Heliyon 7 (2021) e06492

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Prevalence and severity of non-carious cervical lesions and dentin hypersensitivity: association with oral-health related quality of life among Brazilian adults

Anna Rachel dos Santos Soares [a,*], Loliza Luiz Figueiredo Houri Chalub [b], Rayssa Soares Barbosa [c], Deborah Egg de Paiva Campos [c], Allyson Nogueira Moreira [d], Raquel Conceição Ferreira [b]

[a] Postgraduate Program of Dentistry, School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil
[b] Department of Social and Preventive Dentistry, School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil
[c] School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil
[d] Department of Restorative Dentistry, School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil

ARTICLE INFO

Keywords:
Non-carious cervical lesions
Dentin hypersensitivity
Oral health-related quality of life
Patient reported outcomes measures
Oral impacts
Epidemiology

ABSTRACT

Objectives: To assess the association between dentin hypersensitivity (DH) (with or without non-carious cervical lesions (NCCL)) and physical and psychosocial oral health impact.

Methods: A cross-sectional population-based study with one-stage random sample of adults living in a Brazilian municipally was conducted between 2018 and 2019. Interviews and oral examinations were performed by calibrated examiners (Kappa $\geq$0.7). The participant was considered as having physical and psychosocial impact if at least one item of the Oral Health Impact Profile (OHIP-14) was experienced fairly often or very often. NCCL was assessed by the Tooth Wear Index (codes 2 to 4) and DH was evaluated by a tactile test with a probe in the cervical area of teeth. The combination of these clinical variables resulted in categories of the independent variable: without DH or NCCL, NCCL without DH, DH without NCCL, and both DH with NCCL. The covariables were sociodemographic and economic factors, health habits, and oral conditions. Associations were investigated by Poisson Regression models using Direct Acyclic Graph (Stata 17).

Results: Of 197 adults, 59.3% had oral health impact and 31.3% had DH with NCCL. Higher frequency of oral health impact was observed in adults with DH alone. A higher impact on the physical pain dimension of the OHIP-14 was observed in adults with DH and NCCL (PR: 2.46; 95% CI: 1.21–5.00) and with DH alone (PR: 2.03; 95% CI: 1.21–3.41).

Conclusion: NCCL and DH are common conditions in adults and the presence of DH is associated with higher oral health impact. Regardless the presence of NCCL, DH is associated with the physical pain dimension of OHRQoL.

1. Introduction

Tooth wear is a universal physiological phenomenon, with slow, continuous and irreversible progression. It is associated with aging, oral hygiene, eating and parafunctional habits [1, 2]. A non-carious cervical lesion (NCCL) is a tooth wear in the area close to the cementoenamel junction (CEJ) and is unrelated to the presence of microorganisms. The pooled prevalence of NCCL worldwide and in South America is 46.7 and 69.0%, respectively [1]. However, the methodological heterogeneity as to the sample size, age and type of studied population, nomenclature, diversity in the definition, and diagnosis and assessment methods contributes to the variability of these estimates, with prevalence rates varying from 9.1 to 93.0% [1].

Exposed cervical dentin, with or without tooth wear, can result in dentin hypersensitivity (DH), defined as a short, sharp pain in response to thermal, evaporative, tactile, osmotic, or chemical stimuli that cannot be attributed to any other defect or pathology [3, 4]. Similar to NCCL, the prevalence of DH varies widely. The pooled prevalence of DH worldwide is 11.5% (95%CI: 11.3–11.7), disregarding the heterogeneity among studies (fixed-effect meta-analysis). The use of a random model

* Corresponding author.
E-mail address: anna.soares@outlook.com (A.R.S. Soares).

https://doi.org/10.1016/j.heliyon.2021.e06492
Received 21 September 2020; Received in revised form 27 February 2021; Accepted 8 March 2021

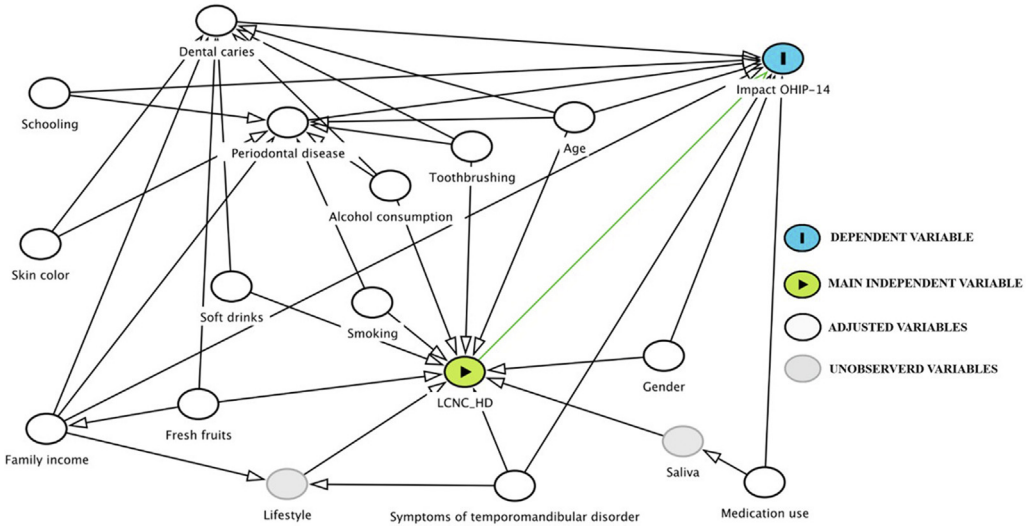

Figure 1. Direct Acyclic Graph (DAG) to assess the association between the presence of dentin hypersensitivity (DH) (with or without non-carious cervical lesions (NCCL)), and physical and psychosocial oral health impact.

(random-effect meta-analysis), assuming heterogeneity among studies, results in a pooled prevalence of 33.5% (95% CI: 30.2–36.7), which can be interpreted as the average prevalence of the included studies [5]. An epidemiological study in a European population showed a DH prevalence of 41.9% [6]. Among Brazilians, the DH prevalence ranges from 17.0 to 46.0% [7, 8].

These prevalence estimates were obtained mainly through studies with convenience samples (students [9], patients from educational clinics [8, 10, 11, 12, 13], private practices [7, 14, 15], and labor workers [16]). Epidemiological studies on the prevalence of NCCL [17, 18, 19, 20, 21] and DH [6, 19, 22, 23, 24] with probability sampling of adult populations are less frequent [19].

Patient-centered outcomes of the effects of DH indicate the impact of DH on physical and psychosocial dimensions of oral health-related quality of life (OHRQoL). Additionally, the analysis of these outcomes contributes to clinical decision-making, favoring the communication between professionals and patients and the patient's involvement in their own health care [25, 26, 27, 28, 29, 30, 31].

