Journal of Dentistry xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Dentistry

journal homepage: www.elsevier.com/locate/jdent

Root caries experience in Germany 1997 to 2014: Analysis of trends and identification of risk factors

Falk Schwendicke[a,*], Joachim Krois[a], Ulrich Schiffner[b], Wolfgang Micheelis[c], Rainer A. Jordan[c]

[a] Department of Operative and Preventive Dentistry, Charité–Universitätsmedizin Berlin, Germany
[b] Department of Restorative and Preventive Dentistry, University Medical Center Hamburg, Germany
[c] Institute of German Dentists (IDZ), Cologne, Germany

ARTICLE INFO

Keywords:
Caries
Cross-sectional study
Epidemiology
Elderly
Gerodontology
Health services research

ABSTRACT

Introduction: We assessed time trends in root caries experience, i.e. the sum of filled and carious root surfaces (FRS, CRS), and evaluated risk indicators of FRS/CRS in Germany.
Methods: FRS and CRS from repeated waves (1997, 2005, 2014) of the nationally-representative German Oral Health Studies were analyzed in 35–44- and 65-74-year-olds (adults/younger seniors; n = 4388). Weighted means were interpolated cross-sectionally across age groups by fitting piecewise-cubic spline-curves, and population-level FRS and CRS calculated. We also projected population-level FRS and CRS to 2030. To evaluate risk indicators of FRS and CRS, zero-inflated negative-binomial regression was applied.
Results: In adults FRS increased from 1997 to 2005 at individual and population level (from a mean of 0.49 to 0.63 surfaces; from a total of 6.2 to 8.7 million surfaces) and then decreased to 2014 (to 0.16 surfaces/1.6 million surfaces). CRS constantly increased (1997: 0.37 surfaces/4.7 million surfaces; 2014: 0.94 surfaces/9.3 million). In younger seniors, FRS increased from 1997 to 2005 (from 0.67 to 1.92 surfaces; 5.0 to 17.5 million surfaces) and then decreased to 2014 (0.89 surfaces/7.5 million surfaces). CRS constantly increased (1997: 0.39 surfaces/2.9 million surfaces; 2014: 1.43 surfaces/12.1 million surfaces). Driven by demographic changes until 2030, population-level FRS and CRS is likely to increase in younger seniors, but not adults. Sex, toothbrushing behavior, age, coronal caries experience and the number of teeth with probing-pocket-depths ≥ 4 mm were associated with FRS and CRS.
Conclusions: While FRS does not show a clear trend, CRS has constantly increased since 1997. Concepts for preventing and managing CRS in Germany are needed.
Clinical significance: Evaluating time trends and assessing risk indicators of root caries experience is helpful to understand morbidity dynamics, plan resource allocation and identify individuals/groups at risk. While FRS shows no clear trend, CRS has increased since 1997 in Germany. Concepts for addressing the emanating treatment needs are needed.

1. Introduction

In many industrialized countries and most age groups, the prevalence and experience of coronal caries lesions has been decreasing in the last decades [1]. Consequently, the number of coronal restorations and missing teeth decreases. For example, in Germany, the number of filled teeth has declined dramatically over the last 20 years and will decline further in the future in all but the very old. Tooth loss has decreased by two-thirds since 1997, and is expected to decrease even further [2]. Hence, more teeth are retained lifelong, paired with an increasing lifespan of the individual [3,4].

These retained teeth are at risk for periodontal disease. For example, in Germany, periodontal treatment needs have increased in the elderly since 1997, and by 2030, the average senior is expected to show 12 teeth with probing pocket depths (PPDs) ≥ 4 mm [5]. Periodontally affected teeth often show exposed root surfaces; these are, in turn, prone for root caries lesions, especially in elderly with impaired dexterity and oral hygiene, and reduced salivary flow [6,7]. Generally, gingival recession and the resulting root exposure are risk factors for root caries [1].

Treating root caries lesions and re-treating existing root surface restorations is challenging due to difficulties in moisture control,

* Corresponding author at: Charité–Universitätsmedizin Berlin, Department for Operative and Preventive Dentistry, Aßmannshauser Str. 4-6, 14197 Berlin, Germany.
E-mail address: falk.schwendicke@charite.de (F. Schwendicke).

https://doi.org/10.1016/j.jdent.2018.08.013
Received 16 June 2018; Received in revised form 24 August 2018; Accepted 26 August 2018

suboptimal conditions for adhesive placement (with dentin being the sole adhesive substrate), and a lack of retention in often saucer-shaped root cavities with limited access (at least proximally), resulting in poor survival of root surface restorations [8–10]. These poor survival rates apply to a range of materials which can be used for this indication; composites, resin-modified and conventional glass ionomers all show high risk of failure in root surface lesions. So far, the evidence to support one specific material is not given; however, in contrast to most coronal restorations in permanent teeth, composites do not seem to necessarily perform better than glass ionomer cements [11]. Hence, to avoid needing to place any root restoration at all, individuals at risk for root caries should be identified early on for targeted prevention and to arrest initial lesions [12].

The present study determined trends in root caries experience from 1997 to 2014 in Germany based on three waves of the German Oral Health Studies (Deutsche Mundgesundheitsstudien, DMS), which are nationally representative investigations. Our analyses also consider the demographic changes occurring, as these decisively impact on the population-level burden and emanating treatment needs. In an auxiliary analysis, and assuming individual root caries experience to remain constant from 2014 onwards, we also projected the population-level of root caries experience to 2030. We further evaluated risk indicators for root caries experience.

