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# A Silent Public Health Crisis: Untreated Caries and Dental Infections Among 6- and 12-Year-Old Children in the Philippine National Oral Health Survey 2006

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## Abstract

The oral health status of 6- and 12-year-old Filipino children was assessed in a representative national sample of 2030 6-year-old and 2022 12-year-old children, using WHO Basic Methods for Oral Health Surveys (4th edition, 1997) and the PUFA (pulpal involvement [P/p], ulceration caused by dislocated tooth fragments [U/u], fistula [F/f], and abscess [A/a]) index. A subsample of 242 12-year-old children was included to assess backward comparability between the 1998 Oral Health Survey that used WHO Basic Methods (3rd edition, 1987). The results showed that 97% of 6-year-old children had caries (mean dmft 8.4), 85% showed dental infection (mean pufa 3.4), 20% reported pain when examined. In all, 82% of 12-year-old children had caries (mean DMFT 2.9), 56% prevalence of pulp involvement (mean PUFA 1.0), and 16% reported pain when examined. Differences in methodology between the 1998 and the 2006 surveys are likely to have had an effect on the observed reduction in DMFT, indicating that the real caries prevalence had not changed much and remains very high.

## Keywords

oral health survey methods, dental caries, dental infection, oral pain, DMFT comparability, PUFA

## Introduction

Regular epidemiologic surveys looking at oral health status have been recommended by the World Health Organization (WHO) since 1971, when the first standard protocol for oral health

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surveys was defined. This standardized the epidemiological data collection and dominated survey approaches until today.<sup>1,2</sup> Oral health surveys typically focus on a narrow set of epidemiological data about oral diseases, with emphasis on caries and/or periodontal disease, using clinical indicators developed in a descriptive academic context. Recently, efforts have been made to develop oral health indicators for integration in routine national health data collection systems.<sup>3-5</sup>

The main objectives of National Oral Health Surveys (NOHS) are usually to monitor disease levels, to assess treatment needs, to evaluate the impact of existing strategies, and to give oral diseases visibility in the public and political domain.<sup>6</sup> However, surveys often produce information with limited relevance for decision making or planning.<sup>7,8</sup> Moreover, the DMFT (decayed, missing, filled, teeth) index, when used to measure the burden of dental decay is not well suited to estimate treatment need.<sup>9,10</sup> In spite of this, there is a persistent assumption that descriptive oral health surveys are a prerequisite for the planning of health promotion programmes and oral health services; in reality, existing services are rarely the result of planning based on epidemiological surveys.

The objectives of the 2006 NOHS among the child population in the Philippines were to monitor disease trends, allowing the determination of the appropriateness of oral health strategies applied since the last survey, and to give sound arguments to advocate for innovative integrated approaches to child health in the school context. The last nationwide oral health survey from 1998 reported caries levels that were among the worst worldwide.<sup>11</sup> This time, in addition to DMFT data, the PUFA (pulpal involvement, ulceration caused by dislocated tooth fragments, fistula, and abscess) index was introduced; an index designed to assess the presence of oral conditions and infections resulting from untreated caries in the primary (pufa) and permanent (PUFA) dentition.<sup>12</sup> Furthermore, the survey included simple indicators for socioeconomic status, personal hygiene, as well as anthropometric measures (details are reported in separate publications).<sup>13</sup>

### *Objective of This Article*

This article details the caries-related findings of the 2006 NOHS in the Philippines for 6- and 12-year-old children. It also discusses the problem of comparability of results between the NOHS of 2006 and the previous study of 1998 since this is an important aspect of determining whether a reduction of caries among 12-year-old schoolchildren has been achieved. The relevance of the survey for national and international contexts is discussed.

