Research, Society and Development, v. 11, n. 3, e57411326645, 2022
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v11i3.26645

Prevalence of non-carious cervical injuries and their associations with risk factors: integrative literature review

Prevalência de lesões cervicais não cariosas e suas associações aos fatores de risco: revisão integrativa de literatura

Prevalencia de lesiones cervicales cariosales y sus no asociaciones con factores de riesgo: revisión integrativa de la literatura

Recebido: 07/02/2022 | Revisado: 20/02/2022 | Aceito: 26/02/2022 | Publicado: 08/03/2022

Kananda Galdino de Araújo
ORCID: https://orcid.org/0000-0001-5015-7303
Federal University of Rio de Janeiro, Brazil
E-mail: kananda_galdino@hotmail.com
João Victor Frazão Câmara
ORCID: https://orcid.org/0000-0002-9687-4401
Saarland University, Germany
E-mail: jvfrazao92@hotmail.com
Mariana Silva Thiel Ribeiro
ORCID: https://orcid.org/0000-0001-5015-7303
Federal University of Rio de Janeiro, Brazil
E-mail: dra.marianathiel@gmail.com
Gisele Damiana da Silveira Pereira
ORCID: https://orcid.org/0000-0002-0511-5486
Federal University of Rio de Janeiro, Brazil
E-mail: giseledamiana@yahoo.com

Abstract
Objective: To determine the incidence of the main risk factors and also the prevalence of non-carious cervical lesions (NCCL) in relation to sex and age. Methodology: The literature search was conducted using the keywords and MeSH terms “Tooth Cervix”, “Non carious cervical lesions” and “Tooth Wear”, in the MEDLINE databases via PubMed and Scopus. Observational studies were included, which aimed to assess the relationship between sex, age and risk factors with cervical injuries. In addition, only studies in English, from the last five years, in their full version, were selected. Literature reviews, clinical cases, studies that did not include the main observation, studies that deviated from the topic and in other languages were excluded from the research. Results: 441 articles were identified, of which 17 were selected. There was no significant percentage difference between males and females, with percentages of 49% and 51%, respectively. Regarding the prevalence associated with the age group, a higher incidence was observed in the population over 65 years of age (36%). Regarding risk factors, gastroesophageal reflux, parafunctional habits, occlusal disorders and brushing problems were reported, but the acidic diet was the most incident in the literature (in 76.4% of the selected articles). Conclusion: The prevalence of NCCL increases with age, however it does not depend on sex, with an acidic diet being considered a risk factor.
Keywords: Tooth wear; Sex; Risk factor.

Resumo
Objetivo: Determinar a incidência dos principais fatores de riscos e, ainda, a prevalência das lesões cervicais não cariosas (LCNC) em relação ao sexo e a idade. Metodologia: A busca na literatura foi conduzida utilizando as palavras chaves e termos MeSH “Tooth Cervix”, “Non carious cervical lesions” e “Tooth Wear”, nas bases de dados MEDLINE via PubMed e Scopus. Foram incluídos estudos observacionais, dos quais tinham como objetivo avaliar a relação entre sexo, idade e fatores de risco com as lesões cervicais. Além disso, foram selecionados apenas estudos em inglês, dos últimos cinco anos, em sua versão completa. Revisões de literatura, casos clínicos, estudos que não incluíram a observação principal, estudos que fugissem do tema e em outros idiomas foram excluídos da pesquisa. Resultados: Foram identificados 441 artigos, dos quais 17 foram selecionados. Não houve diferença percentual significativa entre os sexos masculino e feminino, com porcentagem de 49% e 51%, respectivamente. Em relação à prevalência associada à faixa etária, foi observada maior incidência na população acima de 65 anos de idade (36%). Sobre os fatores de risco, foram relatados o refluxo gastroesofágico, hábitos parafuncionais, distúrbios oclusais e problemas com escovação, porém a dieta ácida, foi a mais incidente na literatura (em 76,4% dos artigos selecionados). Conclusão: A prevalência das LCNC aumenta de acordo com o decorrer da idade, contudo independe do sexo, sendo a dieta ácida considerada como fator de risco.
Palavras-chave: Desgaste dos dentes; Sexo; Fatores de risco.

Resumen

Objetivo: Determinar la incidencia de los principales factores de riesgo y también la prevalencia de lesiones cervicales no cariosas (NCCL) en relación con el sexo y la edad. Metodología: La búsqueda bibliográfica se realizó utilizando las palabras clave y términos MeSH "Tooth Cervix", "Non carious cervical lesions" y "Tooth Wear", en las bases de datos MEDLINE vía PubMed y Scopus. Se incluyeron estudios observacionales, que tuvieron como objetivo evaluar la relación entre sexo, edad y factores de riesgo con lesiones cervicales. Además, solo se seleccionaron estudios en inglés, de los últimos cinco años, en su versión completa. Se excluyeron de la investigación revisiones de literatura, casos clínicos, estudios que no incluyeran la observación principal, estudios que se desviaran del tema y en otros idiomas. Resultados: se identificaron 441 artículos, de los cuales se seleccionaron 17. No hubo diferencia porcentual significativa entre hombres y mujeres, con porcentajes de 49% y 51%, respectivamente. En cuanto a la prevalencia asociada al grupo de edad, se observó una mayor incidencia en la población mayores de 65 años (36%). En cuanto a los factores de riesgo, se reportaron reflujo gastroesofágico, hábitos parafuncionales, trastornos oclusales y problemas de cepillado, pero la dieta ácida fue la más incidente en la literatura (en el 76,4% de los artículos seleccionados). Conclusión: La prevalencia de LCNC aumenta con la edad, sin embargo no depende del sexo, considerándose una dieta ácida un factor de riesgo.