General health-related quality of life measures such as the EuroQol five-dimensional (EQ-5D) [32] and specific OHRQoL measures such as the Oral Health Impact Profile (OHIP), Oral Impacts on Daily Performance (OIDP) [29, 30, 31, 33, 34, 35, 36, 37, 38, 39, 40], and the Dentine Hypersensitivity Experience Questionnaire (DHEQ) [32, 41, 42, 43, 44, 45, 46, 47] have been used in clinical trials [29, 31, 35, 36, 39, 42, 43, 44, 45, 46, 47] and observational studies [30, 32, 33, 34, 37, 38, 40, 41, 48]. Clinical trials have shown improvements in quality of life indicators from different DH clinical treatments [29, 31, 35, 36, 39, 42, 43, 44, 45, 46, 47], indicating that such measures are sensitive for assessing variations in this condition. Evidence from patient-centered measures was also obtained in a longitudinal study with a convenience sample of 101 students and staff from an English university, showing that beliefs about illness and coping strategies were good predictors of OHRQoL in individuals with DH [32]. Another study with the same sample showed that psychological variables such as resilience and personal mood could affect the pain experienced by people with DH [48].

Most observational studies have cross-sectional designs with convenience samples from university clinics [30, 34, 37, 41] or private practices [29], including participants with DH complaints [37, 41] or who sought health services for DH [29], and samples that included participants with and without DH [30, 34]. The analytical approach of these studies was hypothesis testing to compare the oral health impact, measured by OHRQoL instruments (OIDP and OHIP) according to the presence or severity of DH [30, 34, 37, 41] or correlation analysis between OHRQoL scores and DH severity [41], without controlling for confounding factors. These studies were consistent in showing worse OHRQoL indicators in groups with DH or with greater DH severity. Individuals with DH complaint had higher predicted OHIP mean scores than the general population [29]. Most of these observational studies, however, did not consider the presence of cervical wear [29, 30, 34, 37, 41]. A study with a representative sample of adults evaluated the association between the presence of gingival recession, DH, and the presence of oral health impact, measured by the OHIP-14. The authors showed that DH alone was not associated with a higher impact but the association was significant for the presence of both DH and gingival recession after adjusting for confounding factors such as age, gender, socioeconomic status, smoking habits, frequency of dental visits, and missing teeth [40]. Thus, there is a lack of studies evaluating the association between DH, with or without NCCL, and the presence of impact from a population perspective, using study designs that consider potential confounding factors of this association.

This study aimed to estimate the prevalence and severity of NCCL and DH and the association of DH (with or without NCCL) with the presence of physical and psychosocial oral health impact, measured by an OHRQoL instrument among adults. The hypothesis was that the presence of DH is associated with the presence of oral health impact regardless of the presence of NCCL.

2. Materials and methods

A cross-sectional study was conducted in 2018 and 2019 with adults living in the urban area of Rio Acima, a metropolitan municipally of Belo Horizonte, Minas Gerais, Brazil. The research was approved by the Research Ethics Committee (protocol CAAE 82540517.9.0000.5149) and signed informed consent was obtained from all participants.

The population was people from 30 to 49 years old. The sample size calculation was based on the prevalence of oral health impact (15.9%), NCCL (69%), and DH (88.7%) according to previous studies [1, 49, 50]. The formula for estimating a proportion for finite populations $n = [EDFF*N*p\,(1-p)]/[(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$ was used, where EDFF is the design effect (1.2), N is the finite population (N = 2716 adults), p is the prevalence of the evaluated condition, α is the selected level of significance (95%), $Z_{1-\alpha/2}$ is the value from the standard normal distribution holding 1- α/2 below it (Z = 1.96), and d is the margin of error (7%). The correction for finite population was performed because the adults are from a small municipality of 2716 inhabitants in the studied age range (from the 2010 Brazilian census [51]). The 7% margin of error was

Table 1. Distribution of adults regarding the investigated dependent, independent and covariables. Rio Acima. Brazil (n = 197).

Variables	Total	%	95% CI
DEPENDENT			
Impact of oral conditions on daily activities			
Without impact	83	40.70	32.47–49.49
With impact	114	59.30	50.51–67.53
INDEPENDENT			
Presence of NCCL and DH			
Without NCCL or DH	58	28.97	20.38–39.39
NCCL, without DH	66	32.28	25.48–39.92
DH without NCCL	15	7.42	4.34–12.42
NCCL and DH	58	31.33	22.77–41.38
COVARIABLES			
Sociodemographic and economic characteristics			
Gender			
Male	57	29.75	23.55–36.80
Female	140	70.25	63.20–76.45
Age			
30–39 years old	94	46.99	37.59–56.60
40–49 years old	103	53.01	43.04–62.41
Self-declared skin color			
White	23	11.90	7.50–18.38
Black + Brown + Yellow + Indigenous	172	88.10	81.62–92.50
Education (in study years)			
Up to 4 years	48	28.03	20.92–36.45
5–8 years	37	19.43	14.52–25.51
9 or more years	112	52.54	43.01–61.88
Family Income			
Up to US$283.00	67	36.16	26.67–46.87
From US$283.00 to US$377.00	64	34.03	27.95–40.68
Above US$377.00	63	29.81	22.03–38.97
Health habits and behavior			
Toothbrushing frequency			
Less than twice a day	10	6.39	3.47–11.47
Twice or more times a day	187	93.61	88.53–96.53
Fresh fruit consumption			
Rarely or never	46	24.67	19.27–31.00
Once or more times a day	79	36.38	29.93–43.36
Once or more times a week + Several times a month, but not every week nor every day	72	38.95	32.26–46.09
Coca Cola or other soft drinks consumption			
Rarely or never	102	49.57	40.37–58.79
One or more times a day	17	9.34	6.08–14.08
One or more times a week	55	28.57	20.88–37.75
Several times a month, but not every week nor every day	23	12.53	8.41–18.25
Smoking			
Never	137	68.78	58.26–77.66
Former smoker	35	19.17	13.33–26.79
Smoker	25	12.05	8.13–17.49
Alcohol consumption			
Never	33	15.48	10.73–21.81
Former drinker	53	26.29	18.79–35.48
Current drinker	111	58.23	49.69–66.31
Health conditions			
Medication use			
No	104	52.87	42.12–63.35
Yes	93	47.13	36.65–57.88
TMD symptoms			
No	144	73.32	66.90–78.88
Yes	53	26.68	21.12–33.10
Dental Caries			

(*continued on next page*)

Table 1 (*continued*)

Variables	Total	%	95% CI
None	52	26.40	19.14–28.72
At least one tooth	145	73.60	7.28–80.86
Periodontal Diseases			
Healthy	62	31.47	23.11–38.67
Gingivitis	15	7.61	4.52–12.24
Periodontitis	120	60.91	53.73–69.91

The proportions were calculated considering the sample weight. TMD: Temporomandibular Disorder.