## **Materials and Methods**

### *Sampling*

In 2006, the Philippines had an elementary school population of about 13 million children with 12 million attending public elementary schools. To obtain a representative sample of public school children, a stratified multistage cluster sampling design was used. The sample size calculation was based on the estimated caries prevalence of 80%, a desired precision of 2% with a confidence level at 95%. In each of the 17 regions in the Philippines, schools were excluded from the sample if fewer than 60 children were enrolled in grade VI, the access to the school took longer than 1 hour by local transport from the main highway and/or the school was situated in an area of civil unrest. In each region, 2 rural and 2 urban public elementary schools were randomly selected using the "Barangay" classification of the Philippine National Statistic Office, which defines the rural or urban character of a Barangay (the smallest administrative unit in the Philippines). In each of the

68 participating schools, 30 students from grade I aged 6 ( $\pm 1$ ) years and 30 students from grade VI aged 12 ( $\pm 1$ ) years were randomly selected from the teachers' records books.

### *Ethical Considerations*

The survey was conducted under the authority of the Health and Nutrition Center of the Philippine Department of Education (DepEd).<sup>14</sup> Data were collected between November 2005 and February 2006. Written parental/legal guardian consent was obtained prior to the examinations and full confidentiality was ensured through an encoding system where private information was removed prior to data processing. Since the Health and Nutrition Center of the Philippine DepEd routinely conducts a physical and oral examination of all elementary school children each year, this national oral health survey was considered to be part of this routine. Given that the survey was a purely descriptive epidemiological study and did not involve any interventions, the DepEd did not consider there to be a need for an ethical review process and approved the survey.

### *Reliability of Data*

Five survey teams, each consisting of 2 dentists and 2 recorders, received a 2-day theoretical training, followed by a 3-day clinical training and calibration. The training was conducted by an experienced epidemiologist of the WHO Collaborating Centre in Jena, Germany. During the entire survey, each examiner reexamined 7.5% of the children.

### *Data Analysis*

SAS version 9.1 was used to compute descriptive data, for example, averages, standard deviations, and confidence intervals. Reproducibility of examiners was assessed with unweighted  $\kappa$  values. Interexaminer  $\kappa$  values for caries detection ranged from 0.78 to 0.92, and intraexaminer reproducibility varied between  $\kappa$  values of 0.80 to 0.98.

### *Examination Details*

Oral examinations were performed in the school courtyard, or in case of rain, inside the classroom. Prior to the oral examination the children brushed their teeth. Examiners sitting in a "12 o'clock position," wearing gloves and mask, examined the children lying in a supine position on school benches or tables. Teeth were dried with cotton pellets. A CPI ball-end probe and a lighted mouth mirror (Mirrorlight, Kudos, Hong Kong) were used. The CPI probe was used gently to detect and confirm visual evidence of caries according to the caries diagnosis criteria of WHO Oral Health Surveys Basic Methods 4th edition.<sup>2</sup> Noncavitated caries lesions were not scored. In addition, teeth presenting early stages of cavitation but where the ball-end probe could not enter were not scored as caries and were excluded from the analysis.

The PUFA/pufa index was used according to standard procedure and was recorded separately from the DMFT/dmft scores.<sup>12</sup> The presence of either a visible pulp (P/p), ulceration of the oral soft tissues due to root fragments (U/u), a fistula (F/f), or an abscess (A/a) was recorded. The PUFA/pufa index per child was calculated in the same cumulative way as the DMFT/dmft index and represents the number of teeth meeting the PUFA/pufa diagnostic criteria. The assessment was made visually without the use of an instrument.

Anthropometric data and body mass index were assessed according to a standard methodology.<sup>13</sup> Finally, all children were asked (in local dialect) about the presence of pain at the time of

examination; whether they had a television at home and their number of siblings. A trained assistant recorded all data on a standardized form.

