Evaluation of the Status of Primary Dentition in 6–7-Year-Old Children from Białystok District Using the Mean dmf and the Index of Clinical Consequences of Untreated Caries (pufa)

Ocena stanu uzębienia mlecznego dzieci 6–7-letnich z powiatu białostockiego za pomocą liczby puw i wskaźnika następstw nieleczonej próchnicy zębów (pufa)

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Abstract

Background. An epidemiological evaluation of caries requires the use of various indices. In populations with a high prevalence of caries it is advisable to determine the level of progression of the process, including the presence of clinical consequences of caries, which is possible by using the PUFA/pufa index.

Objectives. The paper presents the results of an evaluation of the status of primary dentition in children aged between 6 and 7 years from Białystok and the surrounding area by means of the dmf and pufa indices.

Material and Methods. The survey included 332 children aged between 6 and 7 years living in the Białystok District. The presence of decayed, missing and filled (dmf) teeth was evaluated by means of a dental examination. The pufa index was used to evaluate the pulp involvement and the presence of inflammations caused by untreated dental caries.

Results. Dental caries was found in 86.1% of the sample population, and caries with clinical consequences in 41.3%. The mean dmf was slightly higher in the group of 7-year olds whereas a higher pufa index was found in 6-year-old children. A statistically significant correlation between the number of teeth with active caries and the pufa index in the sample population was proven. The presence of filled teeth was a factor reducing the risk of occurrence of clinical consequences of caries.

Conclusions. The pufa index is a useful tool in epidemiological studies. It allows evaluating the incidence and prevalence of clinical consequences of untreated dental caries. The children living in the Białystok District are characterised by a high prevalence of dental caries in primary dentition expressed in high values of the dmf and pufa indices (Dent. Med. Probl. 2013, 50, 2, 160–166).

Key words: dental caries, dmf, pufa.

Streszczenie

Wprowadzenie. Ocena epidemiologiczna próchnicy zębów wymaga zastosowania różnorodnych wskaźników. W populacjach o dużym nasileniu choroby próchnicowej jest celowe określenie stopnia zawansowania procesu, w tym obecności powikłań próchnicy zębów, co umożliwia zastosowanie wskaźnika PUFA/pufa.

Cel pracy. W pracy przedstawiono wyniki oceny stanu uzębienia mlecznego dzieci w wieku 6–7 lat z terenu Białegostoku i okolic wskaźnikami dmf i pufa.

Material i metody. Badaniem objęto 332 dzieci w wieku 6–7 lat mieszkających na terenie powiatu białostockiego. Badaniem stomatologicznym oceniono obecność zębów z próchnicą, usuniętych i wypełnionych (puw). Wskaźnikiem pufa oceniano zajęcie procesem chorobowym miazgi i obecność zębopochodnych stanów zapalnych.
Status of Primary Dentition in 6–7-Year-Old Children

In most epidemiological studies concerning dental caries, the mean DMF index in relation to whole teeth or their surfaces is used to evaluate tooth decay. This index was proposed in 1969 by the World Health Organization (WHO) in consultation with the World Dental Federation (FDI) and to the present day constitutes a basis for the calculations of the prevalence and incidence of dental caries [1–3]. The World Health Organization established the conditions which are to be met during the evaluation of the dental status. A detailed instruction containing the criteria for the evaluation of the tooth surface and an assessment form were prepared [1]. Soon it turned out that the DMF index was not sufficient to describe the full caries spectrum because it did not take into consideration the changes to the enamel without the presence of a cavity. This is why the International Caries Detection and Assessment System (ICDAS II), which divided caries into three phases in the enamel and three degrees of progression of caries cavities within the dentin, was developed [4]. It is particularly used in epidemiological studies conducted in developed countries, where the incidence of caries is low, as well as in studies on the effectiveness of prevention programmes.

