

# PUFA – An index of clinical consequences of untreated dental caries

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**Abstract – Rationale:** Dental caries is a global public health problem, especially in children. Most caries in developing countries remains untreated. Only limited data are available on the clinical consequences of untreated dental caries because there is no measure to quantify the prevalence and severity of oral conditions resulting from untreated dental caries. **Objectives:** To present a new index to evaluate the prevalence and severity of oral conditions resulting from untreated dental caries. To validate the index within the Philippines National Oral Health Survey, 2006. **Methods:** The PUFA index records the presence of severely decayed teeth with visible pulpal involvement (P/p), ulceration caused by dislocated tooth fragments (U/u), fistula (F/f) and abscess (A/a). **Results:** Good kappa values show the reliability of the index. The prevalence of PUFA/pufa >0 was 85% and 56% for 6- and 12-year-olds, respectively. The mean number of teeth affected (PUFA/pufa) was 3.5 and 1.2 for 6- and 12-year-olds, respectively. In 6- and 12-year-olds, 40% and 41% of decayed teeth had progressed to odontogenic infections. **Conclusion:** The PUFA index complements classical caries indices with relevant information for epidemiologists and health care planners.

**Key words:** caries assessment; children; index; untreated caries PUFA ratio; untreated dental caries

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## Introduction

Despite improvements in oral health in high-income countries during the last decades (1) dental caries is still a major global public health problem. Treatment of caries in young children is virtually nonexistent in low- and middle-income countries (2) and remains limited even in high-income countries such as the United States, Saudi Arabia, and the United Kingdom (3–5).

The burden of untreated caries in children has been documented in several studies (6–8). The consequences of untreated caries often present as dental emergencies in children's hospitals (9). Moreover, in British Columbia, Canada, infectious complications from untreated caries are the most common reason for hospitalization of children (10). Research suggests that untreated caries can have an

effect on children's growth and their general health (11–13).

For the last 70 years, data on caries have been collected worldwide using the DMFT/dmft index (14). This classical index provides information on caries and restorative and surgical treatment but fails to provide information on the clinical consequences of untreated dental caries, such as pulpal involvement and dental abscess, which may be more serious than the caries lesions themselves. A deep caries cavity with pulpal involvement is usually considered under the code 'caries of dentin' (15, 16) and pulpal involvement is not mentioned at all in the caries scoring system in the latest edition of Oral Health Surveys – Basic methods WHO (17). Some limited information might be obtained on the severity of advanced caries lesions by the scoring of 'teeth indicated for

extraction' under treatment needs (17) but this code does not give the precise reason for extraction. For example, 'indicated for extraction' could be for reasons other than the consequences of untreated dental caries, e.g. as a sequel to trauma, for orthodontic or cosmetic reasons, or in preparation for a prosthesis. Moreover, 'treatment needs' for extraction are rarely reported in the literature and the consequences of untreated dental caries are hardly ever mentioned.

In 2007, the WHO World Health Assembly recognized the growing burden of oral diseases worldwide and emphasized the need to scale up action based on comprehensive data collection systems (18). In view of the global epidemic of untreated caries in children there is an urgent need to establish a scoring system that both assesses and quantifies various advanced stages of caries. The lack of a generally accepted and applied measurement tool means that only very limited data on a population level are available on the prevalence of caries with pulpal involvement or dental sepsis. Furthermore, the available data are not readily comparable due to the different scoring systems used (19, 20).

The objective of this study was to develop a new index to assess the prevalence and severity of oral conditions related to untreated caries. A second objective was to validate the index and to use the new index in assessing the prevalence and severity of oral conditions related to untreated caries in a national oral health survey in the Philippines.

## Materials and methods

### *The PUFA index*

PUFA is an index used to assess the presence of oral conditions resulting from untreated caries. The index is recorded separately from the DMFT/dmft and scores the presence of either a visible pulp, ulceration of the oral mucosa due to root fragments, a fistula or an abscess. Lesions in the surrounding tissues that are not related to a tooth with visible pulpal involvement as a result of caries are not recorded. The assessment is made visually without the use of an instrument. Only one score is assigned per tooth. In case of doubt concerning the extent of odontogenic infection, the basic score (P/p for pulp involvement) is given. If the primary tooth and its permanent successor tooth are present and both present stages of odontogenic infection, both teeth will be scored. Uppercase letters are used for

the permanent dentition and lowercase letters used for the primary dentition. The codes and criteria for PUFA index are as follows:

P/p: Pulpal involvement is recorded when the opening of the pulp chamber is visible or when the coronal tooth structures have been destroyed by the carious process and only roots or root fragments are left. No probing is performed to diagnose pulpal involvement (Fig. 1a, b, photo 1 and 2).