Palabras clave: Desgaste de los dientes; Sex; Factores de riesgo.

1. Introduction

The cervical region is considered a fragile area of the tooth, since it has a fine enamel structure, with a lower content of minerals and a greater amount of proteins (Bhundia et al., 2019), thus facilitating the occurrence of tooth decay of lesions that generate the irreversible loss of tooth structure near the cementoenamel junction (Teixeira *et al*., 2018). Also, this area coincides with the fulcrum area of occlusal forces, a factor that contributes to the appearance of morphologically distinct lesions (Bhundia, *et al*., 2019).

Cervical pathologies are classified into carious lesions and non-carious lesions. While cervical carious lesions are caused by processes that involve microorganisms, non-carious cervical lesions (NCCL) have a non-bacterial multifactorial etiological cause (Aw et al., 2002), with combinations of friction, abrasion, biocorrosion and occlusal stress (Grippo et al., 2012). Cervical abrasion is a multifactorial process in which its etiologies include factors related to brushing, while friction is due to contact between teeth, most often related to clenching and/or grinding (Rajendran *et al*., 2019). Regarding occlusal factors, it is seen that enamel hydroxyapatite crystals rupture due to increased stress of occlusal origin (Grippo *et al*., 2012; Yoshizaki *et al*., 2017).

Biocorrosive tooth wear is defined as an irreversible loss of tooth structure caused by acidic chemical action without any bacterial involvement (Silva *et al*., 2001). The acid source may be intrinsic, including gastroesophageal reflux, or extrinsic, which may come from acidic diets, exacerbated by reduced salivary flow, in addition to saliva modifying effects (Alvarez-Arenal *et al*., 2019). It is common to come across studies that prove that the prevalence of cervical lesions is increasing due to the longer exposure of teeth to risk factors associated with population aging. As consequence, maintaining the natural dentition of patients at more advanced ages exposes the teeth to risk factors for a longer period when compared to the dentition of young patients (Marochi & Queiroz, 2001). However, another study reported the high prevalence of NCCL at an early age, caused, in turn, by the increased consumption of acidic diets, which can be considered an important oral health problem (Alvarez-Arenal *et al*., 2019).

This fact becomes even more important since advanced stages of NCCL affect not only aesthetics, but also the health and function of the stomatognathic system, and may be commonly associated with dentin hypersensitivity (HD) (Sawlani *et al*., 2016). Therefore, it is important to be aware of the risk factors, in addition to investigating how much each one is contributing to the evolution of each stage of the installed lesion. Recognition of the lesion at an early stage is very important to establish a correct early diagnosis and precise treatment, addressing not only therapeutic measures, but also preventive measures for the appearance of new lesions and the progression of existing ones.

Thus, the objective of this study was, through an integrative review of the literature, to determine the incidence of the

main risk factors of NCCL and the prevalence in relation to sex and age.

The cervical region is considered a fragile area of the tooth, since it has a fine enamel structure, with a lower content of minerals and a greater amount of proteins (Bhundia et al., 2019), thus facilitating the occurrence of tooth decay of lesions that generate the irreversible loss of tooth structure near the cementoenamel junction (Teixeira *et al*., 2018). Also, this area coincides with the fulcrum area of occlusal forces, a factor that contributes to the appearance of morphologically distinct lesions (Bhundia, *et al*., 2019).

Cervical pathologies are classified into carious lesions and non-carious lesions. While cervical carious lesions are caused by processes that involve microorganisms, non-carious cervical lesions (NCCL) have a non-bacterial multifactorial etiological cause (Aw et al., 2002), with combinations of friction, abrasion, biocorrosion and occlusal stress (Grippo et al., 2012). Cervical abrasion is a multifactorial process in which its etiologies include factors related to brushing, while friction is due to contact between teeth, most often related to clenching and/or grinding (Rajendran *et al*., 2019). Regarding occlusal factors, it is seen that enamel hydroxyapatite crystals rupture due to increased stress of occlusal origin (Grippo *et al*., 2012; Yoshizaki *et al*., 2017).

Biocorrosive tooth wear is defined as an irreversible loss of tooth structure caused by acidic chemical action without any bacterial involvement (Silva *et al*., 2001). The acid source may be intrinsic, including gastroesophageal reflux, or extrinsic, which may come from acidic diets, exacerbated by reduced salivary flow, in addition to saliva modifying effects (Alvarez-Arenal *et al*., 2019). It is common to come across studies that prove that the prevalence of cervical lesions is increasing due to the longer exposure of teeth to risk factors associated with population aging. As consequence, maintaining the natural dentition of patients at more advanced ages exposes the teeth to risk factors for a longer period when compared to the dentition of young patients (Marochi & Queiroz, 2001). However, another study reported the high prevalence of NCCL at an early age, caused, in turn, by the increased consumption of acidic diets, which can be considered an important oral health problem (Alvarez-Arenal *et al*., 2019).

