SCIENTIFIC RESEARCH REPORT

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Prevalence of non-carious cervical lesions among the general population of the Republic of Srpska, Bosnia and Herzegovina

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Introduction: As non-carious cervical lesions (NCCLs) may compromise aesthetics and function, knowledge of their aetiological covariables enhances management of clinical complaints and success of restorative treatments. **Aims:** The primary aim of this study was to assess the presence of NCCLs among the general population of the Republic of Srpska, Bosnia and Herzegovina and the potential association with patient-related risk factors. **Methods:** A prevalence study of NCCLs included 738 respondents from eight towns/municipalities. Two dental practitioners examined all respondents. NCCLs were diagnosed according to the Smith and Knight tooth wear index, measured using a Williams periodontal probe. Data regarding risk factors were obtained through a structured questionnaire. Multivariate logistic regression was used to analyse the association of risk factors and the occurrence of NCCLs. **Results:** Non-carious cervical lesions were diagnosed in 384 (52%) respondents. Multivariate regression analysis showed that several variables were independently associated with the risk of developing NCCLs, including frequent consumption of acid food ($P = 0.001$), frequent consumption of acid drinks ($P = 0.001$), retaining drink in the mouth ($P = 0.001$), alcohol consumption ($P = 0.030$), bruxism ($P = 0.018$) and gastro-oesophageal reflux ($P = 0.023$). First mandibular premolars were the most affected teeth (left: 46.0%; right: 44.0%), followed by the second right maxillary premolars (37.3%), second left maxillary premolars (33.6%) and finally by the first right maxillary premolars (34.0%). **Conclusion:** The results of the current study suggest that NCCLs occur frequently and have a multifactorial aetiology. The lowest prevalence was recorded among individuals younger than 20 years of age. As the majority of risk factors are modifiable, regular dental care could lead to the early detection of NCCLs.

Key words: *Non-carious cervical lesions, patient-related risk factors, prevalence study, tooth, wear index*

INTRODUCTION

Non-carious cervical lesions (NCCLs) are defined as the loss of hard tooth tissue at the cemento–enamel junction[1–7]. These lesions are unrelated to dental caries and occur most often on the buccal surfaces of the mandibular first premolars (32.3%) and maxillary second premolars (22%)[2]. The prevalence of NCCLs ranges from 0.8% to 85.7%[8]. Elderly people commonly have a higher number and greater severity of lesions than do individuals younger than 40 years of age, because of exposure to various aetiological factors over a long period of time[9]. Notwithstanding previous studies, which identified the multifactorial aetiology of NCCLs, the views on its origin are still conflicting[10–14]. Grippo *et al.*[10] designate NCCLs as being caused by a complex interaction of erosion/corrosion, stress and friction, suggesting that the term 'erosion' (physical mechanism causing tooth wear by friction from the movement of liquids) should be substituted with the term 'biocorrosion' (the loss of dental tissue from chemical processes)[10,15]. Biocorrosion of teeth can be extrinsic-chemical exogenous,

intrinsic-biochemical endogenous and idiopathic[16]. Attributable to tensile stresses and occlusal compressive forces, dental flexure in the cervical area results in abfraction (microstructural loss of dental tissue weakened in areas of concentrated stress), fatigue of dentin and enamel, as well as in deformation of the tooth structure[17]. Friction from exogenous materials, such as markedly vigorous oral hygiene, chewing on toothpicks or using abrasive toothpaste, leads to abrasion of the tooth surface[16]. The aetiology of NCCLs also includes attrition. Attrition is the gradual physiological process of wearing down hard tooth tissue, caused by friction through tooth-to-tooth contact during mastication. Parafunctional habits (bruxism, clenching) may cause pathological levels of attrition on occlusal and incisal dental surfaces[18]. Cumulative effects of biocorrosion, attrition, abrasion and abfraction are often outcomes of detrimental unmodifiable (such as age and gender) or modifiable patient-related factors. Modifiable factors include drinking beverages that are acidic or contain a large amount of alcohol or sugar, consuming acidic food, poor oral hygiene methods, medical predisposition, tobacco usage, mastication of hard and resistant foods, biting of hard objects, holding of objects with teeth, playing woodwind instruments, severing thread with teeth, exposure to acidic industrial gases and other harmful environmental factors[10]. Excessive hand force during toothbrushing (in conjunction with the abrasiveness of toothpastes and horizontal brushing along the cervical margins) could be a cause of permanent wear of the dentin in the cervical region of the teeth and of trauma to the periodontium[19–21]. Doubts about these explanations were expressed recently because NCCLs often appear not only on a single tooth but also in a non-brushing population[22,23].