### *Subsample Comparing 2 WHO Survey Methods*

To ensure backward comparability with the 1998 NOHS, a subsample of 242 12-year-old children from 2 schools in Cagayan de Oro were examined twice. The first examination was done by an examiner who participated in the 1998 NOHS and who had been calibrated according to the 3rd edition of the WHO Basic Methods for Oral Health Surveys (examiner 1).<sup>15</sup> In accordance with the methods used in the 1998 NOHS, children did not brush their teeth prior to the first examination. They were examined under daylight in a seated position. Examination instruments comprised a sharp explorer and a mouth mirror. Teeth were not dried. Caries was recorded as present when the sharp probe stuck in a lesion or when the probe detected a smooth tooth surface defect or a soft floor, undermined enamel or a softened wall.

The second examination was performed by an examiner who participated in the 2006 NOHS and had been calibrated according to the 4th edition of the WHO Basic Methods for Oral Health Surveys (examiner 2).<sup>2</sup> After the first examination described above, children brushed their teeth before being examined in a supine position for a second examination. After the teeth were dried with cotton pellets, a CPI ball-end probe and lighted mouth mirror were used to diagnose caries according to the method of the 2006 NOHS. Intraexaminer consistency was assessed through reexamination of 29 children by each of the 2 examiners.

## **Results**

### *Six-Year-Old Children*

A total sample of 2030 6-year-old children (980 boys/1050 girls, mean age 6.6 years) was examined. The overall caries prevalence was 97.1%. The mean dmft was 8.4 (d = 8.0, m = 0.4, f = 0).

For the permanent dentition the DMFT was 0.7, exclusively concentrated on the D-component and almost all decay occurring on the first molar. Caries scoring at surface level revealed a mean dmfs of 28.2 and a DMFS of 1.1. The score for the first molar was 1.0 DMFS. The Care Index was 0% in both dentitions (the Care Index indicates the percentage of dental decay that was treated by the provision of fillings and is calculated as  $[F/DMF] \times 100$ ).

In all, 85% of 6-year-olds examined presented at least 1 tooth with pulp involvement. The pufa index for the primary dentition was 3.4, and the PUFA index for the permanent dentition was 0.1. Oral pain at the time of examination was reported by 20% (Table 1). No statistically significant difference between children from rural and urban areas was found.

### *Twelve-Year-Old Children*

A total of 2022 12-year-old children were examined (982 boys/1040 girls, mean age 11.8 years). The overall caries prevalence was 82.4%. The mean DMFT was 2.9 (D = 2.7, M = 0.2, F = 0). The caries burden was concentrated on the first permanent molars, with 1.6 DMFT. With respect to surface level the mean DMFS was 7.7 with 5.1 DMFS on the first molars. No fillings were present.

Overall, 56% of children presented at least 1 tooth with pulp involvement. The mean pufa index of the remaining primary dentition was 0.2 and the PUFA index of the permanent dentition was 1.0. Oral pain at the time of examination was reported by 16% (Table 2). No statistically significant difference between children from rural and urban areas was found.

**Table 1.** Summary of Results for 6-Year-Old Children From the 2006 NOHS and Comparison With Results From 1998 (SD and CI in Parentheses)

	2006	1998
No. of schools	68	16
n (no. of children)	2030	1031
Gender distribution male/female	980/1050	501/530
Mean age (years)	6.6 ( $\pm 0.5$ )	5
Caries prevalence primary dentition	96.8% (96.0-97.6)	94.4% (93.0-95.8)
Caries prevalence permanent dentition	36.4% (34.3-38.5)	—
Caries prevalence both dentitions	97.1% (96.4-97.8)	—
Mean dmft	8.4 ( $\pm 4.2$ )	—
Mean DMFT	0.7 ( $\pm 1.1$ )	—
Mean DMFT first molar	0.6 ( $\pm 1.0$ )	—
Mean dmfs	28.2 ( $\pm 16.8$ )	—
Mean DMFS	1.1 ( $\pm 2.5$ )	—
Mean DMFS first molar	1.0 ( $\pm 2.2$ )	—
Pufa/PUFA prevalence	85.0% (83.5-86.5)	—
Mean pufa	3.4 ( $\pm 2.6$ )	—
Mean PUFA	0.1 ( $\pm 0.5$ )	—
Prevalence of self reported problem	20.0% (18.3-21.7)	—

Abbreviations: NOHS, National Oral Health Survey; SD, standard deviation; CI, confidence interval; DMFT/dmft, decayed, missing, filled teeth; DMFS/dmfs, decayed, missing, filled surfaces; PUFA/pufa, pulpal involvement, ulceration caused by dislocated tooth fragments, fistula, and abscess; “—”, not reported in the 1998 NOHS.

