

# Dental Caries Indices used for Detection, Diagnosis, and Assessment of Dental Caries

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## ABSTRACT

**Background:** Due to increasing problem of oral health diseases worldwide, there is urgent need of comprehensive data collection system. Traditionally, carious lesions were detected and evaluated using physical criteria that consist of size, depth, and existence or absence of cavitations. Untreated caries in children were increasing like epidemic and there is an urgent need to determine a system that can assess initiation of dental caries to advanced stages so as to determine the disease diagnosis and decide on appropriate clinical treatment. Paucity of consistent and standardized criteria to detect caries which are applicable universally is a major issue in caries measurement. This may result in confusion among clinicians, educators, and researchers in interpretation of data from various research studies, leading to apparently conflicting results.

**Aim:** This article is presented with the aim of studying in detail about different dental caries indices used for detection, diagnosis, and estimation of dental caries.

**Conclusion:** Reliable, reproducible, and realistic detection and estimation of dental caries lesions as a result of dental caries have been a challenge for a long time. There are many promising newer dental caries indices, which will help in identifying caries at early or precavitated stage and accurate diagnosis of dental caries.

**Keywords:** Dental caries, Detection, Diagnosis.

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## BACKGROUND

Dental caries is defined as the destruction of the dental hard tissue due to localized acidic by-products from bacterial fermentation on dietary carbohydrates.<sup>1,2</sup> In late 19th century, precavitated lesions was recognized by scientists, and still, the word dental caries has been used along with frank cavities for a long time.<sup>3</sup>

Currently, dental caries is described to arise from a variety of disease states starting from initial subclinical lesion and continue to subsurface changes to clinically detectable lesions which can be seen as small cavities with considerable dentinal involvement at later stages.<sup>4,5</sup> Dental caries is a disease that occurs after tooth eruption, as it usually starts just after the teeth eruption into the oral cavity.

It affects both males and females of all ages and all socioeconomic groups. A method of detection and estimation of dental caries lesions as a result of dental caries disease which is reliable, reproducible, and practical has been a big problem for a long period of time.<sup>3,6</sup> Carious lesions can be present on all surfaces of primary, permanent, and mixed dentition.

The lesions on the surface of tooth can then be calculated based on:

- Type of the teeth (incisors, canines, premolars, and molars) or
- Surfaces (occlusal, proximal, and free smooth surfaces).

Mixed dentition stage: This starts from 6 to 12 years of age, when the permanent teeth erupt and the primary teeth are exfoliating. The mixed dentition period is the initial stage in which association between the number of caries lesions and the primary and permanent teeth can be determined.

Several studies in the past have shown direct association between caries experience between the primary and permanent teeth.<sup>7,8</sup> In a prospective clinical trial caries studies, the exfoliated tooth presents a special problem, as the tooth and tooth surfaces need to be included in both of the examinations.<sup>9</sup> Various indices are used for detecting dental caries in both primary and permanent dentition, depending on the involvement of coronal tissue or root caries.

Klein and Palmer<sup>10</sup> and Knutson introduced Decayed-Missing-Filled (DMF) Index for dental caries in permanent teeth. The World Health Organization<sup>11</sup> has included the index in the oral health assessment form which is used for conducting national oral health surveys. The main advantage of this index is that it is simple to use, valid, and reliable, and is still being used very commonly for evaluating and comparing caries status among population groups.

## DENTAL CARIES INDEX

In this index, the absence or presence of dental caries is presented as the DMF index in an individual or group,

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community, state, and country. The count in DMF index according to definition varies from 0 to 32, when applied at the tooth level (i.e., DMFT), and in case of tooth surface level, it ranges from 0 to 128 (i.e., DMFS).

Since its discovery in 1938, the DMF index has been used very usually as a measure to detect dental caries. Burt and Eklund<sup>12</sup> have described details of DMF index and its limitations.

There are two major issues with the DMF index in the current time as caries estimation moves toward detection of precavitated or early lesions:

- This index is unable to determine restorative or preventive treatment need.
- In various studies, it has been reported that DMF indices may not be comparable unless detection criteria and examination methods are clearly described.<sup>13</sup>

The DMF index score shows a total caries experience of an individual and it does not differentiate between untreated decay and well-restored tooth, as equal weights were given to decayed, missing because of caries, filled tooth, or tooth surface.<sup>12</sup> Despite various problems, the DMFT index is universally used until the criteria for dental caries status is defined more evidently.

Due to these limitations, there is an urgent need for a more uniform description of caries measurement criteria and examination methods.<sup>13-15</sup> The DMFT/S index is used for long period of time to measure dental caries in cases where decay extends into the dentin.<sup>11,16</sup> Over the years, for various reasons, DMFT index has also been criticized<sup>17</sup>:

- Lack of reliability in diagnosis of caries.
- During examination, it is very difficult for any examiner to confirm the reason for extraction.
- Secondary carious lesions with restorations are not counted.
- It is difficult to estimate caries activity by using DMFT.
- Carious lesions in enamel are not counted.
- DMF values do not reveal teeth/surfaces at risk.
- Missing teeth, untreated caries, or restored teeth are given equal weight.
- DMF index has a limitation of overestimation of caries experience in teeth restored with preventive resin restorations or cosmetic restorations.
- DMFT index is of a very little use in estimating treatment needs.
- This index does not include sealants.