This fact becomes even more important since advanced stages of NCCL affect not only aesthetics, but also the health and function of the stomatognathic system, and may be commonly associated with dentin hypersensitivity (HD) (Sawlani *et al*., 2016). Therefore, it is important to be aware of the risk factors, in addition to investigating how much each one is contributing to the evolution of each stage of the installed lesion. Recognition of the lesion at an early stage is very important to establish a correct early diagnosis and precise treatment, addressing not only therapeutic measures, but also preventive measures for the appearance of new lesions and the progression of existing ones.

Thus, the objective of this study was, through an integrative review of the literature, to determine the incidence of the main risk factors of NCCL and the prevalence in relation to sex and age.

2. Methodology

2.1 Eligibility Criteria

Studies that matched the following criteria were included: analytical observational studies, being case-control, cohort and cross-sectional studies that aimed to observe the prevalence of NCCL among different age and sex groups, in addition to the main associated risk factors to these groups. Filters related to the year were applied, using articles published between the years 2015 to December 2020, and the English language. Only studies in their full version were used. As exclusion criteria, literature reviews, clinical cases, studies that did not include the main observation, studies that deviated from the theme and in languages other than English were declined.

2.2 Search strategy

An electronic search was conducted independently until December 7, 2020 to identify potential studies. The following databases were screened: MEDLINE via PubMed and Scopus. A specialist librarian (D.M.T.P.F.) guided the entire research strategy. A combination of MeSH/DECs, keywords, synonyms and free terms related to "non-carious cervical lesion" was used, with the Boolean operators OR and AND following the syntax rules for PubMed and adapted for other databases (Chart 1).

Chart 1. Research strategy used for each database.

Data base	Search strategy
PubMed	(Tooth Cervix [mesh] OR Tooth Cervix [tiab] OR Cervix Dent* [tiab] OR Cervix Tooth [tiab] OR Non carious cervical lesions [tiab]) AND (Gingival Recession [mesh] OR Gingival Recess*[tiab] OR Dentin Sensitivity[mesh] OR Dentin Sensitivit* [tiab] OR Dentine Sensitivit* [tiab] OR Dentin Hypersensitivit* [tiab] OR Dentine Hypersensitivit* [tiab] OR Tooth Sensitivit* [tiab] OR Tooth Wear [mesh] OR Tooth Wear* [tiab] OR Dental Wear* [tiab])
Scopus	("Tooth Cervix" OR "Cervix Dentis" OR "Cervix Tooth" OR "Non carious cervical lesions") AND ("Gingival Recession" OR "Gingival Recessions" OR "Dentin Sensitivity"OR "Dentin Sensitivities" OR "Dentine Sensitivity" OR "Dentine Sensitivities" OR "Dentin Hypersensitivity" OR "Dentin Hypersensitivities" OR "Dentine Hypersensitivity" OR "Dentine Hypersensitivities" OR "Tooth Sensitivity" OR "Tooth Sensitivities" OR "Tooth Wear" OR "Tooth Wears" OR "Dental Wear" OR "Dental Wears")

Source: Authors.

2.3 Selection of studies

After conducting the searches, all identified citations were imported into a bibliographic reference manager (online version of EndNote®, version X7; Clarivate Analytics, Philadelphia, PA, USA) to remove duplications. Subsequently, two reviewers (K.G.A., V.O.M.) independently reviewed all titles and abstracts and then applied eligibility criteria. The two reviewers' forms were compared and inconsistencies were compared by a third reviewer (M.S.T.R.). Studies that met the inclusion criteria and those with insufficient title and abstract data to determine their eligibility were selected for a full analysis. After full-text analyzes of potentially relevant studies, those who met all selection criteria were considered eligible for this study and underwent the data extraction process.