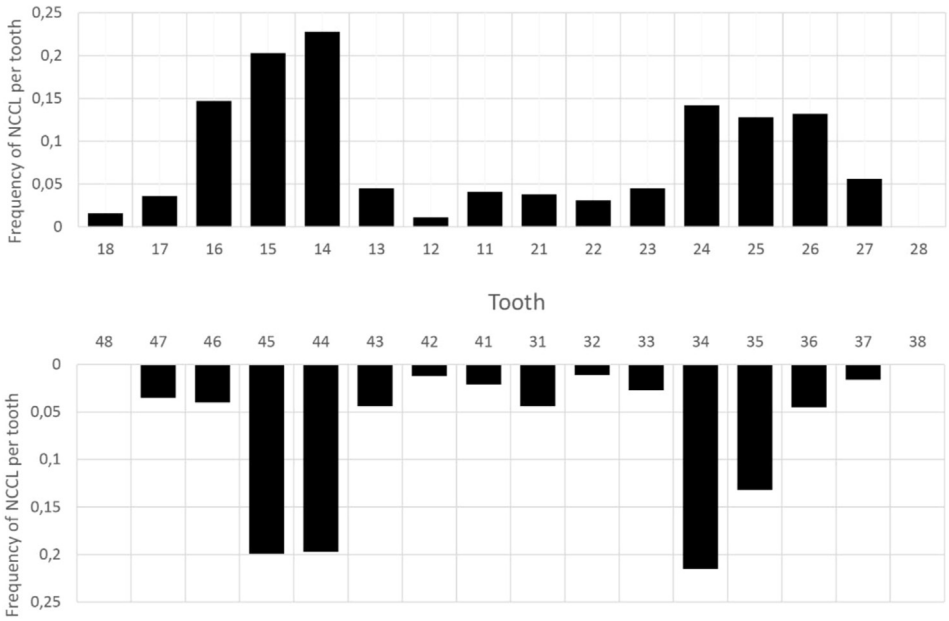

Figure 2. Percent of non-carious cervical lesions (NCCL) per teeth in the upper and lower dental arches.

chosen to obtain a viable sample size, maintaining an adequate precision of the estimates. The required sample size was 122, 190, and 92 to estimate the prevalence of oral health impact, NCCL, and DH, respectively, and the highest sample size was used. The Epi Info™ 7.2.1.0 (Centers for Disease Control and Prevention, Atlanta, GA, USA) software was used to calculate the sample size.

A single-stage probabilistic sampling by clusters (census sectors) using a proportion of the population from all city sectors was adopted. After the identification of the 13 urban sectors, a random selection of streets (primary sampling unit) was carried out. The number of streets selected in each sector was a proportion of the total number of streets in each census sector. A prior enrollment was performed to identify the eligible adults in households on the selected streets. All people from 30 to 49 years of age were invited to participate in the research. Those who agreed to participate were examined and interviewed at home. Totally edentulous individuals, those who used a fixed orthodontic appliance, had cognitive or mental impairment, or any limitation that would obstruct the examination and interview were excluded. Those who refused to participate or were not found after three contact attempts were considered missing.

2.1. Data collection

Data was collected by an interview and oral examination in the participant's home. Oral examinations were performed according to the World Health Organization (WHO) standards for epidemiological studies [52]. Examiners (dentists) and assistants (graduate students in Dentistry) were trained in four 32-hour workshops addressing codes and criteria for assessing oral conditions and interview training (interviewee approach and interviewer standardization). Practical training simulated the conditions of home examinations, allowing time estimation for the exams and interviews. The calibration process for oral examinations used the *inlux* method to assess oral health conditions (crown and root conditions). The *inlux* is a type of calibration with slides and photographs, in which cases are presented following the same principles as an in vivo calibration with volunteers [53]. The intra-examiner and inter-examiner Kappa coefficients were >0.80 and 0.70–1.0, respectively. Subsequently, clinical training was conducted by a specialist in Periodontics to assess the presence and severity of NCCL and DH. A tablet software was used to record and store the collected data eliminating the use of paper forms and allowing data to be quickly exported for analysis. In this software, the interview questions and clinical examination indexes were pre-programmed with answer options, avoiding typing errors and allowing the automatic generation of the database. The software used offline forms allowing researchers to store a backup of their data on the tablet and upload it as soon as internet connection was available.

2.1.1. Dependent variable

The dependent variable was presence of physical and psychosocial oral health impact, assessed by the validated Portuguese version of the OHIP-14 [54]. The OHIP-14 assesses oral health impact [26] in seven dimensions: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, and social disability and handicap. Participants rate the frequency of each situation, choosing one of the following options: never, hardly ever, occasionally, fairly often, and very often. Individuals who answered “fairly often” and/or “very

Table 2. Crude and adjusted prevalence ratios of the association between presence of oral health impact and presence of NCCL, with or without DH, and socio-demographic and socioeconomic characteristics, health conditions, and health habits and behaviors among participants 30–49 years old. Rio Acima. Brazil (=197).

Variables	Presence of oral health impact	
	Crude PR (95%CI)	Adjusted PR (95%CI)
INDEPENDENT		
Presence of NCCL and DH		
Without NCCL or DH	1	1
NCCL without DH	0.819 (0.500–1.343)	1.089 (0.712–1.668)
DH without NCCL	1.681 (1.170–2.415)	1.579 (1.026–2.429)
NCCL and DH	1.209 (0.826–1.769)	1.338 (0.930–1.926)
COVARIABLES		
Sociodemographic and economic characteristics		
Gender		
Male	1	1
Female	1.551 (1.180–2.037)	1.463 (1.073–1.994)
Age group		
30–39 years old	1	1
40–49 years old	0.905 (0.709–1.155)	0.873 (0.699–1.091)
Self-declared skin color		
White	1	1
Black + brown + yellow + indigenous	1.005 (0.690–1.464)	1.216 (0.873–1.693)
Education (in study years)		
Up to 4 years	1	1
5–8 years	0.928 (0.704–1.223)	0.934 (0.717–1.215)
9 or more years	0.647 (0.484–0.866)	0.674 (0.484–0.937)
Family Income		
Up to US$283.00	1	1
From US$283.00 to US$377.00	0.645 (0.496–0.838)	0.952 (0.734–1.234)
Above US$377.00	0.795 (0.643–0.983)	0.649 (0.465–0.907)
Health habits and behaviors		
Toothbrushing frequency		
Less than twice a day	1	1
Twice or more times a day	0.665 (0.515–0.859)	0.536 (0.373–0.770)
Fresh fruit consumption		
Rarely or never	1	1
Once or more times a day	0.929 (0.654–1.319)	0.964 (0.699–1.331)
Once or more times a week + Several times a month, but not every week nor every day	0.802 (0.602–1.069)	0.827 (0.633–1.080)
Coca Cola or other soft drink consumption		
Rarely or never	1	1
One or more times a day	1.078 (0.764–1.522)	0.745 (0.477–1.164)
One or more times a week	0.867 (0.675–1.114)	0.989 (0.781–1.252)
Several times a month, but not every week nor every day	0.927 (0.605–1.418)	0.842 (0.584–1.214)
Smoking		
Never	1	1
Former smoker	0.944 (0.674–1.323)	0.968 (0.707–1.324)
Smoker	1.139 (0.786–1.652)	1.219 (0.828–1.796)
Alcohol consumption		
Never	1	1
Former drinker	0.931 (0.705–1.231)	0.977 (0.638–1.496)
Current drinker	0.821 (0.614–1.098)	1.115 (0.849–1.464)
Health conditions		
Medication use		
No	1	1
Yes	1.426 (1.149–1.769)	1.380 (1.108–1.719)
TMD symptoms		
No	1	1
Yes		1.491 (1.159–1.919)
Dental Caries		
None	1	1
At least one tooth	1.444 (1.021–2.043)	1.351 (1.004–1.818)
Periodontal Disease		

(*continued on next page*)

Table 2 (*continued*)

Variables	Presence of oral health impact	
	Crude PR (95%CI)	Adjusted PR (95%CI)
Healthy	1	1
Gingivitis	0.776 (0.490–1.230)	0.590 (0.396–0.877)
Periodontitis	1.034 (0.809–1.321)	0.937 (0.742–1.183)

95% confidence intervals in parenthesis. The proportions were calculated considering the sample weight.