Significant caries index (SiC) measurement shows that DMF index produces skewed distribution of dental caries experience.<sup>18</sup> The SiC calculates mean DMFT of one-third of the population having highest DMFT values, and online Microsoft Excel application was used for estimation. Bratthall<sup>19</sup> introduced this index in order to measure people with the highest dental caries experience in the population under investigation.

The SiC tries to remove limitation of the DMFT index in accurately determining the skewed distribution of dental caries experience in a population, mainly in developed countries leading to wrong conclusion that the caries situation for the whole population is good, while in reality, several individuals still have caries.

In a research study conducted in Nevada, the problem of skewed distribution of dental caries experience was analyzed in detail; in this study, it was confirmed that dental caries was a frequent chronic disease among youths of Nevada, and the mean SiC score calculated was considerably higher than DMFT scores among all surveys conducted in the year across and among comparison groups ( $p < 0.001$ ).

The conclusion of the study was that both caries indices (DMF and SiC) should be used in combination which may help to determine inequalities in oral health more precisely in various groups in the entire population and within the whole community in order to recognize the need for special preventive oral health interventions.<sup>20</sup> The calculation of SiC is done by selecting individuals based on their DMFT values; among these, the mean DMFT among one-third population having highest caries scores is calculated. This value obtained is the SiC index. Therefore, by using the SiC index, preventive or control measures can be done by concerned authority among this subgroup.

As SiC index is an expansion of DMF index and follows the same criteria as that of DMF index, it may have limitation in determining dental caries among population subgroup in the same manner as that of DMF index. The SiC index is more appropriate to be used in population groups having low caries level and skewed distribution.

To determine the serious outcomes of untreated caries, another caries index can be used known as pulp-ulcer-fistula-abscess (PUFA) index. To find out pulpal involvement (p), ulceration (u), fistula (f) formation, and abscess formation (a) in the primary dentition, PUFA index is used, while PUFA scores are similar in the permanent dentition. These two indices are becoming appropriate tools for measuring oral health and planning strategy.<sup>21</sup> As compared with DMF index, PUFA index records the advanced stages of untreated caries lesions, which result in greater impact on concerned decision-makers.

The scoring method of PUFA index (PUFA index scoring system) is as follows:

P/p—this refers when opening of pulp chamber is evident or complete decay of crown part of tooth structure and tooth is left with only root fragments; in this situation, pulpal involvement is recorded. In this index, no probing is done to diagnose pulpal involvement.

U/u—ulceration is defined as trauma from sharp parts of tooth and it is recorded when sharp edges of a dislocated tooth having pulpal involvement or root

fragments have caused traumatic ulceration of the surrounding soft tissues ex tongue or buccal mucosa.

F/f—fistula is scored when pus-releasing sinus tract which is related to a tooth having pulpal involvement is present.

A/a—abscess is present in a situation when a pus containing swelling is present which is related to a tooth having pulpal involvement.

### International Caries Detection and Assessment System

It includes early enamel caries lesions categorized according to the stage of their progression.<sup>22,23</sup> Various *in vitro* and clinical studies were conducted to test the reproducibility and validity of the International Caries Detection and Assessment System (ICDAS).<sup>24-26</sup> The ICDAS is now globally recommended for dental health surveys.<sup>12</sup> In 2004, the International Consensus Workshop on Caries Clinical Trials described the exact meaning of caries diagnosis (which means a summation of all available data by human professional), and later divided it for carious lesion detection (which describes some objective method of finding whether or not disease is there) and lesion assessment (which aims to classify or monitor a lesion after it has been detected).<sup>9</sup>

There is major decline in caries prevalence and severity among developed countries due to preventive measures, such as water fluoridation.<sup>17,18</sup> Due to low prevalence of caries and its slow progression, there has been an increase in the prevalence of precavitated caries (reversible condition) lesions as compared with cavitated lesions (irreversible condition).<sup>21</sup> Thus, it is necessary to develop criteria to detect caries at initial stages (precavitated), as compared with frank cavitated and irreversible lesion only.<sup>20</sup> Current agreement is to find dental caries at the precavitated lesion stages.<sup>9</sup>

The epidemiologic assessment of disease prevalence and treatment need is affected by the stage at which it is detected in a population and decision of a dental clinician and practitioners.<sup>8,23</sup> An important problem in caries estimation is the absence of rational and uniform criteria applicable across the world, which may lead to confusion and difficulty in interpretation of data among clinicians, educators, and researchers from different studies which may lead to conflicting results.