Morphologically, NCCLs present as saucer-shaped or wedge-shaped, with each type being associated with different contributing factors[24,25]. As NCCLs may compromise aesthetics and function, knowledge of their characteristics and aetiological covariables among local populations enhances management of clinical complaints and success of restorative treatments[26].

The primary aim of this study was to assess the presence of NCCLs among the general population of the Republic of Srpska, Bosnia and Herzegovina and the potential relationship between patient-related risk factors. The secondary aim was to determine the number and location of teeth most commonly affected by NCCLs.

METHODS

Study design and participants

A prevalence study of NCCLs was conducted to investigate the prevalence of NCCLs and effects of a variety of risk factors. The study included 738 respondents from eight towns/municipalities in the Republic of Srpska, Bosnia and Herzegovina. Two towns were selected based on the number of inhabitants and economic development. Municipalities were selected randomly, by allocating a certain number to each municipality. The strips with the municipalities' names were put in a box, mixed, and then six strips were pulled out from the box.

At each of the above locations, at least 80 individuals were selected randomly. Exclusion criteria for enrollment in the study included having extensive dental caries, a dental prosthesis, dental braces and previously undergoing tooth whitening.

School-age respondents were selected according to the location of the school, starting with the first class from the numerical list. Elderly respondents were recruited from their own homes. The researchers chose homes in the vicinity of the school. By going to the left side of the school, starting with the first street number and following on to the next street number, the researchers screened for individuals older than 65 years of age. The working age population was selected by selecting names from the employee lists from local companies. The respondents were enrolled consecutively until the required sample size per location and age group was achieved.

Each respondent ≥18 years of age was informed about the research objectives and asked to sign a consent form agreeing to participate in the study. For children under the age of 18 the parent provided written informed consent on behalf of the child. Respondents, children and parents had an opportunity to ask any questions related to the study. Consent procedure included the clause that confidentiality and anonymity would not be breached by releasing any personal information without the subjects' permission, including a signed informed consent form. Data were stored securely in a form that prevented identification of individuals. The study and consent procedure were independently reviewed and approved by the Ethics Committee of the Faculty of Medicine Foca (Code No.01-1502).

The study was conducted in accordance with the World Medical Association Declaration of Helsinki, as revised in 2008. Data collection took place in 2016.

Clinical assessment

To detect the presence and location of NCCLs, two precalibrated dentists performed an intra-oral examination with the respondents in a dental chair, focussing the examination on the cervical portion of the vestibular surface of the teeth using a sterile flat mirror and a periodontal probe with 1-mm graduations

(Williams periodontal probe). The kappa statistic was used to test reliability. Prior to beginning and three times during the course of the study, both dentists determined the presence and depth of NCCLs in 20 randomly selected patients. The kappa coefficient values ranged between 0.81 and 0.92 for intra-examiner agreement and between 0.78 and 0.85 for interexaminer agreement. Number of teeth present, number of NCCLs, their size and their location were analysed and recorded. NCCLs were considered if loss of dental tissue near the cemento–enamel junction were found in the absence of caries.

The tip of the probe was placed into the gingival sulcus and kept parallel to the line angle of the root of the tooth. If the Williams probe was retained because of some irregularities in the cervical surface, tooth wear was measured according to the Smith and Knight tooth wear index (TWI)[27].

The TWI scores were classified as 0 (no loss of enamel surface characteristic, no loss of contour), 1 (minimal loss of enamel contour), 2 (defect <1 mm in depth), 3 (defect 1–2 mm in depth) or 4 (defect >2 mm in depth/pulp exposure/secondary dentine exposure). The letter R was employed to mark the surfaces that could not be evaluated according to TWI (restored surface, a surface that was fractured as a result of extensive caries and a surface covered with plaque or dental calculus). The differentiation in these cases was provided by comparing the affected tooth with the morphology of the same area observed on adjacent and contralateral teeth.

According to the presence or absence of an NCCL, the respondents were allocated into one of two groups: a group with NCCLs and group without NCCLs.

