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Higher experience of caries and lower income trajectory influence the quality of restorations: A multilevel analysis in a birth cohort

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ABSTRACT

Objectives: This study aimed to evaluate the quality of posterior restorations (amalgam or composite) placed in adults from a birth cohort and its association with clinical and socioeconomic determinants experienced during their life course.

Methods: A representative sample (n = 539) of all 5914 births occurring in Pelotas (Brazil) in 1982 was prospectively investigated. Quality of posterior restorations (satisfactory or unsatisfactory) was assessed at 31 yrs-old, using modified USPHS criteria. Trained and calibrated dentists performed clinical examination. Explanatory variables included demographic and socioeconomic, oral health and dental service utilization patterns during the life course. Tooth related variables (type of tooth, material, size of cavity) were also analyzed. Untreated caries and socioeconomic status were assessed by group-based trajectories analyses. Multilevel Regression models were used to determine factors associated with restoration outcomes.

Results: In total 2123 restorations (53% composite) were evaluated of which 107 (5%) were assessed as failed. The main reasons for failure were tooth/restoration fracture (50.5%) and secondary caries (30.7%). Failures in posterior restorations showed a significant association with socioeconomic aspects (lower tertile of income at age 30 – prevalence ratio (PR) 2.21 [95% CI 1.19–4.09]), clinical variables (trajectory of higher untreated caries – PR 2.11 [95% CI 1.23–3.61]) and also with tooth-related factors (Restorations involving three or more surfaces – PR 5.51 [95% CI 3.30–9.19]) after adjustment for each other.

Conclusions: These findings suggest that, although tooth-related variables have an important role in restoration longevity, patient-related factors, such as socioeconomic variables and untreated caries are also associated with failure and should be taken into account when evaluating longevity of posterior restorations.

Clinical significance: This was the first study assessing long-term trajectory of untreated caries, showing an association between higher experience of caries during the life-course and unsatisfactory restorations. The findings suggest that individual related factors should be considered when planning treatment and in future research evaluating the longevity of dental restorations.

1. Introduction

Direct restorations are the most common option for dentists to replace dental structure in posterior teeth. The advantages are the relatively low cost and limited need for removal of healthy dental tissue when compared to indirect restorations [1]. In addition, direct restorations have been widely used also because of their good clinical performance [2–4].

Currently, amalgam and composite resins are the first choice materials for class I and class II restorations, presenting a similar annual failure rate [5–8]. Secondary caries and tooth or restoration fracture are the most common reasons of restoration failures [5]. In recent years it is being recognized that restoration failure is not only linked to clinical factors but also to patient factors [9], including socioeconomic [10], clinical [11–13] and dentist related variables [7,14].

Dental caries is one of the most investigated factors related to patient. Studies on longevity of restorations have been using a variety of methods to assess individuals' caries risk, such as the caries experience

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measured by DMFT index [15], the history of new lesions in short periods of time by clinical [16] or radiographic evaluation [17] and; the number of restorations in mouth [18]. In all cases, an increased caries risk has a negative influence on longevity of restorations. An analysis in a birth cohort has shown that the progression of caries occurs relatively linearly during life, i.e., the rate of disease progression is relatively constant over time, varying according to the risk of each individual [19]. In this way, it would be interesting to evaluate if the risk of caries, represented by the trajectory of the disease in the life course, would be associated to a higher risk of failures in restorations.

Birth cohort studies provide reliable data on exposures and outcomes during life course, which is difficult to determine by other study designs [20]. There are few population-based studies that have evaluated the influence of individual-related factors on the quality of restorations [10,12]. Thus, the aim of this paper was to assess the association between failure of restorations and individual and clinical factors experienced during life course.

2. Materials and methods

This birth cohort study is reported in accordance with the STROBE statements guidelines.

2.1. Pelotas cohort study 1982

Pelotas is a medium-sized city located in a relatively affluent area in the south of Brazil. In 1982, all infants born at three maternity hospitals in the city were identified, and the 5914 live-born infants and their mothers were weighed and measured; the mothers were also interviewed. This population has been followed several times, and further information is available elsewhere [20]. In 1997 (when the children were 15 yrs of age), a systematic sample of 70 census tracts (27% of the total) was selected, and every household in these tracts was visited; 1076 cohort members were interviewed. Of these, 900 were randomly selected for the Oral Health Study (OHS-97), which consisted of an interview and dental examination. In 2006, when those individuals were 24-years-old (OHS-2006), 888 subjects investigated in the OHS-97 (98.7%) were contacted for another assessment comprised of interviews and oral health exams. From those, 720 were clinically examined. In 2013, the same 888 individuals investigated in the OHS-97 were again invited to participate in a new oral health assessment (OHS-13). In this last evaluation individuals were examined for quality of posterior restorations, presence of periodontal disease (bleeding on probing, probing depth and gingival margin), dental caries and other oral conditions. Oral examination was performed at home, using mirror, probe and artificial light, by six dentists previously trained and calibrated. Inter-examiner reliability was calculated and the lowest kappa for quality of restorations was 0.70. In order to assure the quality of the study, 15% of interviews were repeated.