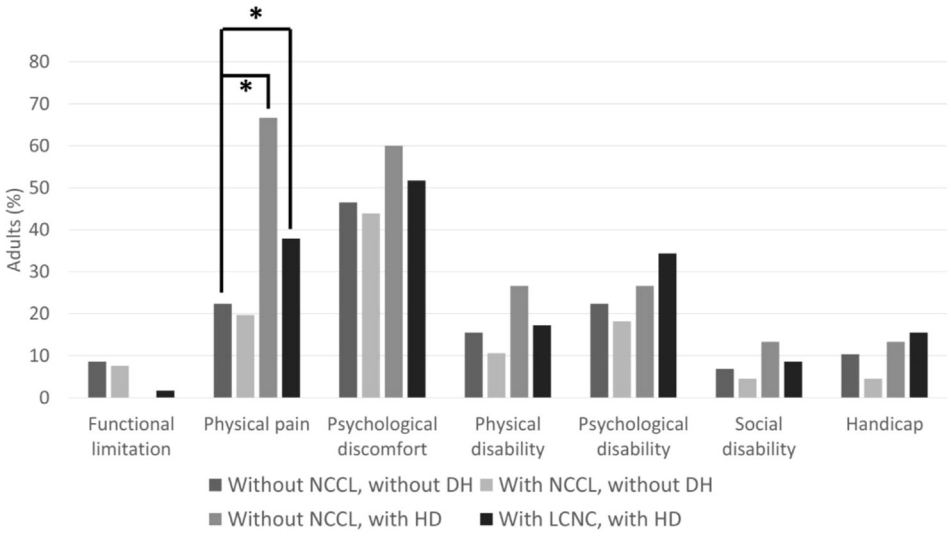

Figure 3. Proportion of adults (30–49 years old) with presence of physical and psychosocial oral health impact (OHIP-14) according to the presence of DH, with or without NCCL. Rio Acima, Brazil (n = 197). The proportions were calculated considering the sample weight. (*)Associations were adjusted for gender, age, skin color, education, family income, medication use, toothbrushing frequency, diet - fresh fruits, diet - Coca-Cola and other soft drinks, smoking, alcohol consumption, TMD symptoms, dental caries, and periodontal disease.

often" to at least one of the OHIP-14 items were considered to have an impact. The presence of impact was also estimated for each of the dimensions of the OHIP-14, using this same methodology.

2.1.2. Independent variable

The main independent variable was obtained by combining the DH and NCCL variables, categorized into: without NCCL or DH, NCCL without DH, DH without NCCL, and both DH and NCCL. Additionally, the DH and NCCL severity levels were evaluated.

The Tooth Wear Index (TWI) [55] was used to assess the presence and severity of NCCL using a William's periodontal probe (Trinity®). The TWI quantifies tooth wear in four degrees: 0 – no change of contours; 1 - minimal loss of contour; 2 - less than 1 mm deep defect; 3 - 1–2 mm deep defect; 4 - more than 2 mm deep defect, or pulp exposure, or exposure of secondary dentine. The index does not consider the etiology or type of wear. Restored teeth or teeth with extensive caries or no caries were also coded. The cervical buccal and lingual surfaces of all teeth were evaluated. In case of uncertainty, the lowest wear score was attributed. NCCL was considered when codes 2, 3, or 4 were recorded in at least one surface [10].

DH was assessed by the participant's response to the tactile stimulus of lateral movements with a probe on the cervical surfaces. In the presence of DH, pain severity was assessed by the Visual Analogue Scale (VAS), being 0 "no pain" and 10 "most severe pain" and categorized as "mild" (1–2), "moderate" (3–7) or "severe" (8–10). The prevalence of DH was estimated by the frequency of individuals who reported pain intensity ≥1 on the VAS scale.

2.1.3. Covariates

Sociodemographic and economic characteristics, oral hygiene and eating habits, health behaviors (smoking and alcohol consumption), and health conditions [medication use, symptoms of temporomandibular disorders (TMD), presence of dental caries and periodontal disease] were used as covariates. The variables were selected based on their previous evidence of direct or indirect association with presence of NCCL or DH or patient-centered outcomes, interfering with the investigated association [3, 6, 11, 17, 18, 21, 49, 56, 57]. Age was associated with a higher prevalence of OHRQoL impact and there is evidence of an increased prevalence of NCCL and DH with aging [12, 18, 19, 21, 29, 49, 58]. Women tend to have a greater OHRQoL impact [19, 49] that can be explained by their greater self-care in general and oral health, also reflecting in the presence of higher prevalence of NCCL and DH due to traumatic toothbrushing [2, 11, 13, 19, 20]. Medication use was associated with dental erosion from side effects such as heartburn, gastroesophageal reflux and xerostomia, contributing to the development of NCCL, DH, and oral health impact [59]. Socioeconomic conditions related to income and education also influence the OHRQoL [49] and there is consistent evidence of the social determinants of oral diseases [26]. Aspects of the diet were evaluated to verify the theory of dental erosion in which a sugar-rich diet would lead to dental caries and thus impact quality of life [11, 12, 20, 59]. The presence of TMD symptoms and active bruxism was previously associated with a negative impact on OHRQoL [56], and parafunctional habits were related to the presence of NCCL [2, 11, 21, 58]. Individuals with gingival recession are more likely to present NCCL and DH, which can be related to the root debridement treatment and a greater exposure of the root surface to acids and abrasive agents [2, 3, 10, 13, 19, 31, 42, 58]. The presence of periodontal disease and gingival recession has also been associated with OHRQoL [57].

2.1.4. Data analysis

Descriptive analyses were performed to estimate frequencies of the investigated variables and covariates and to evaluate the distribution of NCCL in upper and lower dental arches. Poisson regression models were used to investigate the association between the presence of DH (with or without NCCL) and the presence of physical and psychosocial oral health impact. A directed acyclic graph (DAG) was constructed from the theoretical framework to guide the selection of covariates for adjusting the association of interest [60] (Figure 1). The DAG is an important tool for

Table 3. Adjusted prevalence ratios of the association between presence of oral health impact in the Physical Pain dimension of the OHIP-14 with the presence of NCCL, with or without DH, and sociodemographic and socioeconomic characteristics, health conditions, and health habits and behaviors among participants 30–49 years old. Rio Acima. Brazil (n = 197).