Questionnaire

A self-administered questionnaire was used to assess patient-related risk factors for the development of NCCLs. The items were identified for inclusion in the questionnaire based on a literature review[10]. Sociodemographic data collected were age, gender, occupation, education and place of residence. The possible risk factors were noted. Toothbrushing included frequency, method (horizontal or vertical techniques), intensity of toothbrushing (mild, moderate, hard), hardness of toothbrush (soft, medium or hard) and duration of toothbrushing. Biting and chewing habits (occurrence and frequency of bruxism, clenching or chewing on hard objects) were evaluated. The questionnaire also contained items about medical history [related to gastrointestinal problems such as belching, heartburn, vomiting, gastro-oesophageal reflux (GER), peptic ulcer disease], eating disorders (anorexia, bulimia), medication list, teeth whitening, orthodontic treatment, frequency of consuming acidic food and fruits, frequency of having carbonated beverages and alcohol, smoking status and use of narcotics.

Pilot testing was conducted to evaluate user-friendliness of the questionnaire. The respondents selected for the pilot testing were 20 people who were representative of the target population. Cronbach's alpha coefficient was calculated to assess the reliability, and its value of 0.780 was found to be acceptable. The respondents' identifiers were not collected to ensure anonymity and confidentiality throughout the study.

Statistical analysis

Statistical analysis was carried out using the Statistical Package for Social Science (SPSS) version 19 (SPSS IBM, Inc., Chicago, IL, USA). Patients' sociodemographic characteristics were analysed using descriptive statistics. Categorical variables were tested using the chi-square test. To explore the influence of patient-related risk factors on the development of NCCLs, univariate logistic regression analysis was undertaken. Statistically significant independent variables were included in multivariate logistic regression models. Values of $P < 0.05$ were considered significant.

RESULTS

The survey included 738 respondents. Their mean age was 37.75 ± 16.45 years, and age range was 13–74 years. The ratio of male to female patients was 50.9%:49.1%. NCCLs were diagnosed in 384 (52%) of respondents.

Statistically significant differences in the prevalence of NCCLs were not found according to gender ($P = 0.270$), place of living ($P = 0.094$), hardness of toothbrush ($P = 0.062$) and smoking ($P = 0.067$). The lowest prevalence of NCCLs was recorded in the age group between 10 and 25 years (16.3%) and the highest prevalence (81.1%) was detected among respondents older than 65 years ($P = 0.001$). Respondents with a higher level of education had a higher prevalence of NCCLs than did those with lower education ($P = 0.001$). Respondents in a group with NCCLs changed a toothbrush more frequently ($P = 0.021$), drank with a straw ($P = 0.001$), took long-term medication ($P = 0.001$), but used toothpaste with toothbrushing less compared with a group without NCCLs ($P = 0.001$; *Table 1*).

Table 2 shows the distribution of NCCLs according to the tooth type and mouth quadrants. First mandibular premolars were the teeth most affected (left: 46.0%; right: 44.0%), followed by the second right maxillary premolars (37.3%), the second left maxillary premolars (33.6%) and the first right maxillary premolars (34.0%). The proportion of central

incisors and lateral incisors affected with NCCLs was higher in the mandible than in the maxilla. It was observed that the majority of NCCLs on canine teeth occurred in the left mandibular quadrant, followed by right mandibular quadrant (*Table 2*).

The distribution of TWI scores per teeth and mouth quadrants is presented in *Table 3*. NCCLs on central incisors most commonly occurred in the form of an initial contour defect, labelled as score 1. The values of all TWI scores were higher on the mandibular central and lateral incisors than on the maxillary central and lateral incisors. The highest frequency of scores 2 and 3 was recorded for the first mandibular premolars, mandibular canines and second premolars. Score 4, a contour defect more than 2 mm in depth, were the most prevalent scores on the first mandibular premolars and mandibular canines.

Frequency of toothbrushing once and twice daily, unspecified toothbrushing technique and no consumption of acid drinks were protective factors for the development of NCCLs, while the presence of health problems, parafunction habits, horizontal toothbrushing technique, alcohol consumption, consumption of acid drinks, retaining drink in mouth before swallowing and long-term use of medication were identified as risk factors (*Table 4*).

Multivariate analyses showed that several variables were independently associated with the risk of developing NCCLs, including frequent consumption of acid food ($P = 0.001$), frequent consumption of acid drinks ($P = 0.001$), retaining drink in the mouth ($P = 0.001$), alcohol consumption ($P = 0.030$), bruxism ($P = 0.018$) and GER ($P = 0.023$; *Table 5*).

