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Introducing a Specific Term to Present Caries Experience in Populations with Low Caries Prevalence: Specific Affected Caries Index (SaC)

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Abstract
Up to now, indices like the mean dmft/DMFT and the SiC (Significant Caries Index) have been used to depict caries experience in populations with high prevalence. With the caries decline, particularly for populations with low caries levels, these indices reach their statistical limits. This paper aims to introduce a specific term, the Specific affected Caries Index (SaC) for the risk groups in populations with low caries prevalence and to illustrate its use based on the consecutive German National Oral Health Survey (GNOHS) in children. In groups with a caries prevalence less than one-third of the population, many caries-free children (DMFT = 0) are included in the SiC (risk group), which calls for a new way of illustration. Mean caries experience (DMFT), caries prevalence, the SiC and SaC were portrayed for 12-year-olds in the GNOHS from 1994/95 to 2016. The SaC describes the mean caries experience (DMFT) in the group presenting caries experience (DMFT >0). In 12-year-old 6th graders in Germany, the mean caries experience decreased from 2.4 (1994/95) to 0.4 DMFT (2016), with a recent prevalence of 21.2% (DMFT > 0, 2016). In 2016, the mean number of affected teeth in children with DMFT >0 (SaC) was 2.1, while the SiC including 12% DMFT-free children in the risk group was 1.3. The SiC fails to reflect the caries severity in children in a population with low caries prevalence. Therefore, the newly introduced term Specific affected Caries Index (SaC) may be used to describe accurately caries experience in caries risk children in populations presenting low caries prevalence.

Introduction

Following the international trend, a substantial decline in caries experience in children and adolescents has also been observed in Germany. Data from the last national surveys [DAJ, 2010; IDZ, 2016; Team DAJ, 2017] showed an important reduction in the D_3MFT values with a significant increase in caries-free children in 6-, 7-, 9-, 12-, and 15-year-olds. However, with the caries decline, the mean caries experience of a population (e.g., DMFT) does not depict the correct situation of dental health of the entire population any longer, as there is no normal distribution in the caries experience anymore.

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Table 1. Definitions of caries indices and their calculation

Index	Term of the index	Calculation
DMFT	Mean caries experience [Klein et al., 1938]	Mean DMFT in the entire population
SiC	Significant Caries Index [Bratthall, 2000]	Mean DMFT in the third of the population with highest DMFT scores
SaC	Specific affected Caries Index	Mean DMFT in the group of individuals with DMFT >0 or if caries prevalence and mean DMFT are known: (100%/caries prevalence) × mean DMFT

In case of a caries prevalence of 100%, the mean DMFT corresponds to the SaC. In case of a prevalence of caries in 1/3 of the population (~33.3%), the SiC corresponds to the SaC.

Table 2. Caries data calculated based on the German National Oral Health Surveys from 1994 to 2016

Examination year	Mean DMFT	SiC_{DMFT}	SaC_{DMFT}	Caries prevalence, %
1994/95	2.44	5.33	3.49	69.9
1997	1.75	4.46	2.86	61.3
2000	1.21	3.43	2.54	47.6
2004	0.98	2.87	2.42	40.4
2009	0.72	2.16	2.30	31.3
2016	0.44	1.32	2.09	21.2

Data source: Team DAJ [2017]. SiC, Significant Caries Index; SaC, Specific affected Caries Index.

In addition to the mean dmft/DMFT [WHO, 1997], the Significant Caries Index (SiC) was introduced [Bratthall, 2000] to focus attention on individuals with the highest caries experience within in a population with a skewed distribution of dental caries. To calculate the SiC, the mean caries scores of the highest affected subgroup (third of the population with the highest caries levels) is selected, which still reflects a large group within a population that has markedly elevated caries levels. Nonetheless, the SiC is only appropriate when at least one-third of children exhibit a DMFT >0; otherwise caries-free children would be included in the "risk group." More so, the WHO describes a mean value of 1 DMFT as a goal in oral health for the year 2020. This creates the problematic situation of calculating a "mean" value for data with non-normal distribution and including a considerable number of DMFT-free children in a so-called risk group. It is recognised that resources intended for caries control are limited; therefore, populations having higher caries levels should accurately be identified and targeted by oral health strategies. Thus, in order to analyse the remaining pockets and problems of the persisting caries prevalence, this study aims to introduce a specific term, depicting a mathematically more precise calculation of caries data using the Specific affected Caries Index (SaC), which may be used for populations presenting low prevalence like the 12-year-olds in Germany. In addition, its use is demonstrated based on the consecutive German National Oral Health Survey (GNOHS) in children.