Neither the DMF index nor ICDAS II nor other caries indices take into consideration the complications resulting from the lack of treatment of carious teeth [5,6]. The protocols of some epidemiological studies include the codes denoting the indications to pulp treatment and to extraction [1]; however, the information concerning detailed treatment needs have rarely been presented in the literature. In addition, teeth are classified for extraction not only because of the consequences of caries, but also after sustained injuries or for orthodontic reasons, and in adults also due to prosthetic indications [5]. The assessment of the seriousness of a disease is an important element in assessing the treatment. The presence of teeth with advanced caries and odontogenic infections in the oral cavity is a significant clinical problem and has an influence on the quality of life and the general state of health [5, 7–9]. The procedure in the case of teeth with affected pulp or periapical tissues considerably differs from the treatment of teeth with non-complicated caries, particularly in the primary dentition. As the example of the Philippines shows, the description of the dental status of a population by means of the DMF index only may lead to very wrong conclusions. As a result of a National Oral Health Survey conducted in this country in the years 2005–2006 it was found that the mean DMF in 12-year-old children was lower than 3, which meant that this country achieved the oral health goal set for the year 2000. However, it was noticed that advanced caries lesions with pulpal involvement in the same population affected up to 41% of teeth with cavities. This finding caused a radical change in the picture of oral health of Filipino 12-year-olds, and revealed the need to develop an epidemiological tool for the assessment of advanced stages of dental caries [5].

Recently, Monse et al. [5] presented a PUFA index describing the clinical consequences of untreated dental caries. The designation PUFA/pufa comes from the first letters of the names of registered pathologies in English. P/p denotes the pulp involvement, U/u – the ulceration of soft tissues, F/f refers to the presence of an odontogenic fistula, and A/a denotes an abscess. The pulpal involvement (P/p) is diagnosed when it is visible as a result of denudation due to caries or crown destruction – until it is fully destroyed and only the dental root is present. The ulceration refers to such soft tissue injuries which were caused by the presence of sharp edges of teeth with pulpal involvement. Fistula and abscess are two forms of purulent inflammations of periapical tissues. Only a visual assessment of dental status, without the use of a dental probe, is carried out. This index was developed on the pattern of the DMF index, which facilitates its use and the interpretation of data. Similar to the DMF/dmf index, capital letters denote the information concerning the permanent dentition, and small letters the primary dentition. The index values for deciduous teeth range from 0 to 20, and for permanent teeth from 0 to 32. The incidence of consequences of untreated car-
ies in a population (the percentage of individuals with the index greater than 0) and the mean PUFA index calculated as a sum of teeth with one of the assessed pathologies diagnosed are evaluated. The PUFA index finds a particular application in populations with a high incidence of dental caries. The information should be presented in combination with the results of the assessment of dentition by means of the DMF/DMF index or the ICDAS II [10]. By dividing the PUFA index by the number of teeth with active caries (P) and multiplying the obtained result by 100, the percentage of teeth with cavities that have developed as a consequence of dental caries can be calculated. So far, few publications indicating the usefulness of the PUFA index in epidemiological studies have been available [8–12].

The paper presents the results of an evaluation of the status of primary dentition in children aged between 6 and 7 years from Bialystok and the surrounding area by means of the DMF and PUFA indices.

**Material and Methods**

The study protocol was accepted by the Bioethical Committee of the Medical University of Bialystok, No. R-I-002/352/2012. The study was preceded by a calibration session on the DMF and PUFA indices consisting of two parts: theoretical (analysis of available publications) and practical examination of 10 children aged between 5 and 7 years, twice, at an interval of 1 week in conditions similar to those planned for the study.

The study, which was conducted within the period from September 2012 to January 2013, included children attending the forms 0 to 2 in five randomly chosen schools from the Bialystok District. The minimum size of a sample population was estimated at 239 individuals, assuming the number of children aged between 6 and 7 years in this area to be around 9000, and the incidence of caries of deciduous teeth at 80%; a 95% confidence interval and a 5% measuring error were assumed. The programme started by obtaining the consents from the headmasters to conduct it in the schools. In addition, written consents from the children's parents or guardians were obtained. Children who at the moment of examination attained the age of 5 years and did not reach the age of 8 years were qualified for the study. The reasons which caused the exclusion of a child from the study included: the absence at school at a given day, a clearly negative attitude of a child towards the examination, the use of permanent orthodontic appliances making the assessment of the dental status impossible. The assessment of the dentition was carried out in conditions adopted by the World Health Organization for epidemiological studies [1]. The examiner had an artificial light, a flat dental mirror and a periodontal probe ending with a ball with the diameter of 0.5 mm at her disposal. The results were entered into the assessment form. At the end of each day, a re-assessment of the oral cavity of randomly chosen children (approximately 5% of the sample population) was carried out.