### Results of the Subsample Comparing 2 WHO Survey Standards

The intraexaminer  $\kappa$  value of examiner 1 was 0.78 and that of examiner 2 was 0.85. In total, the data of 242 11- to 13-year-old children comprising 119 boys and 123 girls with a mean age  $11.2 \pm 2.1$  years were available for analysis. Caries prevalence of the subsample according to the methods used for the NOHS 1998 was 88.8% and the mean DMFT was 3.3 with a D-component of 3.2, a M-component of 0.1, and a F-component of 0 (Table 3). Caries prevalence of the same 242 children according to the methods used for the NOHS 2006 was 71.5% and the mean DMFT was 2.4 (D = 2.3, M = 0.1, F = 0).

The caries prevalence using the 2006 method was 17.3% lower than that found when the 1998 method was used. The DMFT value using the 2006 method was 27.3% lower as compared with the 1998 method with a confidence interval of 12.0% to 42.5% (Table 3).

### Discussion

The article presents the results of the NOHS in the Philippines, a representative study of 6- and 12-year-old children, using WHO Basic Methods (4th edition) and the PUFA index.<sup>2,12</sup> The survey also included a subsample of 12-year-old children to assess backward comparability between the 1998 NOHS that used the 3rd edition of the WHO Basic Methods.<sup>15</sup> Almost all 6-year-old children had caries (mean dmft 8.4), and the large majority showed dental infection (mean pufa 3.4), with one fifth reporting the presence of pain at examination. The large majority of 12-year-old children had caries (mean DMFT 2.9), whereas just more than half showed dental infection (mean PUFA 1.0); 16% reported pain at examination.

**Table 2.** Summary of Results for 12-Year-Old Children From the 2006 NOHS and Comparison With Results From 1998 (SD and CI in Parentheses)

	2006	1998
No. of schools	68	16
n (no. of children)	2022	1029
Gender distribution male/female	982/1040	467/553
Mean age (years)	11.8 ( $\pm 0.7$ )	12
Caries prevalence permanent dentition	78.4% (76.6-80.2)	91.7% (90.0-93.4)
Caries prevalence primary dentition	15.2% (13.6-16.8)	—
Caries prevalence	82.4% (80.7-84.0)	—
Mean DMFT	2.9 ( $\pm 2.9$ )	4.6
Mean DT	2.7 ( $\pm 2.9$ )	4.2
Mean MT	0.2 ( $\pm 1.0$ )	0.3
Mean FT	0	0
Mean DMFT first molar	1.6 ( $\pm 1.3$ )	—
Mean DMFS	7.7 ( $\pm 8.6$ )	—
Mean DMFS first molar	5.1 ( $\pm 5.3$ )	—
Pufa/PUFA prevalence	56% (53.8-58.2)	—
Mean pufa	0.2 ( $\pm 0.6$ )	—
Mean PUFA	1.0 ( $\pm 1.3$ )	—
Prevalence of self reported problem	16% (14.4-17.6)	—

Abbreviations: NOHS, National Oral Health Survey; SD, standard deviation; CI, confidence interval; DMFT/dmft, decayed, missing, filled teeth; DMFS/dmfs, decayed, missing, filled surfaces; PUFA/pufa, pulpal involvement, ulceration caused by dislocated tooth fragments, fistula, and abscess; “—”, not reported in the 1998 NOHS.