U/u: Ulceration due to trauma from sharp pieces of tooth is recorded when sharp edges of a dislocated tooth with pulpal involvement or root fragments have caused traumatic ulceration of the surrounding soft tissues, e.g., tongue or buccal mucosa (Fig. 1c, d, photo 3 and 4).

F/f: Fistula is scored when a pus releasing sinus tract related to a tooth with pulpal involvement is present (Fig. 1e, f, photo 5 and 6).

A/a: Abscess is scored when a pus containing swelling related to a tooth with pulpal involvement is present (Fig. 1g, h, photo 7 and 8).

The PUFA/pufa score per person is calculated in the same cumulative way as for the DMFT/dmft and represents the number of teeth that meet the PUFA/pufa diagnostic criteria. The PUFA for permanent teeth and pufa for primary teeth are reported separately. Thus, for an individual person the score can range from 0 to 20 pufa for the primary dentition and from 0 to 32 PUFA for the permanent dentition. The prevalence of PUFA/pufa is calculated as percentage of the population with a PUFA/pufa score of one or more. The PUFA/pufa experience for a population is computed as a mean figure and can therefore have decimal values. The 'Untreated Caries, PUFA Ratio' is calculated as

$$\frac{\text{PUFA+pufa}}{\text{D+d}} * 100$$

### *Reproducibility of the PUFA/pufa index*

To assess the reproducibility of the PUFA/pufa index three examiners were trained in its use. Fifty, 6-year-old children and 49, 12-year-old children were examined for PUFA/pufa and the reproducibility assessed by the kappa statistic.

### *Use of the PUFA/pufa index in the National Oral Health Survey of the Philippines*

The Philippines National Oral Health Survey (NOHS) was conducted from November 2005 to February 2006 under the authority of the Department of Education (21). In each of the 17 regions of