Variables	Impact on physical pain – OHIP-14
	Adjusted PR (95%CI)
INDEPENDENT	
Presence of NCCL and DH	
Without NCCL or DH	1
NCCL without DH	1.204 (0.596–2.581)
DH without NCCL	2.468 (1.217–5.007)
NCCL and DH	2.037 (1.215–3.416)
COVARIABLES	
Sociodemographic and economic characteristics	
Gender	
Male	1
Female	2.963 (1.409–6.232)
Age group	
30–39 years old	1
40–49 years old	0.904 (0.603–1.353)
Self-declared skin color	
White	1
Black + brown + yellow + indigenous	1.160 (0.513–2.625)
Education (in study years)	
Up to 4 years	1
5–8 years	0.956 (0.543–1.685)
9 or more years	0.649 (0.397–1.061)
Family Income	
Up to US$283.00	1
From US$283.00 to US$377.00	0.580 (0.359–0.936)
Above US$377.00	0.939 (0.551–1.598)
Health habits and behavior	
Toothbrushing frequency	
Less than twice a day	1
Twice or more times a day	0.877 (0.308–2.507)
Fresh fruit consumption	
Rarely or never	1
One or more times a day	0.883 (0.580–1.344)
One or more times a week + Several times a month, but not every week nor every day	0.713 (0.438–1.158)
Coca Cola or other soft drinks consumption	
Rarely or never	1
One or more times a day	0.800 (0.386–1.659)
One or more times a week	0.841 (0.484–1.461)
Several times a month, but not every week nor every day	0.765 (0.292–2.002)
Smoking	
Never	1
Former smoker	0.898 (0.490–1.648)
Smoker	1.010 (0.522–1.954)
Alcohol consumption	
Never	1
Former drinker	0.658 (0.326–1.327)
Current drinker	0.927 (0.561–1.531)
Health conditions	
Medication use	
No	1
Yes	1.624 (1.047–2.518)
TMD symptoms	
No	1
Yes	1.801 (1.190–2.724)
Dental Caries	
None	1
At least one tooth	1.460 (0.905–2.356)

(*continued on next page*)

Table 3 (*continued*)

Variables	Impact on physical pain – OHIP-14
	Adjusted PR (95%CI)
Periodontal Diseases	
Healthy	1
Gingivitis	0.502 (0.230–1.097)
Periodontitis	0.705 (0.383–1.298)

Exponentiated coefficients; 95% confidence intervals (CI) in parenthesis. The proportions were calculated considering the sample weight.

reducing estimate bias through the selection of covariates and model adjustment involving exposure (main independent variable) and an outcome (dependent variable). The graph also illustrates the adjustment variables and variables that were not measured in the study, which can interfere in the causal path between the exposure and outcome variables [60]. The DAG was used also to adjust regression models for each dimension of the OHIP-14. All analyzes were performed considering the correction for the design effect and sample weight for each individual, the probability of random street selection, and the non-response rate on each street. Statistical analyses were performed using SPSS® 17.0 (SPSS Inc., Chicago, IL, USA) and Stata® 15.0 (StataCorp, CollegeStation, Texas, USA) softwares.

3. Results

One hundred and ninety-seven adults participated in the study. The average age was 40.05 years (SD = 0.364), the majority was female (70.2%), non-white (88.1% black, brown, yellow and indigenous, of which 55.3% were brown), with ≥9 years of education (52.5%) and with a monthly family income of up to US$ 283 (36.2%) (Table 1).

Physical and psychosocial impact of oral health was reported by 114 individuals (59.3%; 95% CI: 50.51–67.53). The dimensions with highest frequency of impact were psychological discomfort (49.6%, 95% CI: 41.2–58.1) and physical pain (30.9%; 95% CI: 23.3–39.8), followed by psychological disability (25.7%; 95% CI: 19.9–32.5), physical disability (16.3%; 95% CI: 12.19–21.52), handicap (11.4%; 95% CI: 6.4–19.6), social disability (6.7%; 95% CI %: 4.0–11.0), and functional limitation (5.4%; 95% CI: 2.9–9.5).

DH prevalence was of 38.75% (95% CI: 29.39–49.03), mostly of moderate (15.92%; 95% CI: 9.45–25.58) and intense (13.34%; 95% CI: 8.36–20.63) severity. Most of the participants (63.6%; 95% CI: 53.47–72.44) had NCCL, with an average of 2.5 affected dental surfaces. Most of the tooth wear lesions were on buccal surfaces (125; 62.8%), while 25 people (19.4%) presented NCCL on the lingual surfaces of teeth. Premolars were the most affected teeth (Figure 2). Approximately 1/3 of the participants had only NCCL (32.28%; 95% CI: 25.48–39.92) or had both conditions (NCCL and DH) (31.33%; 95% CI: 22.77–41.38) (Table 1).

Adults with DH alone showed a higher prevalence of oral health impact (PR: 1.57; 95% CI: 1.02–2.42). Education, toothbrushing frequency, medication use, TMD symptoms, and periodontal disease (gingivitis) were also associated with oral health impact (Table 2).

Figure 3 shows the proportion of oral health impact for each of the dimensions of the OHIP-14 according to the presence of NCCL, with or without DH. Higher oral health impact frequencies were observed for the physical pain and psychological discomfort dimensions. There was a higher prevalence of oral health impact on the physical dimension among those with DH alone (PR: 2.46; 95% CI 1.21–5.00) and those with DH and NCCL (PR: 2.03; 95% CI 1.21–3.41) (Figure 3) (Table 3). For other dimensions, the associations were not significant.

4. Discussion

The present study demonstrated that DH is a discomfort associated with the physical dimension of OHRQoL regardless of the presence of NCCL [4, 18]. Although it is not considered a severe oral health problem by individuals and professionals [4, 15], DH and its severity must be assessed in the oral exam and appropriate treatment should be provided for better comfort and well-being of those affected.

The prevalence of NCCL (63.6%) was close to the values observed in studies from South America (69.0%) [1] and China [19, 20] and in patients (>18 years old) from a teaching clinic in São Paulo, Brazil (67.8%) [12]. A lower NCCL prevalence (46.7%) was estimated in a meta-analysis [1] of studies from several countries and in a sample of Chinese people [17]. A study conducted with 100 labor workers (20–68 years old) from the state of São Paulo found a NCCL prevalence of 76.84% [16], higher than the value observed in the present study. Several differences among studies may explain the different prevalence rates, including age range, socioeconomic and cultural factors, eating habits, toothbrushing, and health behaviors (such as smoking and alcohol consumption), in addition to the study designs, diagnostic criteria, and methodologies [18, 21]. The NCCLs were almost symmetrical and premolars were the most affected teeth, as seen in other studies [9, 14, 17, 19, 21], which can be justified by the greater occlusal forces and the cervical anatomy of posterior teeth especially premolars, as well as the progressive development of posterior group function occlusion [18, 19].

