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Dental Caries Prevalence and Incidence in Pediatric Dentistry

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Dear Editor,

The World Health Organization (WHO) determines dental caries in two different ways (1). The official determination has been specified by the International Statistical Classification of Diseases and Other Health Related Problems (ICD) (2) and the other one is an epidemiological determination presented by Oral Health Surveys (3). Another problem arises from the fact that dental caries affects both permanent and primary teeth and occurs simultaneously during the period of mixed dentition before and during elementary school years. Indeed dental caries is the same disease in both primary and permanent teeth. Nonetheless, the scientific attitude that caries is primarily an infectious disease and that the host has only a minor role prevails in analyzing the carious process. The terms involved in dental caries include caries activity when referring to the presence and virulence of cariogenic infection and caries susceptibility when speaking about the host resistance covering primary and permanent teeth as well as saliva. Caries occurs in subjects who have an imbalance between favorable caries-causing activity and unfavorable susceptibility resulting in a diseased subject. This means that caries normally affect younger patients and in the elderly they occur in the form of root caries on the tooth's cementum. A similar imbalance also exists in osteoporotic-penic subjects where the diagnostic outcome and disease consists of bone fractures. Thus, carious lesions in the dentition of carious subjects can be treated as either a diagnostic outcome or a symptom.

Unknown Prevalence of Dental Caries

In medical epidemiology, disease prevalence may be defined as the proportion of a population that has a disease at a specific point in time and lifetime prevalence as the proportion of the population that has had the disease at some time during their lives (4). Therefore, dental index values should represent present and past caries at the same time, meaning lifelong prevalence (5). This is not the case for dental epidemiology.

Past caries is not a present disease because the treatment has removed the carious lesion and dental fillings are not "diseases" and they may also represent restorations as a result of fractures. The missing teeth category in the ICD may, and often does include other diseases besides "extractions due to caries" only (6).

Although many distinguished organizations believe otherwise there are no solid scientific reports covering caries prevalence especially in children and adolescents (1). The reasons for this are that WHO determines caries as a disease in two different ways, officially in the ICD (2) and epidemiologically in the Oral Health Surveys (3), and that caries extracted teeth and restored teeth are equal in dental indices (1). Regarding epidemiology a subject-specific approach is always the accepted practice. This means that a patient has one or multiple diseases, while the rest of the population is healthy. In statistical analyses, diseased or healthy subjects determine the number of cases (N) and the prevalence of disease in that population.

Regarding dental epidemiology however, this principle has not been followed, and consequently certain incidences are based on the mean number of carious teeth. In addition, there is also a tooth-specific approach where each tooth is either diseased (carious, missing because of caries, or filled) or healthy with the number of teeth equaling N. This is certainly misleading because for example restored or missing teeth are not necessarily "past-carious" teeth (6) and because both states may additionally result from tooth fractures. Therefore, the decayed, missing and filled teeth index (DMF) or primary teeth DMF-index gives no information on caries prevalence.

The comparison of caries prevalence with the prevalence of other diseases is difficult because caries epidemiology does not normally determine caries prevalence

or incidence values but utilizes certain index values originally meant for treatment purposes (7).

Dental incidences were previously regarded as information on caries prevalence or else lifelong prevalence. When it became apparent that these index values had nothing to do with actual caries prevalence the term was changed in the dental literature to the present caries experience.

Information of Dental Incidences

The tooth-specific mean DMF-index values are used to describe present caries (D = decayed) or past caries (M = missing and F = filled) in the dentition (3) but this index was originally intended for the assessment of treatment needs in elementary school children (7). The use of mean dental index values (of DMF) has resulted in a quantification of caries seriousness that is not congruent with current epidemiological practices. A subject is either healthy or has a disease regardless of its severity, which is always another disease in the ICD such as dental caries in enamel (only) (K02.0) or (extending into) dentin (K02.1).

Another example covers the areas above the dentition, the eyes. Over and beyond mythological references (most cover "eyes and teeth") blindness may concern both eyes and is classified in the ICD as "blindness binocular" (H 54.0) while blindness of only one eye is classified as "blindness monocular" (H54.4) with completely different impairment and seriousness. In fact monocular blindness equals a completely edentulous state.

This Practice has Resulted in Another Discrepancy in Dental Epidemiology

This practice has resulted in another discrepancy in dental epidemiology, which is the determination of the prevalence of healthiness in terms of a DMF value of zero. For example, the oral health report by the National Health and Nutrition Examination Survey (NHANES) determines "carious" patients as males or females with at least one tooth with dental decay with the target age being 5 – 150 years (8). The presence of at least one tooth with a dental restoration or dental sealant serves as an indicator of past caries represented by fillings. The presence of dental sealants represents caries prevention (8).

The recently launched T-Health index goes even further in the quantification of caries (9). It weights decayed missing filled or sound teeth by different numbers. However, the quantification of a disease in a patient does not follow the principles of ICD.