Material and Methods

The data for this study were based on recorded figures from the results of the German National Oral Health Surveys (GNOHS) [DAJ, 2010, Team DAJ, 2017], which have been performed since 1994 and take place about every 3–5 years, examining nationally representative samples of children among different age groups (6-, 7-, 9-, 12-, and 15-year-olds).

For the purpose of the present study, traditionally utilised caries indexes (DMFT and SiC; are presented together with the introduced term Specific affected Caries Index (SaC) using the data concerning 12-year-olds taking part in the GNOHS. Indexes used in this study as well as caries data calculations are presented in Table 1. Figure 1 shows the current [Team DAJ, 2017] skewed caries distribution in this specific age group according to absolute numbers of children (non-weighted), and Figure 2 presents the caries development in 12-year-olds in Germany from 1994 to 2016. Data analyses were performed using Microsoft Excel 2010.

Results

In 12-year-old 6th graders, the caries prevalence (DMFT >0) decreased from 69.9 to 21.2% from 1994 to 2016 (Table 2) and resulted in a skewed distribution of the DMFT (Fig. 1). The mean caries experience declined

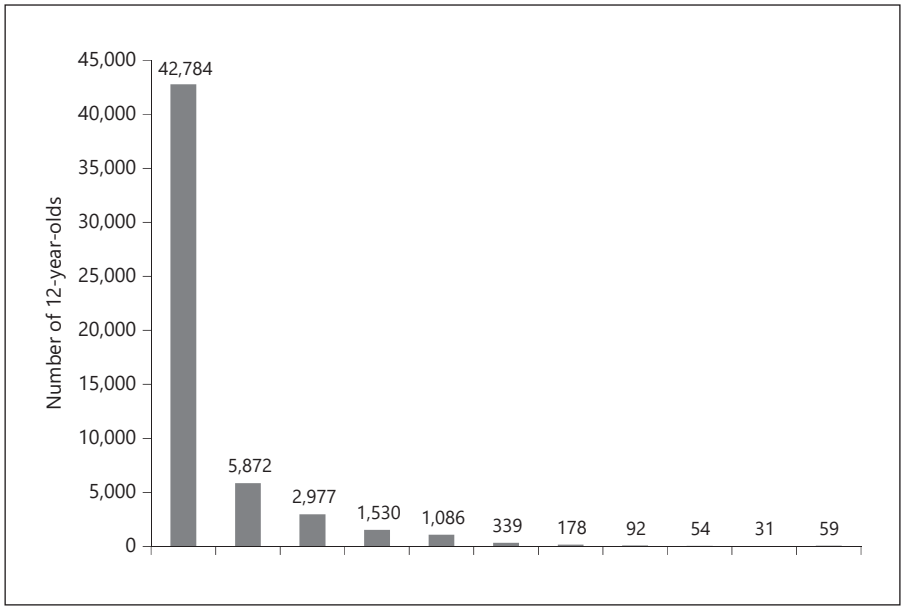
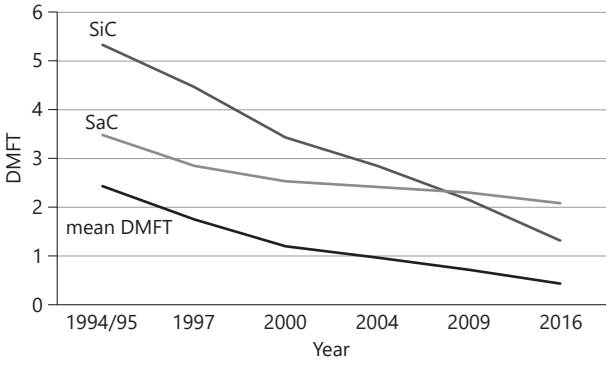


Fig. 1. Skewed distribution of caries (DMFT) in 12-year-old 6th graders in 2016 in Germany (n = 55,002). In 42,784 children, a DMFT = 0 was recorded, and these children therefore had caries-free permanent dentitions on a defect level (77.8%) according to the WHO. Modified from Team DAJ [2017].

from 2.4 (1994/95) to 0.4 DMFT [2016], while the SiC declined from 3.5 to 1.3 DMFT. In 2009, the SiC group (33.3%) mirrored almost exactly the 31.3% group with a DMFT >0. Until 2016, the SiC shows a continuous marked decline to 1.3 DMFT due to the inclusion of 12% caries-free children on the DMFT level which can hardly be called risk individuals. The mean number of affected teeth in children with DMFT >0 introduced here with the term Specific affected Caries Index (SaC) characterises continuously children with caries experience, and it shows the smallest decline, but still a considerable improvement, from 3.5 in 1994 to 2.1 DMFT in 2016. It runs almost parallel to the decreasing mean DMFT in the whole group, indicating a proportional caries decline in the whole population and children with caries. The SiC crosses the line of the SaC, per definition when caries prevalence is 33.3% (one-third; Table 1), which was roughly in the year 2009 (Fig. 2), as the caries risk group changes its proportion to the caries-affected children continuously.