Approximately 1/3 of participants had NCCL with more than 1 mm of wear, a higher prevalence than that observed in a Chinese study with adults aged 35–44 years [18], probably due to the greater age range in the present study since the severity of NCCL tends to increase with age [14, 18, 19, 20]. Once tooth wear occurs, dental treatment is needed to avoid worsening of the condition.

The presence of DH, regardless the existence of NCCL, was reported by approximately 40% of participants. Various prevalence estimates have been reported, with studies using different methodological approaches [5, 6, 7, 8, 12, 13, 19, 22, 23, 24]. Given the high frequency of this condition, the resulting limitations, impairments and disabilities in daily activities must be explored.

Adults with DH but no NCCL showed higher overall oral impact after adjusting for potential confounding factors. Participants with DH, with or without NCCL, presented a higher prevalence of physical pain impact. As the physical pain dimension is based on self-reported pain in the mouth or teeth and discomfort when eating some kinds of food, the finding indicates that DH is perceived as a painful symptom that can restrict food choices. Physical pain from DH affects food selection as indicated by a greater discomfort when drinking cold water (28.3%) or eating ice cream (26.0%), grater difficulties in receiving dental prophylaxis and toothbrushing (14.1%) [15], and a higher need for selecting food due to chewing problems [30].

In the present study, no significant association was found between DH (with or without NCCL) and functional limitations (problems with speaking or altered food taste), psychological discomfort (anxiety and stress due to mouth problems), physical, psychological or social disability (impaired eating, interrupted meals, difficulty in relaxing, feeling ashamed, irritation with other people, or difficulty to perform daily activities), and handicap (feeling that life got worse, inability to perform daily activities). It is likely that, although DH causes pain and discomfort, affected individuals develop adaptive strategies to maintain their normal performance of daily activities [32].

This result is not consistent with findings from clinical trials, which reveal a reduction in the impact on these dimensions after clinical DH treatment [31, 33, 42]. However, some authors have argued that the finding should be carefully interpreted as it may be influenced by social desirability, i.e., trying to please the dentist by reporting better results after treatment, or under-reporting the impact of DH to justify their participation in the study. Additionally, receiving any type of care can have a positive emotional effect, which interferes with the reported oral health impact. Another aspect that must be considered is that intervention studies often select individuals with DH and gingival recession in canines and premolars, which affects not only function but also esthetics. Thus, after surgical intervention of root covering, a higher OHRQoL score may be in part related to esthetics improvements [31].

In the present study, the presence of NCCL alone was not associated with oral health impact. Once the wear process in NCCL reaches pathological levels, dentine exposure and DH can occur, compromising tooth vitality and structural integrity, which could lead to the loss of masticatory units, thus impacting the performance of daily activities [2, 9, 14]. More severe tooth wear had a greater negative impact on the limitation and psychological discomfort dimensions, which may be related to the sum of consequences of the condition (impaired esthetics and DH) [61].

Consistent with the literature, there was a higher prevalence of oral health impact among those with lower educational level [26, 49], less toothbrushing frequency [62], presence of TMD symptoms [2, 11, 21, 58], and periodontal disease [2, 3, 10, 13, 19, 31, 42, 58]. In the present study, a causality model approach was used to guide model adjustments with cross-sectional data. However, the observed associations must be interpreted in light of the inherent limitation of the study design, in which the sample size was not calculated to estimate associations, increasing the possibility of type II error. External validity is restricted to the city of Rio Acima, but the results can be considered as a reference for adults with a similar profile. In addition, some confounding variables were not assessed, such as lifestyle, long-term diseases, and salivary aspects. This definition of the age group was based on the World Health Organization recommendation to delineate the sample for assessing the oral health of adults (35–44 years). However, due to difficulty reaching the minimum sample size, this study included those 30–49 years old to make the research feasible.

The tactile test with a probe can underestimate the presence of DH since the probe can miss sensitive spots, but the thermal or evaporative stimulus were unfeasible due to the conditions of data collection. The TWI index was chosen to score the level of wear of NCCL in all buccal and lingual surfaces of all teeth, irrespective of cause, allowing assessment of NCCL severity according to the degree of wear. This index increases the sensitivity of the exam avoiding underestimation of the condition in the population. The TWI is considered a good index and it has been used in previous epidemiological studies [14, 17, 18, 20, 21]. In this study, the definition of NCCL was based on the presence of any level of wear (Code 2 to 4) to overcome one of the limitations of the index that discriminates between pathological and physiological wear according to the type of tooth and age.

Dental practice must be guided according to the populations' epidemiological reality and the individuals own perception of health. Demonstrating the prevalence of common oral conditions such as NCCL and DH guides professionals in identifying factors that can lead to the development or worsening of these conditions at an individual level and providing appropriate interventions to control the impact of oral diseases in daily life.

5. Conclusion

NCCL and DH are common conditions among adults and DH alone is associated with oral health impact. Regardless of the presence of NCCL, DH is associated with impact in the physical pain dimension of OHRQoL.

Declarations

Author contribution statement

Anna Rachel dos Santos Soares, Loliza Luiz Figueiredo Houri Chalub and Raquel Conceição Ferreira: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Rayssa Soares Barbosa: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Deborah Egg de Paiva Campos: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Allyson Nogueira Moreira: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This work was supported by FAPEMIG, Brazil (Fundação de Amparo à Pesquisa do Estado de Minas Gerais - Programa Pesquisador Mineiro – PPM-00686-16 and PPM-00603-18); "Pró-Reitoria de Pesquisa, Universidade Federal de Minas Gerais", Brazil; "Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES)" [001].

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

[1] D.N.R. Teixeira, R.Z. Thomas, P.V. Soares, M.S. Cune, M.M. M Gresnigt, D.E. Slot, Prevalence of noncarious cervical lesions among adults: a systematic review, J. Dent. 95 (2020).
[2] L. C Levitch, J.D. Bader, D.A. Shugars, H.O. Heymann, Non-carious cervical lesions, J. Dent. 22 (1994) 195–207.
[3] R.C. Olley, H. Sehmi, The rise of dentine hypersensitivity and tooth wear in an ageing population, Br. Dent. J. 223 (2017) 293–297.
[4] C.H. Splieth, A. Tachou, Epidemiology of dentin hypersensitivity, Clin. Oral Invest. 17 (2013) 3–8.
[5] L. Favaro Zeola, P.V. Soares, J. Cunha-Cruz, Prevalence of dentin hypersensitivity: systematic review and meta-analysis, J. Dent. 81 (2019) 1–6.
[6] N.X. West, M. Sanz, A. Lussi, D. Bartlett, P. Bouchard, D. Bourgeois, Prevalence of dentine hypersensitivity and study of associated factors: a European population-based cross-sectional study, J. Dent. 41 (2013) 841–851.
[7] C. Fischer, R.G. Fischer, A. Wennberg, Prevalence and distribution of cervical dentine hypersensitivity in a population in Rio de Janeiro, Brazil, J. Dent. 20 (1992) 272–276.
[8] T. Scaramucci, T.E. de Almeida Anfe, S. da Silva Ferreira, A. C Frias, M.A. Sobral, Investigation of the prevalence, clinical features, and risk factors of dentin hypersensitivity in a selected Brazilian population, Clin. Oral Invest. 18 (2014) 651–657.
[9] D. Telles, L.F. Pegoraro, J.C. Pereira, Incidence of noncarious cervical lesions and their relation to the presence of wear facets, J. Esthetic Restor. Dent. 18 (2006) 178–183.
[10] L. Pikdöken, E. Akca, B. Gürbüzer, B. Aydil, B. Taşdelen, Cervical wear and occlusal wear from a periodontal perspective, J. Oral Rehabil. 38 (2011) 95–100.
[11] W.A. Smith, S. Marchan, R.N. Rafeek, The prevalence and severity of non-carious cervical lesions in a group of patients attending a university hospital in Trinidad, J. Oral Rehabil. 35 (2008) 128–134.
[12] K.T. Yoshizaki, L.F. Francisconi-Dos-Rios, M.A. Sobral, A.C. Aranha, F.M. Mendes, T. Scaramucci, Clinical features and factors associated with non-carious cervical lesions and dentin hypersensitivity, J. Oral Rehabil. 44 (2017) 112–118.
[13] D.N.R. Teixeira, L.F. Zeola, A.C. Machado, R. R Gomes, P.G. Souza, D.C. Mendes, P.V. Soares, Relationship between noncarious cervical lesions, cervical dentin hypersensitivity, gingival recession, and associated risk factors: a cross-sectional study, J. Dent. 76 (2018) 93–97.