For the assessment of the dental status the following diagnostic criteria were adopted [1]: a decayed tooth (d) was diagnosed when the lesions showed a clear cavity, undermined enamel was visible or soft bottom or side walls were found using the periodontal probe. Furthermore, teeth with temporary fillings and with the secondary caries were counted among those with caries. A tooth extracted as a result of caries was classified as missing (m). Since the primary dentition was assessed, the teeth which could be missing due to their physiological replacement with permanent teeth were not taken into consideration. The component (f) preferred to teeth in which the presence of one or more permanent fillings without accompanying symptoms of caries was found.

For the assessment of the dental status by means of the pufa index the following diagnostic criteria were used [5]: pulpal involvement (p) – open pulp chamber is visible or the caries process destroyed the tooth crown leaving the roots; ulceration (u) – sharp edges of a tooth with pulpal involvement caused a traumatic ulceration of surrounding, e.g. lingual or buccal mucosal, tissues; fistula (f) – the presence of an active fistula related to a tooth with pulpal involvement; and abscess (a) – in case of an oedema of soft tissues related to a tooth with pulpal involvement. Only a visual assessment, without the use of a dental probe, was carried out.

The incidence and the mean DMF and PUFA indices for the entire population and in both examined age groups were calculated. The obtained data was statistically analysed using the Mann-Whitney U Test and the Spearman's correlation test, assuming p < 0.05 as statistically significant differences. Cohen's kappa coefficient for the evaluation of the repeatability of obtained results was used.

**Results**

332 children, including 140 aged 6 years and 192 aged 7 years, average age 7 years and 1 month, participated in the survey. This group included 154 boys and 178 girls. The value of the Cohen's kappa
coefficient which was used to measure the repeatability of assessments of tooth surfaces was above 90% for both dmf and pufa indices.

Only 13.9% of the surveyed population was free from the caries of deciduous teeth, whereas 58.7% of the subjects did not have any odontogenic inflammations. The incidence of caries increased between two surveyed age groups by nearly 10%, whereas the incidence of pufa slightly decreased (Fig. 1). The mean dmf index in children aged 6–7 years was around 4.83; in the younger group it was 4.6 teeth, and among the older children it was slightly higher – 5.01. The treatment index was higher in the group of 7-year-olds than in the population of 6-year-olds, 0.51 and 0.4, respectively. Only 46% of teeth were treated in the entire surveyed population. For one examined child, on average 0.95 of a tooth with a clinical consequence of untreated caries was found, whereas the pufa index recorded in 6-year-olds (1.0) was slightly higher than in 7-year-olds (0.92). A detailed distribution of the dmf and pufa indices in the surveyed population was presented in Table 1.

A statistical analysis did not show any differences between the dmf and pufa indices depending on the age of examined children. Only the number of filled teeth (f) was significantly statistically higher in 7-year-old children (2.41) compared to the 6-year-olds (1.76). A positive correlation between the number of teeth missing and with active caries and the pufa index both in the entire surveyed population and in the particular age groups was noticed. In addition, the presence of filled teeth in the oral cavity was a factor reducing the risk of occurrence of clinical consequences of caries (Table 2).

**Discussion**

The incidence of caries in the surveyed group of 6–7-year-old children was very high – only less than one-fifth of them did not have any caries of

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**Table 1. Mean values of dmf and pufa in the sample population**