**Table 3.** Data of 242 Children Examined With Methods Used in NOHS 1998 and NOHS 2006 (SD and CI in Parentheses)

	Method 1998	Method 2006
n (no. of children)		242
Mean age (years)		11.2 ( $\pm 2.1$ )
Caries prevalence	88.8% (84.8-92.8)	71.5% (65.8-77.2)
Mean DMFT (SD)	3.3 ( $\pm 2.5$ )	2.4 ( $\pm 2.1$ ) <sup>a</sup>
Mean DT	3.2 ( $\pm 2.4$ )	2.3 ( $\pm 2.5$ )
Mean MT	0.1 ( $\pm 0.3$ )	0.1 ( $\pm 0.4$ )
Mean FT	0	0

Abbreviations: NOHS, National Oral Health Survey; SD, standard deviation; CI, confidence interval; DMFT/dmft, decayed, missing, filled teeth.

<sup>a</sup>27.3% difference (CI = 12.0% to 42.5%).

### Methodology and Limitations

The sampling of the survey used the “Barangay” classification of the Philippine National Statistic Office to define the rural or urban character of a Barangay (the smallest administrative unit in the Philippines). However, because of increasing urbanization, this classification in many cases defines an area as rural, which in reality has already become urbanized. Additionally, the more affluent segments of the child population attend private urban schools, which were not included in the survey. These factors could possibly explain the lack of statistical difference in DMFT between rural and urban areas.

Using the current WHO standard protocol for oral health surveys ensures a sound methodology and comparability of data.<sup>2</sup> In addition, the survey also looked at caries on the surface level (DMFS). Although this is a more complex and time-consuming procedure it provides valuable information about which surfaces/teeth exhibit the greatest caries burden. Changes in the DMFS score allow for a quick assessment of the effectiveness of previous interventions and programmes. Another aspect that has received limited attention is safeguarding calibration of examination in successive surveys. The problem of reproducibility and consistency of examination emerged from a study where a sample of 12-year-olds were examined by 9 different groups of examiners, all using the same WHO Basic Methods (1997) for dentine caries, but the mean DMFT values for that sample of 12-year-olds ranged from 2.9 to 5.1.<sup>16</sup> To address this effect, one examiner who participated in the 1998 NOHS participated in the examination of the subsample in the 2006 survey.

### *Trend Analysis: Was There a Real Decline in Dental Decay?*

New insight in the damage that may be caused by using a sharp probe for tactile assessment of caries as described in WHO Basic Methods 3rd edition (1987) has led to a modification of the methodology. In contrast to the 1998 NOHS, where a sharp probe was used for caries diagnosis, caries in the 2006 NOHS was assessed using the modified criteria of WHO Basic Methods, 4th edition (1997).<sup>2</sup> Now, a CPI probe alone is used to confirm visual evidence of caries.<sup>2,15</sup> However, the impact of differing diagnostic criteria for caries on epidemiological surveys has rarely been discussed.<sup>16-18</sup> One study estimated the extent of differences in scoring DMFT with different methods of caries diagnosis and reported a 31.8% difference in mean DMFT.<sup>18</sup>

The comparison of DMFT results for 12-year-old children from 1998 and 2006 seems to indicate a considerable decline in DMFT (from 4.6 in 1998 to 2.9 in 2006; 37% reduction). However, the examination of the subsample comparing the survey methods used in 1998 to those in 2006 (examining the same group of children) revealed that DMFT scores were 27.3% lower (confidence interval of 12.0% to 42.5%) with the method used in 2006. This is mainly because of different scoring in the D-component, whereas F- and M-components were assessed consistently with both methods. The fact that the children were examined first using the sharp probe, which has proven to cause damage and break down of enamel might be one of the reasons that lesions were penetrable with a CPI probe during second examination, which would not have been detected without prior examination with a sharp probe. That might explain why the difference in DMFT between the survey methods used in the subsample (27.3%) is lower compared with the difference in DMFT between the surveys in 1998 and 2006 (37.0%). Taking the above into account, it is equivocal whether the observed decline in caries between 1998 and 2006 is a proof of a real change of dental decay status in the child population.