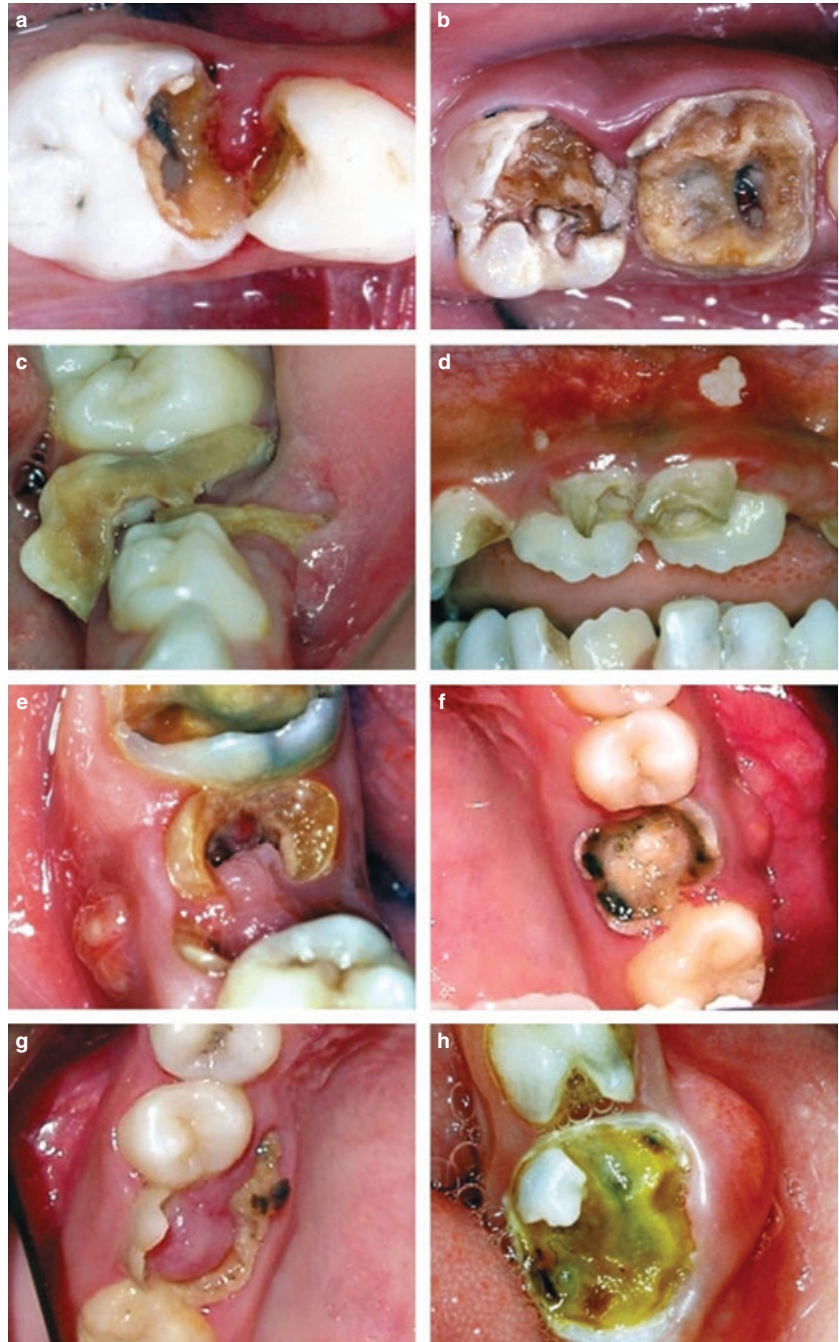


Fig. 1. (a and b) Pulpal involvement (P/p), opening of pulp chamber is visible or coronal tooth structures are destroyed by caries; (c and d) Ulceration (U/u), traumatic ulceration in the soft tissues (tongue and mucosa), caused by tooth or root fragments; (e and f) Fistula (F/f), a sinus tract releasing pus originating from an abscess and opening into the oral cavity; (g and h) Abscess (A/a), dento-alveolar abscess.

the Philippines, two rural and two urban public elementary schools were randomly selected among schools which were easily assessable and in secure areas. In each school about 30, 6-year-old children and 30, 12-year-old children were randomly selected. All children brushed their teeth prior to examination. Oral examinations were performed in the open air in the school playground with children lying in the supine position. A CPI ball-end probe and a lighted mouth mirror (MIRRORLIGHT™, Kudos, Hong Kong) were used as examination tools to score caries according to procedures

described by WHO (17). Initial caries lesions were not scored. Teeth presenting with early stages of cavitation, but where the ball end probe could not enter were not scored as caries. The criteria for the PUFA/pufa index were applied without the use of instruments.

To ensure consistent clinical judgment, all 10 examiners involved in the study underwent 5 days of theoretical and clinical training in caries and PUFA/pufa diagnosis. Laminated pictures were used as a reference for PUFA/pufa scoring. Throughout the survey each examiner re-examined

7.5% of the children and reproducibility was assessed with kappa statistics.

## Results

### *Reproducibility of the PUFA/pufa assessment*

Inter-examiner reproducibility of PUFA/pufa on 99 children prior to the NOHS had an overall kappa value of 0.85. Throughout the national oral health survey, intra-examiner reproducibility varied between kappa values of 0.80–0.98 for scoring DMFT/dmft and 0.80–0.97 for PUFA/pufa for both age groups.

### *Use of the PUFA/pufa index in the National Oral Health Survey of the Philippines*

In the 6-year-old group, 2030 children with a mean age of 6.6 years were examined. The overall caries prevalence was 97%, while 85% of 6-year-olds present at least one tooth with pulp involvement (Table 1). Caries experience in the primary dentition was 8.4 dmft, with 8.0 on the d-component and 0.4 on m component, no teeth were filled. The permanent dentition presented 0.7 DMFT, purely concentrated on the D component and almost all decay occurring in the first molar (Table 2). The pufa index for the primary dentition was 3.4, and the PUFA index for the permanent dentition was 0.1 (Table 2). The ‘Untreated Caries PUFA Ratio’ was 40%, indicating that 40% of the D+d component had progressed to an odontogenic infection. The main component of PUFA/pufa was pulpal involvement (Table 2).

In the 12-year-old group, 2022 children with a mean age of 11.8 years were examined. The overall caries prevalence was 82% and the overall prevalence of PUFA/pufa was 56% (Table 1). In the 12-year-old children, caries experience was 0.2 dmft and 2.9 DMFT (Table 2), with a D component

Table 1. Prevalence of caries (%) and prevalence (%) of PUFA/pufa of 6- and 12-year-old Filipino children

	6-year-olds (n = 2030)	12-year-olds (n = 2022)
Prevalence dmft > 0	97	15
Prevalence DMFT > 0	36	78
Overall caries prevalence	97	82
Prevalence of a pufa	84	12
Prevalence of a PUFA	8	50
Overall prevalence of PUFA/pufa	85	56
Prevalence of FA/fa	18	9

Table 2. Mean caries experience (SD) and mean PUFA/pufa experience (SD) of 6- and 12-year-old Filipino children

	6-year-olds (n = 2030)	12-year-olds (n = 2022)
Mean dmft	8.4 (4.2)	0.2 (0.6)
Mean pufa	3.4 (2.6)	0.2 (0.6)
Mean DMFT	0.7 (1.1)	2.9 (2.9)
Mean PUFA	0.1 (0.5)	1.0 (1.3)
Mean p <sup>a</sup>	2.9 (2.4)	0.2 (0.6)
Mean u	0.3 (1.0)	0.0 (0.2)
Mean f	0.1 (0.4)	0.0 (0.1)
Mean a	0.1 (0.3)	0.0 (0.0)
Mean P <sup>a</sup>	0.1 (1.0)	0.8 (1.2)
Mean U	0.0 (0.1)	0.1 (0.3)
Mean F	0.0 (0.0)	0.1 (0.3)
Mean A	0.0 (0.1)	0.1 (0.2)