Table 1 Sociodemographic/clinical characteristics of respondents and the presence of non-carious cervical lesions (NCCLs)

Variable	NCCLs *n* (%)	Without NCCLs *n* (%)	*P* value
Gender			
Male	188 (48.9)	188 (53.1)	0.270
Female	196 (51.1)	166 (46.9)	
Age (years)			
10–25	26 (16.3)	134 (83.7)	0.001
26–35	64 (39.7)	97 (60.3)	
36–45	105 (66.1)	55 (33.9)	
46–55	87 (66.9)	43 (33.1)	
56–65	46 (78.0)	13 (22.0)	
>65	56 (81.1)	12 (18.9)	
Education			
Elementary school	61 (39.1)	95 (60.9)	0.001
High school	192 (54.2)	162 (45.8)	
Associate degree	50 (49.5)	51 (50.5)	
University degree	81 (66.1)	46 (33.9)	
Place of living			
Urban	244 (52.5)	221 (47.5)	0.094
Rural	140 (51.3)	133 (48.7)	
Intensity of toothbrushing			
Mild	35 (9.1)	43 (12.2)	0.039
Moderate	317 (82.6)	296 (83.6)	
Hard	32 (8.3)	15 (4.2)	
Hardness of toothbrush			
Soft	31 (8.1)	43 (12.1)	0.062
Medium	159 (41.4)	16 (46.3)	
Hard	25 (6.5)	18 (5.2)	
Unspecified	169 (44.0)	129 (36.4)	
Duration of toothbrush used			
1–3 months	116 (30.2)	40 (11.3)	0.021
4–6 months	156 (40.6)	116 (32.8)	
7–12 months	56 (14.6)	72 (20.3)	
>12 months	56 (14.6)	126 (35.6)	
Toothpaste use			
Yes	339 (88.3)	338 (95.5)	0.001
No	45 (11.7)	16 (4.5)	
Way of drinking			
Glass	263 (68.5)	307 (86.7)	0.001
Straw	121 (31.5)	47 (13.3)	
Smoking			
Yes	105 (27.3)	77 (21.7)	0.067
No	279 (72.7)	277 (78.3)	
Medication use			
Yes	82 (21.3)	18 (5.1)	0.001
No	302 (78.7)	336 (94.9)	

$P < 0.05$ is considered significant.

DISCUSSION

The current study represents the first prevalence study of NCCLs in the Republic of Srpska, with a random selection of eight towns/municipalities ensuring the diversity and balance of the population. The results collected point to a high prevalence of NCCLs among the examined population, indicating possible public health problems in the future. A comparison with other prevalence studies could not be carried out because of the nature of the reported results and the variety of study designs and instruments used.

Multivariate regression analysis did not find a significant association between age and NCCLs; however, the lowest prevalence of NCCLs was recorded in the age group 10–25 years, and in agreement with previous studies, the occurrence increased with age[2]. Elderly people are exposed to various aetiological

Table 2 Distribution of non-carious cervical lesions (NCCLs) according to tooth type and mouth quadrant

Tooth type	NCCLs			
	Maxillary		Mandibular	
	Right *n* (%)	Left *n* (%)	Left *n* (%)	Right *n* (%)
Central incisors	39 (6.3)	34 (5.6)	162 (23.6)	16 (23.7)
Lateral incisors	36 (6.0)	33 (5.3)	169 (24.6)	159 (22.9)
Canines	117 (18.4)	122 (20.1)	226 (32.8)	205 (29.3)
First premolar	160 (34.0)	135 (31.6)	261 (46.0)	261 (44.0)
Second premolar	171 (37.3)	151 (33.6)	170 (32.3)	174 (33.0)
First molar	82 (23.8)	30 (8.1)	30 (9.4)	20 (5.7)
Second molar	75 (16.0)	72 (14.3)	50 (11.7)	53 (12.0)
Third molar	12 (2.6)	12 (2.4)	21 (4.1)	17 (3.5)

Table 3 Distribution on Tooth Wear Index (TWI) scores according to tooth type and mouth quadrants

