among 5 and 15-years old schoolchildren in Bengaluru city, India.

The index age groups recommended by WHO for the global monitoring of caries for international comparison and monitoring of disease trends for primary and permanent teeth are 5 and 15 years [13]. Considering the ease of obtaining the required sample size of 5 and 15-year-old children, schools are the ideal study setting for this study. A total of five schools was included using simple random sampling.

Two examiners participated in the study who were trained and calibrated. Both examiners had no previous experience with the new caries assessment system (CAST) and obtained good agreement after training and calibration. The agreement between the examiners was high in recording the cavitated lesions than initial enamel and non cavitated lesions. This slight deterioration in the agreement could be due to the difficulty in differentiating the visible discoloration without enamel breakdown (code 3) from internal caries related discoloration in dentine (code 4). The percentage of teeth identified with CAST codes 3 and 4 in primary and permanent dentition was 2.92% and 2.29% respectively. In order to improve examiner accuracy and agreement, children with CAST codes 3 and 4 were re-examined. De Souza et al. reported the reproducibility of the CAST instrument for use in the primary dentition as 'substantial' to 'almost perfect' and in the permanent dentition of 19-30 years old, almost perfect [10]. A study by Voruganti et al. reporting the reliability of the CAST index in the age-group between 4 and 6 years concluded that the inter- or intra-examiner agreement was substantial to almost perfect for both age groups [19]. These findings could not be related to our study as the agreement was calculated for two sets of categories 'healthy' versus 'diseased' (codes 0-2 Vs. 3-7) and 'non-cavitated' versus 'cavitated' (codes 0-3 Vs. 4-7) teeth.

All the dental examinations were carried out in accordance with the CAST recommendation given by Frencken et al [7]. The armamentarium used was similar for both the caries assessment systems. In this study, the use of diagnostic adjuncts, such as prior tooth brushing and drying were not employed in recording the CAST index. Assaf et al reported that even with the use of auxiliary resources that improve visual examination such as air drying and brushing, all the epidemiological examinations underestimated the non cavitated lesions when compared with the standard examination [20].

As per the National Oral Health Survey 2004 report, the caries experience in the Bengaluru region among 5 and 15-year-old children was 40.6% and 33.3% respectively [21]. According to the Oral Health Survey and fluoride mapping of Bengaluru District 2011, caries experience in 5 and 15-year-old children in Bengaluru city was found to be 40.02% and 47.31% respectively [14]. The present study reported the dental caries experience among 5 and 15-year-old children according to the CAST index to be 52% and 45.6% and as per the WHO criteria, it was assessed to be 42.3% and 24.5% respectively. R Nagarajappa et al reported higher caries prevalence of 65.3% among 15-year-old schoolchildren in Bhubaneswar obtained using CAST index [22].

The advantage of the CAST index over WHO criteria is that it can be reported in two ways. It denotes the proportion of 'healthy' (codes 0-2) versus 'diseased' (codes 3-7). The 'diseased' dentition can be divided into 1) a reversible premorbidity stage (code 3) 2) dentition with morbidity (codes 4 and 5) and with serious morbidity (codes 6 and 7), and 3) dentition with mortality (code 8). The second way of reporting is based on the preventive and curative care required for the target population [7]. Thus, CAST index provides a precise treatment plan efficiently whereas specific treatment planning is not possible according to WHO criteria for DMFT.

The high prevalence of enamel caries and lower prevalence of sealants in both age groups indicate the high risk of caries occurrence in the future. This finding was consistent with the results of studies by R Nagarajappa et al, Dorenia et al, and Babaei et al that reported a low prevalence of children with fissure sealant [22-24]. The presence of pre-cavitated lesions is a predisposing factor for cavity development [25]. Eventually, these initial lesions may progress faster from enamel to dentine and then lead to the development of pulpitis and abscess. Moreover, cavitated lesions were more prevalent among 5-year-old children. Caries in primary molars can be a

predictive factor for the development of cavities in the permanent dentition, particularly in the first molar teeth [26]. According to Burnside et al. caries on a given surface can be used as a predictor of future caries on the corresponding surface on the other side of the mouth [27]. These observations necessitate effective preventive measures and curative care among these groups. Treating dental caries in children at an early stage not only improve their growth and development and but also their quality of life [28].

The present study showed a significant difference in the caries experience assessed using CAST index and WHO criteria. This could be due to the additional detection of initial and non cavitated carious lesions by CAST index codes when compared with WHO criteria. A study by De Souza et al. compared the caries experience obtained using the CAST index and WHO criteria for the age group of 6-11 years and obtained similar results [11]. This finding cannot be compared with our study because of the conceptual difference in caries experience calculation. Besides unmistakable cavitations, initial and non cavitated carious lesions were included for assessing caries experience using the CAST index.

Apart from the main objectives, the time taken for performing the CAST index and WHO criteria were compared. Our findings showed that the two caries assessment criteria differed with respect to examination time. The average examination time was longer for the CAST index when compared with WHO criteria for primary and permanent dentition. This finding differs from a study done by De Souza et al which reported that time spent on examining children was identical for both caries assessment methods [11]. A study by Reddy et al reported that both ICDAS and CAST systems are time-consuming procedures when compared to the DMFT/deft (decayed-extracted-filled teeth) system which is consistent with our findings [12]. Studies that have reported the time taken for recording WHO criteria are limited. The findings of this study might need some caution in interpretation due to the inherent limitations of the cross-sectional study design.

Conclusions

Caries experience assessed using CAST and WHO criteria were found to be significantly different in both age groups. Though the CAST index took a longer examination time, it provides detailed information on the stages of dental caries. To conclude, the CAST index would be suitable for epidemiological surveys as it provides the whole spectrum of dental caries situation and thus gives a real picture of disease burden in a community which will facilitate the health care planners for effective preventive and curative care planning.

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