<sup>a</sup>Note: The mean P/p does not include teeth scored with U/u, F/f and A/a.

of 2.7 and a M component of 0.2. No fillings were present. The mean pufa index of the remaining primary dentition was 0.2 and the PUFA index of the permanent dentition was 1.0 (Table 2). The ‘Untreated Caries, PUFA Ratio’ was 41% indicating that 41% of the D + d component had progressed mainly to pulpal involvement.

## Discussion

During the last decade, international caries epidemiology has focused on the development of more sensitive diagnostic criteria to allow for assessment of the initial stages of caries (22, 23). This is considered important in the light of the decline of cavitated caries lesions in high-income countries where nonoperative and preventive interventions require an index that distinguishes between the different stages of initial caries lesions (24). However, in low- and middle-income countries, as well as deprived communities within high-income countries, where people have little access even to the most basic forms of care there is a need for a diagnostic index that addresses the advanced stages of untreated caries lesions.

The way caries data are presented has a considerable impact on how it is interpreted by health decision makers. For example, the DMFT of 2.9 for 12-year-old Filipinos complies with the WHO/FDI goal for the year 2000 of 3 DMFT for this age group. This can lead to complacency among decision makers since the Philippines have already met WHO/FDI goals based on the DMFT. The reality is

that in this same age group 41% of the decay component has progressed to odontogenic infections, which clearly demonstrates the limited and often misleading explanatory power of the DMFT. By exposing decision makers only to DMFT data, leaves them unaware of the high levels of untreated caries lesions, their severity and associated health and quality of life consequences.

The dental profession should fulfill its ethical mandate and provide health decision makers with relevant information on disease levels. The PUFA index was developed in response to that need. The various clinical stages defined by PUFA have different associations with health conditions. The index defines four different clinical stages of advanced caries providing 'a face of the reality' to the prevailing and often ignored oral conditions. Presenting data based on the PUFA index will provide health planners with relevant information, which is complementary to the DMFT.

The Philippines NOHS was an appropriate occasion to validate the new PUFA index under field conditions in a low-income country with a population suffering from a high burden of untreated caries. The demonstrated high levels of examiner agreement in the Philippines NOHS for PUFA/pufa were similar to reproducibility for DMFT/dmft and indicate the reliability of the PUFA/pufa index. The index proved to be appropriate in quantifying the consequences of severity of tooth decay it is universally applicable in all settings, even under simple field conditions. The index is easy and safe to use, even for nondentists, takes little time to perform and does not require any additional equipment.

The caries prevalence in 6-year-old Filipinos was 97% and in 12-year-olds it was 82%. The respective dmft and DMFT for those age groups were 8.4 and 2.9 DMFT. There were no fillings and very low m/M components for both age groups. That indicates that more than 90% of caries in both age groups remained untreated. The inclusion of data on pulpal involvement, traumatic ulceration, fistula and abscesses (PUFA/pufa) in the Philippines NOHS provided a more comprehensive picture of caries and its consequences related to general health of the Filipino child population. Forty percent of decayed teeth in 6-year-olds and 41% of decayed teeth in 12-year-olds had signs of odontogenic infection. This information may be useful for treatment planning as it will help to calculate the treatment need (tooth extractions, restorations, endodontic treatment)

depending on the capacity of the health care system.

The findings from the Philippines NOHS indicated that 12-year-old children with PUFA >0 had a statistically significant lower body mass index as compared to those with a PUFA = 0. In contrast, no association was found for body mass index of children with a DMFT >0 compared with those with DMFT = 0 (21). Thus, a PUFA/pufa prevalence of 85% for 6-year-olds and of 56% for 12-year-olds implies that the majority of Filipino children have an oral health status that impacts on general health.

Due to a paucity of similar studies it is difficult to compare the present findings with other countries; however, the prevalence of fistulae and abscesses of 18% among 6-year-old Filipinos is consistent with the findings for 5-year-old Scottish children. There, the prevalence of sepsis (defined as the presence of an abscess or fistula) was reported to be 11% for children living in the most deprived areas in Scotland (20).

The use of the PUFA/pufa index in the Philippines NOHS has shown the relevance of this index to address the neglected problem of untreated caries and its consequences. Furthermore PUFA/pufa data may be used for planning, monitoring and evaluating access to emergency treatment and exposure to fluoride as components of the Basic Package of Oral Care (BPOC) (25) and national oral health plans and may have a higher potential than the DMFT to get oral health onto political agendas.

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