[14] J. Borcic, I. Anic, M.M. Urek, S. Ferreri, The prevalence of non-carious cervical lesions in permanent dentition, J. Oral Rehabil. 31 (2004) 117–123.
[15] D.G. Gillam, H.S. Seo, J.S. Bulman, H.N. Newman, Perceptions of dentine hypersensitivity in a general practice population, J. Oral Rehabil. 26 (1999) 710–714.
[16] R.A. Bomfim, E. Crosato, L.E. Mazzilli, A.C. Frias, Prevalence and risk factors of non-carious cervical lesions related to occupational exposure to acid mists, Braz. Oral Res. 29 (2015) 1–8.
[17] H. Jiang, M.Q. Du, W. Huang, B. Peng, Z. Bian, B.J. Tai, The prevalence of and risk factors for non-carious cervical lesions in adults in Hubei Province, China, Community Dent. Health 28 (2011) 22–28.
[18] Z.Y. Lai, Q.H. Zhi, Y. Zhou, H.C. Lin, Prevalence of non-carious cervical lesions and associated risk indicators in middle-aged and elderly populations in Southern China, Chin. J. Dent. Res. 18 (2015) 41–50.
[19] K. Que, B. Guo, Z. Jia, Z. Chen, J. Yang, P. Gao, A cross-sectional study: non-carious cervical lesions, cervical dentine hypersensitivity and related risk factors, J. Oral Rehabil. 40 (2013) 24–32.
[20] J. Yang, D. Cai, F. Wang, D. He, L. Ma, Y. Jin, K. Que, Non-carious cervical lesions (NCCLs) in a random sampling community population and the association of NCCLs with occlusive wear, J. Oral Rehabil. 43 (2016) 960–966.
[21] A. Zuza, M. Racic, N. Ivkovic, J. Krunic, N. Stojanovic, D. Bozovic, D. Bankovic-Lazarevic, M. Vujaskovic, Prevalence of non-carious cervical lesions among the general population of the Republic of Srpska, Bosnia and Herzegovina, Int. Dent. J. 69 (2019) 281–288.
[22] R.S. Costa, F.S. Rios, M.S. Moura, J.J. Jardim, M. Maltz, A. N Haas, Prevalence and risk indicators of dentin hypersensitivity in adult and elderly populations from Porto Alegre, Brazil, J. Periodontol. 85 (2014) 1247–1258.
[23] K. Que, J. Ruan, X. Fan, X. Liang, D. Hu, A multi-centre and cross-sectional study of dentine hypersensitivity in China, J. Clin. Periodontol. 37 (2010) 631–637.
[24] W. Ye, X.P. Feng, R. Li, The prevalence of dentine hypersensitivity in Chinese adults, Jo, Oral Rehabil. 39 (2012) 182–187.
[25] M.J. Santana, L. Haverman, K. Absolom, E. Takeuchi, D. Feeny, M. Grootenhuis, G. Velikova, Training clinicians in how to use patient-reported outcome measures in routine clinical practice, Qual. Life Res. 24 (2015) 1707–1718.
[26] M.F. Silveira, J.P. Marôco, R.S. Freire, A.M.E.B.L. Martins, L.F. Marcopito, Impacto da saúde bucal nas dimensões física e psicossocial: uma análise através da modelagem com equações estruturais, Cad. Saúde Pública 30 (2014) 1–15.
[27] R.M. Baiju, E. Peter, N.O. Varghese, R. Sivaram, Oral health and quality of life: current concepts, J. Clin. Diagn. Res. 11 (2017) Ze21–Ze26.
[28] M.L. Zucoloto, J. Maroco, J.A. Campos, Impact of oral health on health-related quality of life: a cross-sectional study, BMC Oral Health 16 (2016) 1–6.
[29] K. Bekes, M.T. John, H.G. Schaller, C. Hirsch, Oral health-related quality of life in patients seeking care for dentin hypersensitivity, J. Oral Rehabil. 36 (2009) 45–51.
[30] M. Masud, F.H. Al Bayaty, N.A.H. Muhamed, A.S. Alwi, Z. Takiyudin, M.F.H. Hidayat, Gingival recession and dentine hypersensitivity in periodontal patients: is it affecting their oral health related quality of life? J. Int. Dent. Medical Res. 10 (2017) 909–914.
[31] M. Rocha Dos Santos, J.P.M. Sangiorgio, F.L.S. Neves, I.L. França-Grohmann, F.H. Nociti Jr., K.G. Silverio Ruiz, M.P. Santamaria, E.A. Sallum, Xenogenous collagen matrix and/or enamel matrix derivative for treatment of localized gingival recessions: a randomized clinical trial. Part II: patient-reported outcomes, J. Periodontol. 88 (2017) 1319–1328.
[32] J.M. Porritt, F. Sufi, A. Barlow, S.R. Baker, The role of illness beliefs and coping in the adjustment to dentine hypersensitivity, J. Clin. Periodontol. 41 (2014) 60–69.
[33] K.S. Bekes, H. G, C. Hirsch, Improvement of oral health-related quality of life in subjects with dentin hypersensitivity, ZWR (Heidelb.) 117 (2008) 136–142.
[34] V. Goh, E.F. Corbet, W.K. Leung, Impact of dentine hypersensitivity on oral health-related quality of life in individuals receiving supportive periodontal care, J. Clin. Periodontol. 43 (2016) 595–602.
[35] P.I. Idon, T.A. Esan, C.T. Bamise, Oral health-related quality of life in patients presenting with dentine hypersensitivity: a randomized controlled study of treatment effect, Eur. J. Gen. Dent. 6 (2017) 99–105.
[36] T.C. Lima, N.M. Vieira-Barbosa, C. Grasielle de Sá Azevedo C, F.R. de Matos, D.W. Douglas de Oliveira, E.S. de Oliveira, M.L. Ramos-Jorge, P.F. Gonçalves, O.D. Flecha, Oral health-related quality of life before and after treatment of dentin hypersensitivity with cyanoacrylate and laser, J. Periodontol. 88 (2017) 166–172.
[37] T.L. Melo, M.J.C.N. Silva, B.M. de Sousa, S.A.A. de Freitas Pereira, E.M. Pereira, A.F.V. Pereira, Sensibilidade da dentina e o impacto na qualidade de vida de pacientes com periodontite crônica da Universidade Federal do Maranhão, Arq. Odontol. 51 (2015) 179–185.