2.4 Data extraction

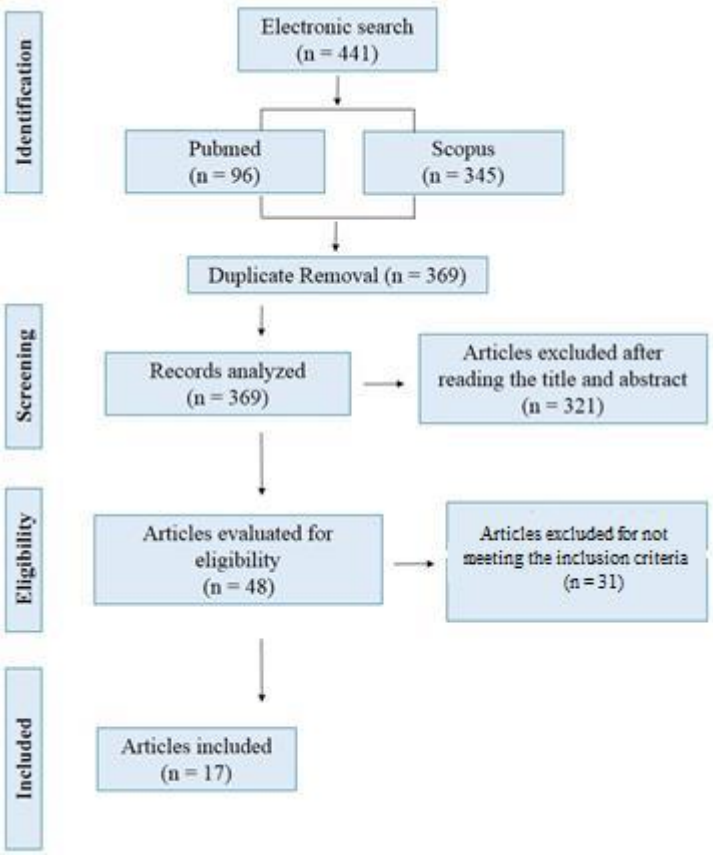
Two reviewers (KGA, VOM) independently extracted the following data: author, year of publication, sample size (n), ratio of men and women with NCCL present, age and the main possible risk factors associated with NCCL most present in the studies.

3. Results

3.1 Selection of studies

441 studies were identified through search strategies in the two databases (MEDLINE via PubMed and Scopus). After removing duplicates, 369 titles and abstracts were analyzed. Subsequently, 321 records were excluded because they did not meet the primary inclusion criteria, leaving 48 articles. These full texts were evaluated for eligibility, and 31 articles were excluded based on inclusion and exclusion criteria. Thus, 17 studies were included for the literature review (Figure 1).

Figure 1. Study selection flowchart.



Source: Authors.

3.2 Study Characteristics

3.2.1 Prevalence of NCCL in relation to sex

According to studies by Medeiros *et al*. (2020), Akmal, Adimulapu and Duraisamy (2020), Rusu *et al*. (2019), O'Toole and Bartlett (2017) and Swalani *et al*. (2016), reported a greater presence of men who had NCCL, when compared to the number of women affected. Medeiros *et al*. (2020), studied only male soccer players from a certain region, which was only possible to report data from this group. Akmal *et al*. (2020) observed a higher prevalence of cervical injury in males (70.9%) compared to females (29.1%). Rusu *et al*. (2019) evaluated a group of patients with NCCL of which 11 were male and 10 were female, without an elaborated choice criterion, only a group of patients who presented for dental treatment. In the study by O'Toole and Bartlett (2017), patients with the presence of cervical lesions with or without dentin hypersensitivity (DH) were evaluated, of which men were more prevalent with cervical lesions without HD (54%). Swalani *et al*. (2016) observed a prevalence of NCCL was almost equally distributed between men and women (15:14) (Table 1).

Table 1. Data from patients with NCCL.

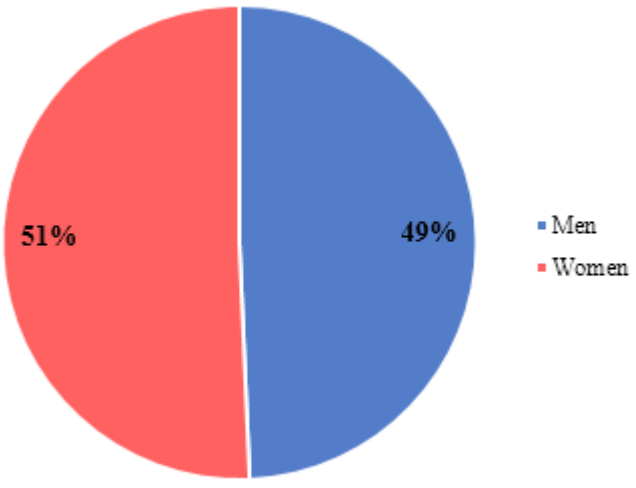
Author, year	Total number of patients	Masculine	Feminine
Medeiros, 2020	43	43	0
Akmal, 2020	371	263	108
Rusu, 2019	21	11	10
Zuza, 2019	384	188	196
Shrestha, 2018	364	131	233
Kolak, 2018	270	129	141
Seong, 2018	349	128	221
Alvarez-Arenal, 2018(1)	140	53	87
Alvarez-Arenal, 2018(2)	140	53	87
O'Toole, 2017	328	177	151
Yoshizaki, 2017	80	38	42
Ispas, 2016	60	30	30
Swalani, 2016	29	15	14
Yang, 2016	314	157	157
Lai, 2015	1704	851	853
Total	**4597**	**2267**	**2330**

Source: Authors.