Year	mean DMFT	SiC	SaC	% DMFT>0
1994/95	2.44	5.33	3.49	69.90%
1997	1.75	4.46	2.86	61.30%
2000	1.21	3.43	2.54	47.60%
2004	0.98	2.86	2.42	40.40%
2009	0.72	2.16	2.3	31.30%
2016	0.44	1.32	2.09	21.20%

Fig. 2. Caries trends depicted by the development of the mean caries experience (DMFT), Significant Caries Index (SiC_{DMFT}), and the Specific affected Caries Index (SaC_{DMFT}) for 12-year-old 6th graders from 1994 to 2016 in Germany. Based on data from Team DAJ [2017]. Caries prevalence for the whole of Germany was weighted according to the different sizes of the federal states due to different sampling procedures and sizes of the federal states resulting in 78.8% caries-free dentitions (DMFT = 0).

Discussion

With the new epidemiological situation of low caries prevalence with a mean caries experience of about 1 dmft/DMFT or even less in some populations, e.g. in 3-, 6-, or 12-year-olds in Germany [Team DAJ, 2017], Scandinavian countries [Oral Health Database, 2018], and e.g.

5-year-olds in England [DPHEP, 2015], the need for a more accurate but still simple way of presenting caries data especially for risk groups is evident. The success of caries decline in Germany affects almost the entire population, as the mean DMFT has decreased by about 80% from 1994 to 2016. Similarly, the SiC has decreased by about 75% in the same time frame. In populations with lower caries prevalence (<1/3 of population with dmft/DMFT >0, mean dmft/DMFT <1), the reporting of the caries experience and distribution has to include also markers of the relatively small caries risk group (SaC) in order to target further preventive efforts and monitor their effectiveness adequately. The caries decline coincides with an increase in caries-free children, and a reduction of individuals with very high caries scores. The fixed 33.3% caries risk group used for the SiC cannot adapt to these changes, while the SaC always gives information on what to expect as mean value in caries-affected children. More so, it can be calculated easily from the caries prevalence (%) and the mean caries experience (dmft or DMFT) of the population without the knowledge of the exact distribution of dmft/DMFT.

The introduction of the International Caries Detection and Assessment System (ICDAS), which includes the assessment of initial carious lesions, does not solve this problem as its full scale requires a clinical setting with properly cleaned teeth, good lighting, and vision conditions, which are not feasible for most epidemiological studies. In order to portray the caries prevalence at the initial level, the GNOHS included the assessment of initial lesions (non-cavitated and microcavitated) together with the dmft/DMFT values, which summarises the standard and the additional number of initial caries lesions (idmft/IDMFT).

The central point of this paper is also relevant for the reporting of caries in the primary dentition (dmft) as, e.g., in Denmark [Poulsen and Malling-Pedersen, 2002] and other Scandinavian countries or England [DPHEP, 2015], e.g. 3- or 5-year-olds have caries prevalence clearly lower than 33.3%. The GNOHS detects a prevalence of caries according to the WHO-criteria of 13.7% in 3-year-olds with a mean dmft of 0.5 [Team DAJ, 2017]. Therefore, the SaC is computed to be 3.6 dmft [(100/13.7) × 0.5 dmft]. Besides the easy calculation, the SaC mirrors what to expect on average in a child with carious defects. Though in all the above-mentioned populations, a fraction of about 80% caries-free individuals on a defect level is a considerable success, the remaining mean caries experience of about 0.5–1 dmft is grossly misleading. The individuals with caries experience present a mean caries score of >3 affected teeth (SaC). Similarly, average caries experience in children with dmft >0 has been presented before, e.g. in 5-year-olds in England (about 3.4 dmft – SaC), where caries prevalence is about 25%. Mean caries experience was reported to be 0.8 dmft in that population [DPHEP, 2015]. This shows that the need for such a specific way to present caries experience in risk groups in populations with low caries prevalence has been recognised and a specific term relating to the SiC would therefore be advisable.

Comparably to other countries, caries decline in Germany has left pockets of persisting caries prevalence. The introduced term Specific affected Caries Index (SaC) can be used to describe in a simple but mainly more accurate way the mean caries experience in the caries risk groups within populations of low caries prevalence.

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Statement of Ethics

For primary data extraction a favourable ethical vote was obtained from the Research Ethics Committee of the University of Greifswald under the protocol number BB 48/10a.

Disclosure Statement

The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

Author Contributions

Conception and study design: J.S., R.M.S., E.S., R.B., C.H.S.; data analysis: J.S., R.B.; writing of the paper: J.S., R.M.S., C.H.S.; review of the paper: E.S., R.B.

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