<table>
<thead>
<tr>
<th></th>
<th>6–7 years</th>
<th>6 years</th>
<th>7 years</th>
<th>P</th>
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<tbody>
<tr>
<td></td>
<td>(6–7 lat)</td>
<td>(6 lat)</td>
<td>(7 lat)</td>
<td></td>
</tr>
<tr>
<td>No. primary teeth (Liczba zębów mlecznych)</td>
<td>14.95 2.98</td>
<td>16.67 2.65</td>
<td>13.70 2.56</td>
<td>0.000</td>
</tr>
<tr>
<td>p/d</td>
<td>2.45 2.74</td>
<td>2.68 3.04</td>
<td>2.29 2.50</td>
<td>0.650</td>
</tr>
<tr>
<td>u/m</td>
<td>0.25 0.63</td>
<td>0.16 0.53</td>
<td>0.31 0.69</td>
<td>0.104</td>
</tr>
<tr>
<td>w/f</td>
<td>2.13 2.23</td>
<td>1.76 2.11</td>
<td>2.41 2.29</td>
<td>0.007</td>
</tr>
<tr>
<td>puw/dmf</td>
<td>4.83 3.13</td>
<td>4.60 3.49</td>
<td>5.01 2.83</td>
<td>0.160</td>
</tr>
<tr>
<td>p</td>
<td>0.87 1.44</td>
<td>0.85 1.48</td>
<td>0.89 1.43</td>
<td>0.772</td>
</tr>
<tr>
<td>u</td>
<td>0.01 0.1</td>
<td>0.02 0.15</td>
<td>0.01 0.07</td>
<td>0.801</td>
</tr>
<tr>
<td>f</td>
<td>0.05 0.32</td>
<td>0.12 0.47</td>
<td>0.01 0.10</td>
<td>0.240</td>
</tr>
<tr>
<td>a</td>
<td>0.01 1.51</td>
<td>0.01 0.08</td>
<td>0.01 0.10</td>
<td>0.959</td>
</tr>
<tr>
<td>pufa</td>
<td>0.95 1.51</td>
<td>1.00 1.61</td>
<td>0.92 1.44</td>
<td>0.955</td>
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</table>
deciduous teeth. This status considerably differs from the recommendations of the World Health Organization. According to the global oral health goals announced by the WHO, by 2000 the incidence of caries in 5-6-year-olds should have been reduced to 50%, and in 2010 even 90% of children in this age were supposed to be free from caries [13]. The prevalence of caries was similarly high because nearly 5 carious teeth fell to one child; the recorded annual increase of caries between 6- and 7-year-olds was 0.4 of a tooth. Even though a favourable, statistically proven tendency consisting in an increase with age of the number of teeth with permanent fillings was recorded, it should not be forgotten that even in 7-year-old children only a half of deciduous teeth with caries was filled. In Poland, the treatment of deciduous teeth is quite commonly neglected, and the treatment index rarely exceeds 30% [14, 15]. This is different from the situation in developed countries where the percentage of treatment of deciduous teeth reaches even 84% [16]. Untreated caries remain without symptoms until the moment of replacement with a permanent tooth [16–18]. The obtained data have clearly shown that the neglect to treat caries increases the risk of its clinical consequences.

The value of the pufa index for one examined child was 0.95 of a tooth, whereas the teeth with pulp involvement (p) were most frequently diagnosed, 0.87 of a tooth on average. A slightly higher pufa index in six-year-old children could have been influenced by diagnosing the pufa codes in deciduous front teeth which were no longer present in 7-year-olds due to their replacement with permanent teeth. The pufa index was already evaluated in the Podlasie region in 2011 in the population of children aged 5 and 7 years [12]. For the entire sample population it was evaluated then to be 2.33, and the 7-year-olds had a pufa index over 2.5 times higher than in the present study. That population was also characterised by other worse caries indices – the percentage of caries-free children found then was only 9.3% and the mean dmf index as high as 6.17. The differences probably arise from the sample selection. In 2012, the sample group was selected in the area of a big city and surrounding districts whereas in 2011 the subjects came from a small town and villages remote from big urban areas. The living environment and the education are important determinants of the oral health status. A worse state of dentition of individuals from rural areas was found many times in various epidemiological studies [19–22].

Little data on the subject of the incidence and prevalence of clinical consequences of untreated caries in children is available in the literature. So far, apart from Poland, the research studies were conducted only in the Philippines and in Brazil [5, 7–11]. Both research teams positively evaluated the possibility of using the pufa index in epidemiological studies. Six-year-old Filipino chil-

![Table 2. Correlation between mean dmf and pufa in the sample population](image)

<table>
<thead>
<tr>
<th></th>
<th>6–7 years (6–7 lat)</th>
<th>6 years (6 lat)</th>
<th>7 years (7 lat)</th>
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<tbody>
<tr>
<td></td>
<td>R</td>
<td>p</td>
<td>R</td>
</tr>
<tr>
<td>puw v pufa</td>
<td>0.555</td>
<td>0.00</td>
<td>0.681</td>
</tr>
<tr>
<td>dmf v pufa</td>
<td>0.741</td>
<td>0.00</td>
<td>0.760</td>
</tr>
<tr>
<td>p v pufa</td>
<td>0.201</td>
<td>0.00</td>
<td>0.191</td>
</tr>
<tr>
<td>d v pufa</td>
<td>–0.111</td>
<td>0.0416</td>
<td>–0.009</td>
</tr>
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</table>
dren had very high caries indices in the primary teeth, the incidence of dmf in them was 97%, and of pufa 84%. Also mean dmf (8.4) and pufa (3.4) indices considerably exceeded those obtained in Poland [5]. In the case of Brazilian children aged 6–7 years, the occurrence of various clinical consequences of untreated caries was found in less than one-fourth of the subjects [8, 10]. According to Figueiro et al. [10], the mean pufa value in this age group was 0.4 of a tooth, and the main component was the pulpal involvement (p) = 0.3 of a tooth on average. Also, conducted studies confirmed the correlation between the occurrence of teeth with pufa > 0 in children with oral pain episodes, a low BMI and a decreased quality of life [7, 8, 10, 11].