2.2. Outcome – quality of restorations

All direct posterior restorations were clinically evaluated and classified as satisfactory or unsatisfactory based on criteria used previously on the same cohort (OHS-2006) [10]. Restorations were classified as clinically satisfactory when they did not need an intervention (repair or replacement). This classification was originated from modified United States Public Health Service criteria (USPHS).

2.3. Tooth-level variables (Clinical factors)

At tooth-level, posterior restoration were assessed by: 1) Tooth type (premolars or molars); 2) Number of surfaces involved on restoration (one; two; three or more surfaces); 3) Restorative material used (amalgam or composite); 4) Estimated time in mouth reported by individuals (up to 10 years and more than 10 years).

2.4. Individual level variables

Individual variables were obtained from previous assessments of the cohort. Individual educational level at age 30 was collected by the number of years of study and categorized in three groups (“more than 11 years”, “from 9 to 11 years”, “less than 9 years”). Family income at age 30 was continuously collected in Brazilian currency (US Dollar 1 = BRL 2.20) and analysed in tertiles (“Higher” (3120–25000 BRL), “Intermediate” (1751–3100 BRL), Lower (85–1747 BRL)). Use of dental services at age 31 was collected through the questions “Have you been to dentist in the last 12 months?” and “Where have you been attended?”. Subsequently, the variable was categorized in “private, no insurance”, “Public service, free of charge” and “Private, reimbursed by dental health insurance”.

To assess periodontal status of individuals, clinical attachment loss was clinically measured by probing depth (distance in millimeters between the gingival margin and gingival sulcus) and gingival level (distance in millimeters between the gingival margin and the cementoenamel junction). Periodontal examinations included a full-mouth protocol, probing six sites per tooth using a PCP2 probe. Individuals were classified following the criteria of Baelum & Lopez [21], where periodontal diseases were identified when individuals had at least one site with simultaneous presence of attachment loss of 4 mm or more and bleeding on probing.

Dental caries experience was investigated at age 15, 24 and 31 by DMFT index [22]. The Decayed component (D) collected at these three moments was organized as a discrete variable. Through a group-based trajectory analysis, the trajectory of caries presence from age 15 to 31 was established.

The risk for occlusal stress due to parafunctions was assessed by seven questions to detecting possible signs of occlusal disorders [23]. In addition, the presence of facets parallel to the normal planes of contour, noticeable flattening of cusps or incisal edges and/or total loss of contour and dentinal exposure when identifiable were investigated. Individuals were classified as having a high risk for occlusal stress when answered positively for two questions and presented at least one of clinical aspects investigated [23].

2.5. Data analysis

Software STATA version 14.2 was used for data analysis. Group-based trajectory modeling was used to identify different trajectories for presence of caries throughout individuals life course. The method was designed to identify groups of individuals (clusters) that share similar trajectories of variables of interest measured over time. The models were estimated with the “traj” command [24].

Decayed component (D) of the DMFT index collected in these follow-ups as discrete variables were used to create a life course trajectory for experience of dental caries. The parameters for trajectory model were determined based on the maximum likelihood of the quasi-Newton method [25,26]. The model selection method considers the estimation of the latent number of categories and the order of the polynomial for each latent trajectory. The final number of trajectories was established when the sequential comparisons of the Bayesian information criterion (BIC) and the adjusted BIC between the model with k and k + 1 trajectories did not result in any more substantial difference in the BIC value. For each group, a quadratic trajectory was considered, starting with only one group in a null model. The BIC analysis supported a model of 2 trajectory groups, being classified as high and low untreated caries during life-course.

Poisson multilevel regression models were used to analyze factors associated to quality of restorations, considering mixed effects and two levels of variables organization: tooth-level (level 1) and individual level (level 2). Variables selection in the model followed a theoretical model, based on the model proposed by Correa [10]. Independent variables were ordered in four blocks to determine their entry in the