2. Methods

Reporting of this study follows the STROBE statement [13] for observational studies and the TRIPOD statement [14] for development of a prediction model.

2.1. Data source and participants

Data from three waves of the DMS were used; DMS III from 1997, DMS IV from 2005 and DMS V from 2014. The DMS involved stratified multi-stage cross-sectional, nationwide probability samples of the civilian non-institutionalized German population, with clinical and socio-epidemiological examinations in different age cohorts (12-years-old, 35–44-years-old, 65-74-years-old, for DMS V also 75-100-years-old). The sampling design, data collection protocols and data availability statements can be found elsewhere [15–18].

Study participants were drawn from local residents' registration offices in 90 randomly selected communities (sample points) using a cluster-random sampling stratified for regions and areas of urbanization. A disproportional sample point selection was performed with 60 study sample points in the Western federal states of Germany and 30 study sample points in the Eastern states.

For the DMS III, 3065 participants were included (response rate of 63.6%); for DMS IV and V, these numbers were 4631 (63.1%) and 4609 (50.1%), respectively. Empirical non-responder analyses were conducted to compare the socio-dental characteristics of responders with the target population according to gender, educational level, dental visiting patterns, and dental/prosthetic status. Non-response bias was found to be minimal (Appendix Table S1 and S2). The study was ethically approved by the Medical Association North-Rhine (No. 2,013,384), as were all data collection protocols. All participants completed written informed consent. All methods were performed in accordance with the relevant guidelines and regulations.

2.2. Data collection

The dental examinations and the socio-scientific survey were carried out at the local sample points. To ensure reproducibility, interviewers and dental investigators were trained and calibrated by experts and multiple reliability checks were performed throughout the field phase (Appendix Table S3).

Dental examinations were performed by three teams working in parallel; each team consisted of one dentist, one interviewer, and one contact person.

Root caries lesions were determined as follows at up to four root surfaces per tooth (depending on the number of surfaces available, i.e. exposed). A root surface was assumed as carious if it was possible to establish cavity formation with or without softening (carious root surface, CRS). If a lesion on a root appeared to be a continuation of a coronal lesion not extending more than 2 mm onto the adjacent root area, this was not regarded as root lesion. Brown, yellow or reddish to brown root surfaces with varying substance loss and a soft to leathery texture (tactile examination using a blunt probe), but also dark brown to black, rather hard root surfaces were considered as root caries lesions. Note that the distinction between these different lesion characteristics, which may allow to classify lesions as active or inactive, had not been made in all DMS. Hence, we were unable to separate active and inactive lesions in this study. Also note that one could assume arrested lesions to not necessarily remain arrested. In this sense, even arrested lesions need to be recorded, as they may require (1) continuous arrestment therapy and (2) restorative treatment in case they progress (re-activate). Filled root surfaces (FRS) were also recorded. Root surfaces which, according to information provided by the individual, had been filled to improve aesthetics only, were not recorded as filled. If a restoration on a root appeared to be a continuation of a coronal restoration not extending more than 2 mm onto the adjacent root area, this was not regarded as FRS as well. The sum of CRS and FRS of an individual was the root caries experience (RCE).

Further parameters were assessed and employed in the current study as covariates. Coronal caries experience (DT, MT, FT) was recorded on 28 teeth (i.e. third molars were excluded), on five surfaces per posterior tooth (premolars and molars) and four surfaces per anterior tooth (incisors and canines), as described in detail elsewhere [4]. Periodontal assessment was performed according to different protocols throughout the DMS waves; a partial mouth recording was the common denominator with two sites (mesio-vestibular and mid-vestibular) measured on the following index teeth: 17, 16, 11, 44, 46, and 47. For the present study, the number of teeth with PPD $\geq$ 4 mm were assessed as covariate. Details on transformation of the partial mouth PPDs full mouth data have been described elsewhere [5].

Further recorded clinical parameters were prosthodontic status, and developmental and acquired dental hard tissue defects. A paper-based questionnaire was completed by the subjects before the clinical examination, comprising questions on oral hygiene habits/prosthesis hygiene, utilization of dental services, questions on childhood and life course, smoking habits, and social demographics including education, income, place of residence and place of birth.

2.3. Missing data

Only the age groups of 35–44 and 65–74-years-old (adults and younger seniors) were used in the present study, resulting in a total number of cases of 5986. In these two age groups, data for FRS and CRS were available for 4449 dentate subjects. We did not impute missing values, hence, we discarded cases with at least one missing predictor variable (approx. 1%), resulting in a final data set with 4388 cases.

2.4. Cross-sectional imputation

In the three waves of the DMS, patient data were available for particular age cohorts. For FRS and CRS, we estimated the weighted means for two DMS age groups (35–44-years-olds and 65-74-years-olds) for each DMS wave (DMS III, IV and V). For age groups not sampled by the DMS we interpolated FRS and CRS cross-sectionally by fitting a piecewise cubic polynomial spline [19] to the weighted means. We set a boundary condition of zero for 12-year-olds. We then summed up FRS and CRS to obtain RCE for each age year with respect to each particular DMS study; the RCE was maximally 112.