A new index called the ICDAS came into existence in 2002 by a group of cardiologists and epidemiologists for caries diagnosis which was proposed as a way to put forward a globally accepted caries detection system. The index was based on visual examination with the help of WHO probe. The short form of this index is ICDAS.<sup>24</sup> This index is a variation of a previous visually ranked

dental caries lesion scoring system, which detects occlusal lesions in permanent teeth and evaluates their depth with adequate accuracy and reproducibility.<sup>25-27</sup>

The ICDAS classifies the caries process into five stages, ranging from first visible signs of dental caries in enamel to excessive cavity with visible dentin that replicate different phases in the occurrence of dental caries on tooth surfaces and the different levels of treatment, ranging from preventive to operative care.

The aim of ICDAS is to present a flexible, yet reliable, system in caries estimation so that clinicians and researchers have the choice based on the phase of caries process and other features according to the requirements of their research or practice. Validity and reproducibility of ICDAS have been field tested.<sup>27</sup> It consists of a 2-digit recognition system (X-Y). In first step, the situation of the surfaces is recorded or described as unrestored, sealed, restored, or crowned.

Then, a 2nd code is given (Y), which ranges from estimation of the first visual changes, that is, cavity in the enamel to extensive cavitation. The description and examples of each code are presented in Table 1.<sup>28</sup> Before examination, thorough cleaning of teeth should be done and then with the help of light illumination, an air syringe, plane buccal mirror, and a WHO periodontal probe, if necessary, examinations must be performed.

As enamel in primary teeth is very thin, it is highly difficult to differentiate precisely between lesions associated with the outer or inner half of the enamel by using the ICDAS index.<sup>29</sup>

Nyvad's system (Table 2)<sup>30,31</sup> is another system to estimate caries activity of noncavitated and cavitated caries. This system has predictive and construct validity (the different conditions of caries lesions project different outcomes) related to caries lesion activity status.<sup>30</sup> In this system, a separate score can be given to all observed characteristics of the lesion, ultimately classifying the lesion as inactive or active. A lesion is classified as active if at least

**Table 1:** Description and score of ICDAS

Score	Criteria
0	No or little change in enamel translucency after air drying for long time (5 sec)
1	1st visual change in enamel (restricted within the limits of a pit or fissure)
2	Clear visual change in enamel
3	Enamel break down which is confined to a small area, in opaque or discolored enamel (there are no visual signs of dentinal involvement)
4	There should be an underline dark shadow from dentin
5	Frank cavitation with dentin is visible
6	Extensive frank cavity with dentin is visible (this involves more than half of the surface)

**Table 2:** Nyvad's system

Score	Category	Criteria
0	Sound	Teeth enamel with normal translucency and texture.
1	Active caries (intact surface)	Enamel with whitish or yellowish surface, and opaque with loss of luster, feels rough when moving gently the tip of the probe across the surface. No clinically visible loss of tooth substance. Fissure morphology is intact; and carious lesion extends along the walls of fissure.
2	Active caries (surface discontinuity)	Active caries (cavity): The same criteria as score 1. Localized surface defect is seen (microcavity) in enamel only; undermined enamel or softened floor is not detectable when explorer is used.
	Active caries (cavity)	Enamel or dentin cavity is easily visible with the naked eye; on gentle probing, surface of cavity feels soft or leathery. Pulpal involvement may or may not be present.
4	Inactive caries (intact surface)	Color of enamel surface is whitish, brownish, or black. When the tip of probe is moved gently, enamel may be shiny and feels hard and smooth across the surface. No clinically detectable loss of substance and intact fissure morphology; lesion may be extending along the walls of the fissure.
5	Inactive caries (surface discontinuity)	Same criteria as score 4. Localized surface defect (microcavity) in enamel only. Undermined enamel or softened floor is not detectable on using explorer.
6	Inactive caries (cavity)	Inactive caries (cavity); Enamel/dentine cavity easily detectable with the naked eye; on gentle probing, surface of cavity feels shiny and hard. Pulpal involvement not present.
7	Filling (sound surface)	
8	Filling + active caries	Cavitated or noncavitated carious lesion may be present.
9	Filling + inactive caries	Caries lesion may be cavitated or noncavitated.

one characteristic of the lesion is similar to active lesion. Various original studies used plaque, as it indicates caries activity. A standard probe is used in this system to determine roughness. In various recent studies, examination was performed by investigators using Nyvad's scoring criteria precisely as published.

But, in order to homogenize the methodology used in the examinations, various modifications of Nyvad system were done and compared with the original version, such as inspection was performed after prophylaxis and WHO probe was used.<sup>31</sup> The depth of lesions on primary teeth was accurately measured using the Nyvad index.<sup>31</sup> As seen in ICDAS, microcavities are those cavitations

restricted to enamel (scores 2 and 5 in the Nyvad system, while score 3 in ICDAS), and frequently involve dentin demineralization among primary teeth.<sup>31</sup>

## CONCLUSION

Reliable, valid, and practical determination and assessment of dental caries lesions as an outcome of dental caries disease have been a challenge for a long time.

There are many promising newer dental caries indices which will help in identifying caries at early or precavitated stage and accurate diagnosis of dental caries.

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