### *Relevance of the New PUFA Index*

This survey was the first NOHS to use the PUFA index.<sup>12</sup> Complementing DMFT data, PUFA allows the measurement of the consequences of untreated caries and highlights the severity of the decay. PUFA goes beyond the information obtained through the Care Index by clearly indicating the worst caries-related problems. Untreated dental decay has significant impacts on children and increases the risk of low body mass index for 12-year-old children, with all physiological, psychosocial, and educational consequences.<sup>13,19</sup> From a biomedical point of view, no individual should have any PUFA score. It is thus a valuable indicator to prioritize treatment needs in populations since individuals with high PUFA burden should receive care first, usually consisting of extraction of the decayed tooth in the context of oral urgent treatment. Oral care

that does not address the PUFA burden as a priority is ethically questionable. Since 2006, other studies have confirmed the validity and usefulness of the PUFA index.<sup>20,21</sup>

### *Appropriateness of Applied Oral Health Strategies in the Philippines*

The survey results also indicated that previous approaches to improve child oral health were not successful—the absence of appropriate and effective preventive measures and the inability to provide simple oral care and pain relief were among the reasons for the high disease burden. The dental workforce of the ministry focused on mass screening and health education, which is unlikely to lead to behavior change regarding hygiene, healthy lifestyle and diet in the long term.<sup>22</sup> Referrals for treatment after school-based screening have only limited effect in high-income countries<sup>23</sup>, even more so in low- and middle-income countries, where affordable oral care for children is not available. The Care Index of zero in the surveyed child population shows this with undeniable clarity.

### *Using the National Oral Health Survey as an Advocacy Tool*

Despite the high number of epidemiological oral health surveys listed in the WHO Oral Health Country/Area Profile Programme there is virtually no literature on how survey results were used in policy and decision processes. In addition, many of the commonly used indices to measure oral health status are not understandable to a lay audience without additional explanation, which makes it difficult to use them for oral health advocacy. The results of the survey were a revelation for the DepEd, the Philippine public and international stakeholders, particularly the high PUFA scores reported.<sup>24,25</sup> As a result, the DepEd and provincial governments agreed to establish a preventive school health programme in primary schools using an innovative integrated approach to the 3 highest impact diseases of children: diarrhea, respiratory tract infections, and dental decay. This Fit for School Programme was initiated in 2008, is currently targeting more than 2.5 million children and shows promising initial results.<sup>26</sup>

### *Relevance of the Survey for National and International Public Health*

Oral health is a neglected area of international health, and inappropriately addressed in health systems of most low- and middle-income countries. This survey has mapped out the extent of the consequences resulting from this neglect: Virtually all 6-year-old children in the Philippines have caries and 85% have signs of dental infection. Treatment options for these children are nonexistent or are unaffordable. As a consequence, pain and infection continue to have a daily impact on their well-being, physical growth, and their mental and educational performance. Based on the experience with the PUFA index we recommend adding this index to the next edition of the WHO Basic Methods for Oral Health Surveys. We furthermore recommend including, wherever possible, an examiner calibrated according to the previous survey to ensure consistency and improve comparability of data collected.

Taking into account that caries risk factors are likely to grow, that more populations will be exposed to them, and that the current Philippine health care system is unable to cope with the problem, it is justified to label the caries situation of the Filipino child population as a public health crisis. Unfortunately, the situation is similar in many other countries.<sup>27,28</sup> Despite a slowly growing recognition of the problem by national governments, the ambitious intentions expressed by WHO<sup>29</sup> are not yet matched by significant tangible action and resource allocation permitting the global caries pandemic to be effectively addressed.<sup>27,30</sup>

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