[38] J. Porter, A. Ntouva, A. Read, M. Murdoch, D. Ola, G. Tsakos, The impact of oral health on the quality of life of nursing home residents, HQLO 13 (2015).
[39] G. Sivaramakrishnan, K. Sridharan, Fluoride varnish versus glutaraldehyde for hypersensitive teeth: a randomized controlled trial, meta-analysis and trial sequential analysis, Clin. Oral Invest. 23 (2019) 209–220.
[40] T.P. Wagner, R.S. Costa, F.S. Rios, M.S. Moura, M. Maltz, J.J. Jardim, A.N. Haas, Gingival recession and oral health-related quality of life: a population-based cross-sectional study in Brazil, Community Dent. Oral Epidemiol. 44 (2016) 390–399.
[41] S. Başaran, C. Celik, Turkish adaptation of dentine hypersensitivity experience Questionnaire (DHEQ), community dent, Health 35 (2018) 47–51.
[42] D.W. Douglas de Oliveira, D.P. Marques, I.C. Aguiar-Cantuária, O. D Flecha, P. F Gonçalves, Effect of surgical defect coverage on cervical dentin hypersensitivity and quality of life, J. Periodontol. 84 (2013) 768–775.
[43] C. Hall, F. Sufi, N. Wang, C.R. Goyal, Efficacy of an experimental 3% potassium nitrate mouthwash in providing long-term relief from dentin hypersensitivity:An 8-week randomized controlled study (Study 1), Am. J. Dent. 30 (2017) 27–34. https://pubmed.ncbi.nlm.nih.gov/29178711/.
[44] C. Machuca, M.V. Vettore, M. Krasuska, S.R. Baker, P.G. Robinson, Using classification and regression tree modelling to investigate response shift patterns in dentine hypersensitivity, BMC Med. Res. Methodol. 17 (2017).
[45] S. Mason, G.R. Burnett, N. Patel, A. Patil, R. Maclure, Impact of toothpaste on oral health-related quality of life in people with dentine hypersensitivity, BMC Oral Health 19 (2019).
[46] F. Sufi, C. Hall, S. Mason, D. Shaw, L. Kennedy, J.T. Gallob, Efficacy of an experimental toothpaste containing 5% calcium sodium phosphosilicate in the relief of dentin hypersensitivity: an 8-week randomized study (Study 1), Am. J. Dent. 29 (2016) 93–100. https://pubmed.ncbi.nlm.nih.gov/27295867/.
[47] F. Sufi, C. Hall, S. Mason, D. Shaw, J. Milleman, K. Milleman, Efficacy of an experimental toothpaste containing 5% calcium sodium phosphosilicate in the relief of dentin hypersensitivity: an 8-week randomized study (Study 2), Am. J. Dent. 29 (2016) 101–109. https://pubmed.ncbi.nlm.nih.gov/27295868/.
[48] J.M. Porritt, F. Sufi, S.R. Baker, Utilising daily diaries to examine oral health experiences associated with dentine hypersensitivity, BMC Oral Health 16 (2016).
[49] M.C.L. Gabardo, S.J. Moysés, S.T. Moysés, M. Olandoski, M.T.A. Olinto, M.P. Pattussi, Social, economic, and behavioral variables associated with oral health-related quality of life among Brazilian adults, Ciência Saúde Coletiva 20 (2015) 1531–1540.
[50] N.F.F. Barroso, P.M. Alcântara, A.M. Botelho, D.W. Douglas-de-Oliveira, P.F. Gonçalves, O.D. Flecha, Prevalence of self-reported versus diagnosed dentinal hypersensitivity: a cross-sectional study and ROC curve analysis, Acta Odontol. Scand. 77 (2019).
[51] IBGE, Instituto Brasileiro de Geografia e Estatística. Censo demográfico: Rio Acima, IBGE, 2010. Accessed from, https://cidades.ibge.gov.br/brasil/mg/rio-acima/pesquisa/23/25888?detalhestrue.
[52] World Health Organization, Oral health surveys: basics methods, in: Organization WH, fifth ed., 2013. Geneva.
[53] R.S. Pinto, D.L. Leal, J.S. Santos, A.G. Roncalli, Projeto SB Minas Gerais 2012: Pesquisa das Condições de Saúde Bucal da População Mineira - Métodos e Resultados Principais, Arq. Odontol. 54 (2018) 1–12.
[54] B.H. Oliveira, P. Nadanovsky, Psychometric properties of the Brazilian version of the oral health impact profile-short form, Community Dent. Oral Epidemiol. 33 (2005) 307–314.
[55] B.G. Smith, J.K. Knight, An index for measuring the wear of teeth, Br. Dent. J. 156 (1984) 435–438.
[56] R.K. Thetakala, B.R. Chandrashekar, S. Sunitha, M. Maurya, P. Sharma, G. Shubhi, Bruxism and oral health-related quality of life among male inmates in a penal institution, Mysore: a cross-sectional study, Indian J. Dent. Res. 29 (2018) 275–279.
[57] E. Bernabé, W. Marcenes, Periodontal disease and quality of life in British adults, J. Clin. Periodontol. 37 (2010) 968–972.
[58] O. Bernhardt, D. Gesch, C. Schwahn, F. Mack, G. Meyer, U. John, T. Kocher, Epidemiological evaluation of the multifactorial aetiology of abfractions, J. Oral Rehabil. 33 (2006) 17–25.
[59] D.W. Bartlett, A. Lussi, N.X. West, P. Bouchard, M. Sanz, D. Bourgeois, Prevalence of tooth wear on buccal and lingual surfaces and possible risk factors in young European adults, J. Dent. 41 (2013) 1007–1013.
[60] I. Shrier, R.W. Plat, Reducing bias through directed acyclic graphs, BMC Med. Res. Methodol. 8 (2008).
[61] M.H.M. Li, E. Bernabé, Tooth wear and quality of life among adults in the United Kingdom, J. Dent. 55 (2016) 48–53.
[62] L.B. Ortíz-Barrios, V. Granados-García, P. Cruz-Hervert, K. Moreno-Tamayo, E. Heredia-Ponce, S. Sánchez-García, The impact of poor oral health on the oral health-related quality of life (OHRQoL) in older adults: the oral health status through a latent class analysis, BMC Oral Health 19 (2019).