According to studies by Zuza *et al*. (2019), Shrestha and Rajbhandari (2018), Kolak *et al*. (2018), Seong *et al*. (2018), Alvarez-Arenal *et al*. (2019, 1,2), Yoshizaki *et al*. (2017), Ispas *et al*. (2016), Yang *et al*. (2016) and Lai *et al*. (2015), reported a greater presence of women who had NCCL. According to Zuza *et al*. (2019), in their study, no difference was found between the sexes, but it was greater for women with a percentage of 51.1%. In Lai (2015), was no statistically significant difference for males and females, with values of p=0.645 in younger patients and p=1,587 in older patients, showing no significant value. In Kolak *et al*. (2018), the percentage of women with NCCL present was 62.7% and in Yoshizaki *et al*. (2017) had a percentage of 53%. Seong *et al*. (2018) had a significant number of women with cervical injuries (63.3%) and in the studies by Alvarez-Arenal *et al*. (2019, 1,2) the number of women was higher in both studies (62%), as the sample was the same for both studies. In the works by Ispas *et al*. (2016) and Yang *et al*. (2016), there was no difference between the sexes, as they researched the same sample number.

After analyzing the search results, the percentage of the number of men and women who had NCCL was measured. Although females had a higher incidence of 51%, this percentage was not significant when compared to males (49%) (Figure 2).

Figure 2. Prevalence of NCCL in relation to sex.



Source: Authors.

3.2.2 Prevalence of NCCL in relation to age

The only study that reported patients presenting with NCCL in the age group of 6-11 was the study by Chiriac *et al*. (2019), as it studied the relationship of children and the main associated risk factors at this age. In both studies by Alvarez-Arenal *et al*. (2019), they only presented data in relation to the age group of 12-30 years, as they studied a specific group of students with an average age of 24.5 years. In the study by Seong *et al*. (2018), only the age group of young adults was analyzed, as it wanted to relate which are the most frequent risk factors in this population, thus presenting a higher number exclusively in the age groups 12-30 and 31-50, with percentages of 78% and 22%, respectively. Most studies (Akmal *et al*., 2020; Zuza *et al*., 2019; Kolak *et al*., 2018; Seong *et al*., 2018; Shrestha *et al*., 2018; O'Toole *et al*., 2017, Yoshizaki *et al*., 2017; Yang *et al*., 2016 and Lai *et al*., 2015 find a higher prevalence in the age group of over 51 years (36%), followed by the age group of 31-50 years (34%), in these studies, a response to this high in these ages is explained by the possibility of being exposed to possible risk factors for a longer time (Table 2).

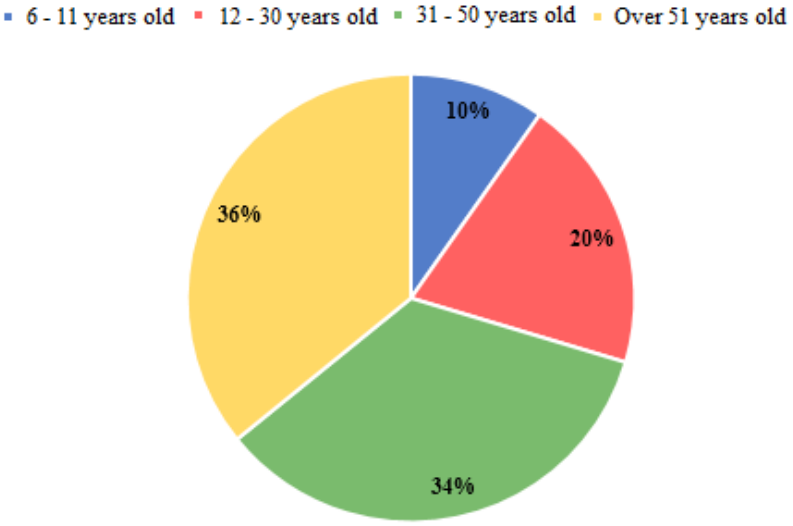
Table 2. Data on patients with NCCL according to age.

		Age			
Author, year	**Total number of patients**	**6-11**	**12-30**	**31-50**	**Over 51**
Akmal, 2020	371	0	30	189	153
Chiriac, 2019	456	456	0	0	0
Zuza, 2019	384	0	90	102	102
Alvarez-Arenal, 2018(1)	140	0	140	0	0
Alvarez-Arenal, 2018(2)	140	0	140	0	0
Shrestha, 2018	364	0	82	95	49
Kolak, 2018	270	0	37	91	142
Seong, 2018	349	0	273	76	0
O'Toole, 2017	328	0	96	139	96
Yoshizaki, 2017	80	0	6	44	30
Yang, 2016	314	0	35	111	168
Lai, 2015	1704	0	0	768	936
Total	**4900**	**456**	**929**	**1615**	**1676**

Source: Authors.

According to the data collected in the literature search, a graph was made with the sum of the ages of each group, and a higher percentage was observed in people over 51 years old (36%) with n = 1676, followed by the group of 31 – 50 years (34%) with n = 1615 (Figure 3).

Figure 3. Prevalence of NCCL in relation to age.



Source: Authors.

3.2.3 Risk factors

According to Medeiros *et al*. (2020), 11.2% of the group analyzed with NCCL had a history of GER. Also, Rusu *et al*., 2019 found the role of gastroesophageal reflux in the appearance of non-carious lesions without patients associating gastric discomfort and eating disorders with teeth defects, with a percentage present in the evaluated patients of 71.42%. According to Zuza *et al*. (2019), in their univariate analysis, obtained a pvalue of 0.001, which was considered very significant for the relationship between cervical lesions and GER. In both studies by Alvarez-Arenal *et al.* (2019, 1,2), there was a relationship between NCCL and GER, but they did not show a high percentage (5.71%). In the studies by Teixeira *et al*. (2018) and Swalani *et al*. (2016), they found an association of NCCL with GER, but they did not find a statistically significant difference p=0.210 and p=0.526 respectively.