The pufa index records the presence of odontogenic inflations in the oral cavity (f and a codes), which has been rarely presented in the literature. Naturally, when using the pufa index, a certain underestimation of the periapical inflammations in view of the episodic nature of abscesses, the possibility of a sporadic fistula closing and the lack of radiological evaluation is to be taken into account [8]. In all available publications, however, the pufa index was primarily influenced by the number of teeth with pulpal involvement, so a slight underestimation of the f and a components should not make a big difference. Pine et al. [9] found in 5-year-old children from Scotland the occurrence of oral sepsis of periapical tissues at a similar level (4.8%), whereas this percentage varied between 2 and 11% depending on the socioeconomic status of the subjects. They found the mean dmf index in children with an odontogenic infection to be 6.3 teeth, compared to 2.36 in those with *caries simplex*. A particularly big difference concerned the teeth with active caries which were 3 times more frequent in children with a co-existing periapical tissue infection. Furthermore, it was noticed that the number of extracted teeth was higher in children without periapical periodontal symptoms. In the present study, however, a positive correlation between the number of extracted teeth and the prevalence of the pufa index was found. Also Figueiredo et al. [10] noticed that in children which prematurely lost primary teeth the risk of development of complicated caries increased several times.

When analysing data concerning the treatment of deciduous teeth in northern England, Levine et al. [17] assessed the incidence of occurrence of complicated caries to be 23.4% of examined teeth, and the percentage of extracted teeth was 23%. According to the "Oral Health Surveillance, Poland 2008" [20], 33.8% of six-year-olds from the Podlaskie Province had teeth requiring pulp treatment, and in 35.3% the presence of teeth classified for extraction was found. These percentages were among the highest in Poland. On the other hand, according to the data from 2010 such needs were found in 18.9% and 59.4%, respectively, of surveyed six-year-olds, which proved that the population covered by the study had caries at a very advanced stage [21]. The treatment needs arising from the presence of teeth with advanced caries in children from Bialystok were also evaluated by Milewska and Łuczaj-Cepowicz [23]. They found that to one 6-year-old child fell on average 2.85 teeth classified for restorative treatment, 0.87 with the indication for endodontic treatment, and 0.93 of a tooth was diagnosed for extraction. The authors used a thermal test and an electronic appliance for testing the pulp sensitivity so that the assessment of the pulpal status carried out by them was very reliable. However, it should be noted that it is not possible to use such devices in big population research studies conducted outside a dental office.

A disadvantage of the pufa index which makes it impossible to refer to the data discussed above is the lack of differentiation between the teeth classified for pulpal treatment and those which should be extracted due to an extensive destruction of the tooth crown. Both clinical situations are diagnosed with the pulpal involvement (p) code. In order to apply the pufa index in the assessment of treatment needs, a separate code for the teeth diagnosed for extraction due to extensive crown destruction would have to be established. On the other hand, Frencken et al. [6] raised the issue whether it was justified to include the diagnosis of "ulceration" (u) in the index of clinical consequences of dental caries (pufa) as it was quite rarely found in surveyed children, which has been also confirmed in the present study. Also they suggested joining the codes related to the presence of a fistula (f) and an abscess (a) because they were only different clinical manifestations of the same disease entity. It is a natural situation that newly developed epidemiological tools are evaluated in respect of the practical application and gradually evolve until they obtain a wide consensus among the researchers.

To sum up, it should be stated that the PUFA/pufa index is a simple and easily applicable epidemiological tool which allows to evaluate the incidence and prevalence of clinical consequences of untreated dental caries. The data obtained in the Bialystok District as well as in other areas of the Podlaskie Province have indicated a high prevalence of clinical consequences of untreated caries in the primary dentition. Taking into consideration a possible negative impact of inflammations on the child’s organism, intensive measures leading to the decrease of the pufa index in this area should be taken.
References


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Received: 7.03.2013
Revised: 28.03.2013
Accepted: 29.04.2013

Praca wpłynęła do Redakcji: 7.03.2013 r.
Po recenzji: 28.03.2013 r.
Zaakceptowano do druku: 29.04.2013 r.