Teeth	TWI scores	NCCLs			
		Maxillary		Mandibular	
		Right *n* (%)	Left *n* (%)	Left *n* (%)	Right *n* (%)
Central incisors	0	583 (84.5)	578 (84.4)	528 (73.0)	526 (72.1)
	1	27 (3.9)	25 (3.6)	50 (6.9)	51 (7.0)
	2	3 (0.4)	4 (0.6)	51 (7.0)	50 (6.9)
	3	9 (1.3)	5 (0.7)	37 (5.1)	42 (5.8)
	4	0 (0.0)	0 (0.0)	24 (3.3)	20 (2.7)
	R	68 (9.8)	73 (10.7)	33 (3.6)	40 (5.6)
Lateral incisors	0	566 (84.5)	585 (86.5)	521 (71.3)	534 (74.2)
	1	24 (3.6)	30 (4.4)	53 (7.3)	47 (6.6)
	2	4 (0.6)	1 (0.2)	54 (7.4)	57 (7.9)
	3	6 (0.9)	2 (0.3)	37 (5.1)	29 (4.0)
	4	2 (0.3)	0 (0.0)	25 (3.4)	26 (3.6)
	R	68 (10.1)	58 (8.6)	40 (5.4)	28 (3.9)
Canines	0	518 (74.8)	486 (73.0)	464 (64.4)	495 (68.8)
	1	34 (4.9)	46 (6.9)	43 (6.0)	33 (4.6)
	2	36 (5.2)	31 (4.6)	74 (10.3)	63 (8.7)
	3	38 (5.6)	37 (5.6.)	84 (11.7)	80 (11.1)
	4	9 (1.3)	8 (1.2)	25 (3.5)	29 (4.0)
	R	57 (8.2)	58 (8.7)	30 (4.2)	20 (2.8)
First premolar	0	311 (56.4)	292 (57.4)	305 (46.7)	332 (49.6)
	1	49 (8.9)	42 (8.2)	48 (7.3)	57 (8.5)
	2	63 (11.4)	59 (12.6)	110 (16.8)	94 (14.0)
	3	46 (8.3)	32 (6.5)	71 (10.9)	83 (12.4)
	4	2 (0.4)	2 (0.4)	32 (4.9)	27 (4.0)
	R	80 (14.5)	82 (16.1)	87 (13.3)	78 (11.6)
Second premolar	0	87 (52.2)	298 (54.0)	356 (56.4)	354 (55.5)
	1	55 (10.0)	59 (10.7)	35 (5.5)	34 (5.3)
	2	64 (11.6)	62 (11.2)	52 (8.2)	66 (10.3)
	3	50 (9.1)	28 (5.1)	64 (10.1)	52 (8.1)
	4	2 (0.4)	2 (0.4)	19 (3.0)	22 (3.4)
	R	92 (16.7)	103 (18.7)	105 (16.6)	110 (17.2)
First molar	0	263 (63.1)	342 (75.5)	291 (66.4)	337 (69.5)
	1	36 (8.6)	8 (1.8)	21 (4.8)	10 (2.1)
	2	39 (9.3)	17 (3.7)	9 (2.0)	7 (1.4)
	3	7 (1.7)	5 (1.1)	0 (0.0)	3 (0.6)
	4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	R	72 (17.3)	81 (17.9)	117 (26.7)	128 (26.4)
Second molar	0	394 (67.3)	431 (68.0)	379 (65.0)	388 (64.1)
	1	39 (6.7)	31 (44.9)	24 (4.1)	28 (4.6)
	2	22 (3.8)	34 (5.3)	15 (2.6)	10 (1.6)
	3	14 (2.4)	7 (1.1)	10 (1.7)	15 (2.6)
	4	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)
	R	116 (19.8)	131 (20.7)	154 (26.4)	164 (27.1)
Third molar	0	458 (79.9)	488 (81.1)	487 (78.7)	473 (80.0)
	1	7 (1.2)	9 (1.6)	12 (19.4)	9 (1.5)
	2	5 (0.9)	1 (0.2)	4 (0.6)	2 (0.3)
	3	0 (0.0)	2 (0.3)	5 (0.8)	1 (0.2)
	4	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.8)
	R	103 (18.0)	102 (17.0)	111 (19.2)	101 (17.1)

R, surfaces that could not be evaluated according to TWI (restored surface, a surface that was fractured as a result of extensive caries and a surface covered with plaque or dental calculus).

factors, which result in deterioration of functionality and aesthetics of the dentition over time[9]. The aging process in humans manifests from the cumulative effect of many aetiological factors, providing the opportunity for a recession in the dentition stemming from gingival retraction, bone loss, root surface and cementum exposure, leading ultimately to cervical lesions[28]. The majority of lesions could also have been overlooked at earlier ages; contributing to the later common occurrence of NCCLs[29,30].