The acidic diet was the most cited risk factor, obtaining 13 of the 17 studies included in this review. For Medeiros *et al*. (2020), the bivariate analysis revealed that soccer players who consumed lemon water during fasting (acid diet), obtained a p <0.001, showed a significant association with the development of NCCL. Zuza *et al*. (2019) and Ispas *et al*. (2016), correlated the consumption of acidic beverages with the appearance of NCCL, presented a p-value of 0.001, as well as in the study by Yoshizaki *et al*. (2017), which obtained a p-value of <0.0001 for the same association between acidic drinks and the emergence of NCCL. According to Chiriac *et al*. (2019), the energy drinks, yogurt, and carbonated drinks had a greater impact for this association of acidic diet with NCCL. In the study by Rusu *et al*. (2019), the association of NCCL with the acidic diet had a percentage of 44%. In both studies by Alvarez-Arenal *et al*. (2019) obtained a significant p-value for acidic diet consumption. For Kolak *et al*. (2018), frequent consumption of citrus fruits was evaluated p=0.003, which was significant for the association of NCCL. In the study by Teixeira *et al*.,2018 and Swalani *et al*. (2016), there was an association of acidic diet with cervical lesions, but did not obtain a significant p-value, p=0.746 and p=0.558 respectively. The high frequency of consumption of acidic fruits was a possible risk factor for NCCL (Yang *et al*., 2016). In the study by Lai *et al*. (2015), this risk factor was only statistically significant in the group of patients over 65 years old (p=0.009).

Parafunctional habits involve bruxism and clenching. For Medeiros *et al*. (2020) and Teixeira *et al*. (2018), there was an association of parafunctional habits between the groups studied for the appearance of cervical lesions, but it was not statistically significant, p=0.642 and p=0.606 respectively. In the study by Zuza *et al*. (2019) obtained a p-value of 0.018, which is a significant value for the association. According to Lai *et al*. (2015), bruxism was only statistically significant in the

group of patients over 65 years old p=0.022.

The risk factor for occlusal disorders constitutes a set of problems that include occlusal trauma, malocclusions and occlusal interferences. In the study by Medeiros *et al*. (2020), an association with malocclusions was observed, but it was not statistically significant p=0.762. In Alvarez-Arenal *et al*. (2019, 1) studied the greater chance of influence of interference in mandibular excursive movements and it was statistically significant for the appearance of cervical lesions p=0.018. In the study by Alvarez-Arenal *et al*. (2019, 2), in the univariate analysis, there was a significant association for protrusive interference and friction for the appearance of NCCL p=0.018 and p=0.019 respectively. Teixeira *et al*. (2018) analyzed in his study the most influential risk factors for the appearance of NCCL, and it was seen that the most important factor was occlusal trauma p=0.014. According to Yoshizaki *et al*. (2017), considering the factors associated with NCCL, there was a positive association between

some occlusal aspects, such as the presence of premature contacts in maximum intercuspation p<0.0001 and on the non-functional side p=0.010.

For risk factors related to the incorrect way of brushing, errors such as excessive force during brushing, inadequate brushing technique, use of abrasive pastes, too hard toothbrush bristles were observed. In the study by Rusu *et al*. (2019), the second most frequent risk factor was errors related to brushing, with a percentage of 17%. In Zuza *et al*. (2019), it was identified that the horizontal brushing technique was a risk factor for the emergence of cervical lesions p=0.009. According to Shrestha *et al*. (2018) and Seong *et al*. (2018), their studies observed a relationship with the development of NCCL and brushing techniques, obtaining a p-value of 0.003 and 0.005 respectively, being statistically significant. For Kolak *et al*. (2018), when it comes to the influence of oral hygiene factors, the analysis showed a significantly higher frequency of multiple lesions among individuals who brush their teeth once a day compared to those who brush their teeth twice or more (p = 0.005) and among patients who do not brush without knowing the type of brush they use (p = 0.006). The following relationships were analyzed: toothbrush size, brushing technique, toothpaste type, brushing force and brushing frequency, and for all they were statistically very significant with p-value <0.001 (Ispas *et al*., 2016). According to Yang *et al*. (2016), found in their study a strong correlation with the emergence of cervical lesions and brushing force <0.05 and in Lai *et al*. (2015) for vertical brushing technique in younger patients had a significant relationship with cervical lesions (< 0.001).

Chart 2. Main risk factors in the literature.