As a disease, blindness in one eye is different from blindness in both eyes, whereas caries on one or multiple primary or permanent teeth leads to one single carious patient. The NHANES counts the presence of one tooth with "dental decay", which is not consistent with the ICD where dental caries is the name of the disease, not a decay with different degrees, and the disease covers the enamel, dentin, cementum etc.

Misinformation in Dental Indices

Diagnosis of dental caries especially in the case of enamel lesions on different tooth surfaces is always uncertain or else "highly subjective" depending on the dentist. In the past when caries progression was believed to be inevitable, subjective diagnoses turned into objective facts when enamel lesions were restored. This resulted in subjective observations turning into objective restorations when the caries cavity was filled.

Finland for example excluded enamel lesions from the DMF-index values in 1982, resulting in a decline in caries experience, which is globally reported as "declining caries prevalence". In fact, nobody knows what the proportion of this decline is since enamel lesions were excluded all over the world. Up to the 1970s, all enamel lesions were restored in most countries but the practice became outdated in the 1980s and was replaced by remineralizing treatment.

In short before 1970, a good dentist restored all initial lesions in enamel whereas after 1980, a good dentist was 'blind' to such lesions and allowed saliva to heal the carious lesions in enamel.

Caries Incidence

Incidence times of any disease including dental caries are the times at which new diseases occur among members of a population. Incidence rates measure new disease per person and incidence proportion measures the proportion of people who develop a new disease during a specified period of time (4). Therefore, incidence variation during the development of dentition should be carefully determined.

Larmas (10) wrote in the leading dental journal a decade ago that "when the focus of dental caries research is widened from lesion formation to pulpal responses, the following hypotheses can be presented (i), dentin caries occurring during primary dentin genesis is different from that occurring during secondary and/or tertiary dentin genesis. (ii) During primary dentin genesis caries progression is rapid but it slows as soon as secondary dentin genesis is involved and may discontinue almost completely when tertiary (reparative) dentin genesis is active".

The rate of caries progression leading to different caries incidence values when the process reaches dentin (and the dentist makes a filling) has also been analyzed. Carlos and Gittelsohn (11) estimated the risk of tooth failure due to caries separately for each tooth as a function of tooth age, using life-table methods in several longitudinal cohorts. They reported maximum caries risk at about two years after tooth emergence in the second permanent molars and one or two years later in all other teeth including the mandibular incisors. Data from the United States during the 1940s and 1950s show caries during primary dentinogenesis to be very rapid in every tooth.

The first carious attack into dentin was even faster in molar teeth according to data from Finland from the 1960s and 1980s (12). A survival model and Bayesian in-

ferential methods were used in statistical analysis and showed that the risk in molar teeth was highest immediately after emergence, in cohorts performed during the 1960s and 1970s, while in the 1980s the risks of individual teeth were so low that no such dependencies on tooth age could be established (12).

Carlos and Gittelsohn (11) excluded all permanent teeth that had erupted before the first examination of their trial. Therefore, their results with regard to molar teeth were biased. Still both of their earlier observations and more recent ones (12) suggest that the caries rate during primary dentin genesis has declined from the 1940s to the present. The latest tooth-specific analysis covering longitudinal analysis of over 36 500 patient-records was published last year (13).

Larmas also conducted an in vitro experiment by dropping lactic acid at pH 4.5 on the occlusal 'window' of an extracted molar, which had been washed with water every morning and every night during the workweek (10). He reported that, “no lesion formation was seen after three years; only slight decalcification of enamel. Caries did not progress in enamel when the “dead” tooth was located outside the oral cavity although the acid attack was constant and lasted for more than three consecutive years with no salivary defense systems being available”.

Because caries in primary teeth will predict caries in permanent teeth, and because caries treatment by drilling of primary teeth is associated with numerous problems owing to the fear of the child, and also the shortage of dentists, the situation results in a vicious cycle in the sense that open (untreated) carious lesions in the oral cavity result in an increase in caries activity. This will increase caries activity and virulence factors in some patients but without any further information on the intraoral distribution of open lesions or caries incidence.

Dental Epidemiology

As early as 1971, Dr. David E. Barmes, back then at WHO, introduced the Oral Health Surveys Basic Methods (3), a widely used piece of work whose 4th edition was published in 1997. He also established the Global Oral Data Bank (GODB) presently known as the Oral Health Database (14) in 1969 and introduced the ICP Index. Unfortunately all of these achievements by Dr. Barmes further distanced dental epidemiology from medical epidemiology as described above.

This does not mean that we are underestimating Dr. Barmes’s role as a dental epidemiologist. We fully agree that at the international level he took oral health out of obscurity, placed prevention at the forefront of global goals and made these goals an integral part of the “Health for All” movement. However, fortunately he also initiated the development of the “official” dental International Classification of Diseases to Dentistry and Stomatology (ICD-DA) (15), classification paving the way for dental epidemiology to return to its medical counterpart, i.e. to the present goal of NIDCR (National Institute and Dental and Cranifacial Research) (16).

The action plan and the resolution on oral health that Dr. Barmes elaborated decades ago are a tribute to the high status that oral health now holds on the development agenda.

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