Premolars, particularly the first mandibular and second maxillary premolars, were the groups of teeth most frequently affected by NCCLs, which corroborates the study findings of Borcic *et al.*[29] Numerous investigations found the highest incidence of NCCLs in the area from the canines to the first molar, especially the mandibular premolars[12,31,32]. Some authors attributed the greatest incidence of NCCLs on premolars to be a result of the naturally imperfect morphology of these teeth, the stronger occlusal forces in the

posterior region and the fact that teeth are prematurely exposed to gingival recession[33]. Que *et al.*[34] found more lesions in the maxillary teeth than in the mandibular teeth.

Donachie and Walls[35] found that mandibular incisors demonstrate a higher degree of abrasion than maxillary incisors; however, the maxillary canines are more frequently affected by this type of lesion than the mandibular canines. The results of the current study are also in agreement with previous research on prevalence of NCCLs[30], indicating that the first mandibular premolars have been identified as the teeth most frequently affected by TWI levels (score) of 2 and 3.

Several studies explored the association between NCCLs and risk factors[2,16,30,34]. The main risk factors related to NCCLs in the current study were frequent consumption of acidic food, frequent consumption of acidic drinks, retention of drink in the mouth, consumption of alcoholic drinks, bruxism and GER. Univariate analysis showed significant association between horizonal toothbrushing and NCCLs; however, multivariate regression analysis failed to identify horizontal brushing as an independent predictor. Horizontal brushing with commercial toothpaste and use of abrasive toothpaste increased the frequency of NCCLs in two studies[19,30] but in recent studies, the hypothesis that the type of toothpaste is significantly associated with the presence or frequency of NCCLs was not confirmed[36]. In contrast to previous research[30] and dentists' common beliefs that hard-bristled brushes and excessive pressure during toothbrushing have an impact on development of NCCLs, an association between the two was not found in the current study[16]. Toothbrush hardness does not affect enamel but could have significant impact on the roughness of the dentin surface[37]. Recognising that the lesions may occur in one tooth without affecting an adjacent tooth, the analysis leads towards the conclusion that toothbrushing-related habits are simply catalysts in the development of NCCLs[11].

In line with this recent study, a higher frequency of bruxism was observed in respondents with NCCLs than in respondents without this parafunction[38]. Grinding of the teeth is considered to be an exacerbating factor for NCCLs, instead of a causal factor, such as for lesions that are mainly abfractions[39]. Bruxism produces elevated stress loads on the stomatognathic system and may therefore cause fatigue and rupture of the connections of the hydroxyapatite crystals during tooth flexion (ultimately contributing to a weakening and loss of subjacent enamel and dentin)[10,39,40]. The combination of bruxism, acidic food, drink consumption and abrasion could potentially lead to the progression of NCCLs[39]. Regarding whether or not bruxism has an impact on NCCLs remains controversial. Further, longitudinal studies are needed to explore the relationship between bruxism and development of NCCLs.

Saliva is responsible for maintaining oral cavity homeostasis, so a reduction in the salivary flow rate results in a decreased neutralising action of food acids and an increased risk of development of erosions. The acidity of oral media is caused by the frequent consumption of acidic foods, acidic and carbonated beverages, citrus fruits and yogurt. A low-pH environment accelerates loss of hard dental tissue and promotes the formation of erosion, demineralisation, attrition and abrasion in particular when mechanical and chemical factors interact (e.g. brushing teeth

Table 4 Univariate analysis of the association between patient-related risk factors and non-carious cervical lesions

Factor	OR	95% CI	*P* value
Frequency of daily toothbrushing			
1 time a day	0.49	0.35–0.70	0.001
2 times a day	0.73	0.54–0.97	0.032
<3 times a day	3.02	2.13–4.29	0.001
Toothbrushing method			
Horizontal technique	1.64	1.13–2.38	0.009
Unspecified	0.71	0.53–0.96	0.026
Parafunctions			
Bruxism	5.98	3.48–10.28	0.001
Clenching	6.29	3.49–11.33	0.001
Biting	3.47	2.25–5.36	0.001
Frequency of consuming acid food	9.30	6.55–13.21	0.001
Consuming acid drinks			
Never	0.12	0.07–0.19	0.001
Frequently	12.75	8.71–18.65	0.001
Retaining drink in mouth before swallowing	7.98	4.72–13.49	0.001
Alcohol consumption	6.20	2.75–13.97	0.001
Heartburn	3.89	2.12–7.14	0.001
Gastro-oesophageal reflux	9.97	3.92–25.35	0.001
Peptic ulcer	4.54	2.17–9.94	0.001
Cardiovascular problems	2.50	1.09–5.72	0.030
Hypertension	2.17	1.22–3.86	0.008
Diabetes	9.44	1.20–7.41	0.033
Medication use	5.07	2.97–8.64	0.001

$P < 0.05$ is considered significant.
OR, odds ratio.