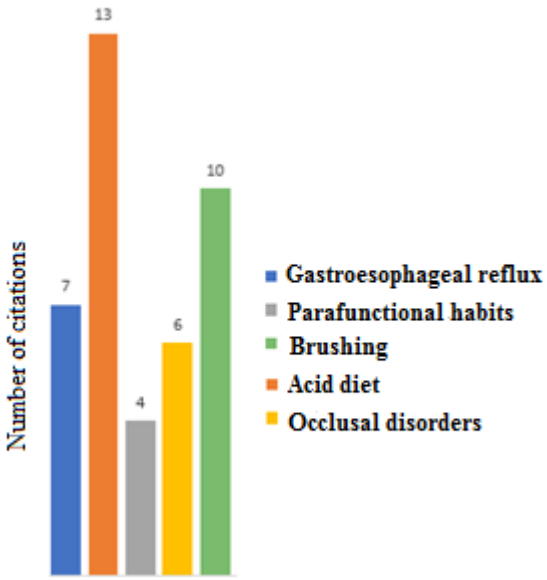
Risk factors	Authors
Gastroesophageal reflux	Medeiros, 2020; Rusu, 2019; Zuza, 2019; Alvarez- Arenal, 2018(1); Alvarez- Arenal, 2018(2); Teixeira, 2018; Swalani, 2016.
Acid diet	Medeiros, 2020; Chiriac, 2019; Rusu, 2019; Zuza, 2019; Alvarez-Arenal, 2018(1); Alvarez- Arenal, 2018(2); Kolak, 2018; Teixeira, 2018; Yoshizaki, 2017; Ispas, 2016; Swalani, 2016; Yang, 2016; Lai, 2015.
Parafunctional habits	Medeiros, 2020; Zuza, 2019; Teixeira, 2018; Lai, 2015.
Occlusal disorders	Medeiros, 2020; Alvarez-Arenal, 2018(1); Alvarez- Arenal, 2018(2); Teixeira, 2018; Yoshizaki, 2017; Swalani, 2016.
Brushing related mistakes	Rusu, 2019; Zuza, 2019; Shrestha, 2018; Seong, 2018; Kolak, 2018; Teixeira, 2018; O'Toole, 2017; Ispas, 2016; Yang, 2016; Lai, 2015.

Source: Authors.

According to the analysis of the literature studied, the most frequent risk factors in the studies were acidic diet (13

citations, corresponding to 76.4%), followed by problems related to toothbrushing (10 citations, corresponding to 58.8%), and the least cited risk factor was parafunctional habits (4 citations, corresponding to 23.5%) (Figure 4).

Figure 4. The most cited risk factors.



Source: Authors.

4. Discussion

The objective of this integrative review was to determine the prevalence of Non-Carious Cervical Injuries (NCCL) in relation to age, sex and which risk factors are most associated with the disease. A search of publications in English and publication date in the last five years was carried out. Observational studies were searched in order to achieve this comparison between the groups of patients with and without NCCL to assess the prevalence of the disease between females and males. The age of the patients was categorized for statistical convenience as 6-11, 12-30, 31-50 and over 51 years old and their main risk factors most cited in the literature.

Although many researchers have discussed this relationship between the presence of NCCL in younger patients as a result of lifestyle, due to the search for healthier habits such as acidic food intake and physical activities, in addition to the daily stress and anxiety of modern life, causing clenching In the electronic search, this more current relationship was not found (Teixeira *et al*., 2020). Based on existing data, the difference between the prevalence for genders did not reach a significant percentage, on the other hand, in relation to the prevalence in relation to age, a higher percentage was observed in older patients, explained in the literature due to the longer duration of treatment exposure to risk factors. The most cited possible risk factors in the literature were gastroesophageal reflux, acidic diet, parafunctional habits, occlusal disorders and problems related to brushing. The acidic diet was the most cited factor in the literature, being more present for the appearance of these lesions, with a percentage of 76.4%.

In relation to males and females, there was a greater propensity for females, but without a significant percentage, 51% were observed. In most cases, cervical lesions are more common with increasing age, but are inaccurate in terms of sex. However, several studies (Akmal *et al.*, 2020; O'toole & Bartlett, 2017; Zuza *et al.*, 2019, Kolak, *et al*. 2018), have reported the difference in the prevalence of cervical injury between men and women. Radentz et al. (1976) revealed that men have more injuries compared to women, with the difference between the sexes coming closer to having statistical significance. As also in the study by Akmal *et al*. (2020), there was a higher prevalence of cervical lesions in males (70.9%) compared to females

(29.1%). The higher prevalence of cervical abrasions is often attributed to the application of greater force and longer duration of toothbrushing by men compared to women (Akmal *et al.*, 2020). Yan and Yang (2014) cited the habit of brushing the teeth as one of the main etiological factors of cervical abrasion, mainly in terms of its technique, frequency and brittle hardness. A previous study (Turssi et al., 2019), reported a statistically significant association between abrasion and brushing habits, which includes brush change technique, frequency and time. Akmal *et al.* (2020) revealed that men tend to brush their teeth longer with more pressure, which explains the higher incidence of cervical abrasion in men than in women.

Other studies have reported a female predilection when it comes to cervical injuries (Shrestha & Rajbhandari, 2018; Seong *et al*., 2018). The difference in the distribution of NCCL between men and women can be explained by the greater masticatory force (greater occlusal loads generate greater concentrations of stress), which makes the tooth structure more susceptible to other risk factors. Interestingly, women were more likely to have NCCL with a history of HD, which may be associated with healthy oral habits or frequent intake of acidic foods and the presence of a lower pain threshold than men (Teixeira *et al*., 2018). However, there are some studies that show no relationship between sex and the prevalence of NCCL (Rusu *et al*., 2019; Yoshizaki *et al*., 2017; Ispas *et al*., 2016; Sawlani *et al*., 2016; Yang *et al*., 2016; Lai *et al*., 2015).