Table 5 Multivariate analysis of the association between patient-related risk factors and non-carious cervical lesions (NCCLs)

Factor	OR	95% CI	*P** value
Frequent acid food consumption	3.89	2.55–6.71	0.001
Frequent acid drinks consumption	3.95	2.21–7.05	0.001
Holding drink in the mouth	3.39	1.69–6.80	0.001
Alcohol consumption	4.52	1.14–17.95	0.030
Bruxism	3.35	1.23–9.12	0.018
Gastro-oesophageal reflux	4.98	1.25–19.91	0.023

*Only statistically significant results are presented.
$P < 0.05$ is considered significant.
OR, odds ratio.

immediately after consuming acid food)[41]. Drinking acid beverages more than once a day and consuming acidic foods were associated with an increased risk for NCCLs in the current study and in the investigation of Bader *et al.*[42] Other studies did not support this finding[2,4]. In addition, the difference between a group with NCCLs and a group without NCCLs was found in the method of consumption regarding drinking. Retaining the drink in the mouth before it is swallowed was a risk factor for NCCLs. Earlier investigations observed that patients who retained drink more frequently had more erosion than did patients with a low degree of dental erosion[43,44].

Regression analysis showed the relationship between NCCLs and GER. Wilder-Smith *et al.*[45] found that the majority of patients with dental erosion have symptomatic GER. Lowering the pH of the tooth surface to <4.5 leads to demineralisation of enamel and dentin[46,47]. However, the exact mechanism of reflux-induced tooth wear erosion is still not well understood.

In agreement with a previous study, consumption of alcoholic beverages was identified as a risk factor for NCCLs[25]. A recent epidemiological study observed that long-term alcohol consumption, even at low doses of alcohol, has a cumulative effect on erosive wear[48]. Alcoholic drinks have acidic and dehydrating effects, and when used long-term, could lead to salivary dysfunction and gastro-esophageal reflux-GER[49]. Alcohol users often have other detrimental dietary habits and experience gastro-esophageal reflux-GER, all of which may lead to susceptibility to erosive wear[48].

Univariate analysis identified peptic ulcer disease, hypertension, diabetes and medication use as risk factors, but multivariate analysis found that these variables were not independent predictors of NCCLs. The complex interplay of individual behaviour, risk and protective factors has an important role in the occurrence and progression of NCCLs as well as in those of the aforementioned chronic diseases. NCCLs causing a loss of tooth structure in the cervical area result in dentin hypersensitivity and aesthetic problems, and may increase the risk of pulp exposure or tooth fracture[50]. Therefore, multidisciplinary, preventive strategies aiming to motivate and change an individual's unhealthy behaviour are much needed. Screening of NCCLs among at-risk individuals should become routine practice in dental clinics[48].

Several limitations need to be considered. It might have been useful to present the percentage distribution of the NCCLs based on aetiology. However, in the current study all forms of NCCLs were included regardless of aetiology because the main aetiological component of NCCls is not always obvious. Different stages of progression were not analysed, so it is unknown if factors associated with the initiation of NCCLs may be different from the factors associated with progression. Other considerations, such as socioeconomic factors, that may play more important roles in the occurrence of NCCLs, were not evaluated in the current study. Future, longitudinal studies exploring the association of exposure factors with lesions categorised according to size and shape are required.

CONCLUSION

The prevalence of NCCLs among the general population in the Republic of Srpska is 52%. The lowest prevalence was recorded among individuals younger than 20 years of age. This study indicates that individuals who consume acid food, acid drinks and alcohol frequently, retain drink in the mouth, and experience bruxism or gastroesophageal reflux have a higher risk of NCCLs. Dental practitioners should investigate multifactorial, aetiological factors contributing to the development of NCCLs because awareness of a patient's dietary habits and oral hygiene could facilitate assessment of risk for these lesions.

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Conflict of interest

The authors report no conflict of interest.

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