Although it had a higher prevalence in older patients, studies support the influence of age on the presence of NCCL and the idea that the onset can occur at very young ages (Chiria *et al*., 2019; Seong *et al*., 2018). A study involving Brazilians aged 40 to 60 years reported a prevalence of NCCL of 67% while a population aged 35 to 74 years in China had a prevalence of 81.3% (Smith et al., 2018; Lai *et al*., 2015). However, a recent clinical trial with patients aged between 18 and 40 years treated for NCCL and cervical HD at a Brazilian university revealed a prevalence of 88.1% and also suggested an increasing distribution of the disease among young people (Teixeira *et al*., 2018).

As demonstrated in previous studies (Kolak *et al*., 2018; Yang *et al*., 2016; Lai *et al*., 2015) and in this review, age may be a determining factor for the prevalence of NCCL, since older populations are probably exposed to etiological factors for a longer time than younger women. Among individuals with neck injury, most of them are in the age group of over 51 years (36%), while individuals between 12-30 years of age (20%) are the least affected with neck injury in this study, not taking into account considering the only study that approached children with NCCL with a very expressive number of participants. These results are in agreement with a study that analyzed the frequency of NCCL in patients referred to a particular dental school in which the highest frequency of patients with NCCL was recorded in the age group over 55 years (94.7%), while these injuries were less represented in the younger age group (35.2%) (Kolak *et al*., 2018).

The most likely reasons for such a distribution of NCCL are the cumulative effect of a large number of etiological factors over a long period of time, a greater degree of gingival recession, fewer teeth present and, therefore, greater occlusal load, loss of protective mechanisms. of natural dentition, reduction in the quality and quantity of saliva, structural and microstructural changes in enamel and dentin that are related to the aging process (Kolak *et al*., 2018). The etiology of NCCL is a matter of numerous controversies, it is believed that these lesions occur as a result of several mechanisms, acting alone or simultaneously. These mechanisms include: friction (abrasion and attrition), biocorrosion (chemical or electrochemical degradation) and occlusal stress, resulting in compression, bending and tension, which in turn lead to microfractures and wear of this more fragile JCE region due to its anatomy (Grippo *et al*., 2012).

The multifactorial nature of NCCL may be responsible for these discrepant results among the evaluated studies. Perhaps one of the causal factors of NCCL could be acting more intensively in a given population, providing specific characteristics in each study in this review. This integrative review analyzed the main etiologic factors suspected of causing NCCL: diet, tooth brushing, medical conditions, adverse habits and occlusal forces.

The role of gastroesophageal diseases in the progression of tooth surface loss is much studied. A systematic review and meta-analyses clearly demonstrated that individuals with GER are more likely to have erosive tooth wear compared to

controls without GER (Jordão et al., 2020). Alaraudanjoki *et al*. (2016) demonstrated that repeated or prolonged exposure of teeth to gastric acids leads to the selective dissolution of specific components of the tooth surface, causing loss of structure and dentinal hypersensitivity. The severity of tooth wear and chemical degradation of structures due to gastroesophageal reflux, for example, is correlated with disease duration and frequency, pH, acid type, salivary quality and quantity, and buffering capacity (Parkinson et al., 2010).

Regarding the acidic diet, the variables are large for each study, the concept of acidic diet encompasses many foods, such as solids, for example acidic fruits, as well as liquids, for example cola-based soda, wines, lemon "shot", and there is no standardized method in the literature to adequately evaluate an acidic diet. In a study involving male soccer players who consumed pure lemon juice on an empty stomach, an association with the presence of NCCL was observed in all of them (Medeiros *et al*., 2020). Other literature has shown that the consumption of citrus fruits and juices, soft drinks, alcohol and vitamin C tablets is recognized as a source of aggression to the tooth structure, which is associated with the presence of NCCL (Smith *et al*., 2008). According to an *in vitro* study, it was concluded that all acidic beverages tested in the research showed erosive potential and caused the morphological changes of the JCE in which the highest degree of damage to the JCE was found in the Red Bull®, Coca Cola® and Juice groups. orange, while the lowest grade was recorded in the samples of the white wine group (Mitic *et al*., 2019). Similarly, an earlier European study with a large sample of 3,187 subjects used descriptors to measure how high a patient's acid intake was (Bartlett *et al*., 2013) and found that fresh fruit and juice intake was positively associated to tooth wear. Thus, in the analysis of the most associated risk factors, the acidic diet had a greater number of citations, a total of thirteen articles, being quite conniving with the world literature, which makes us really believe that it plays a very important role in the development of NCCL.

For parafunctional habits, occlusal parafunction is more likely to favor the loss of tooth substance in the cervical region than physiological processes (Grippo, *et al*., 2012), as the magnitudes of force during bruxism are much greater than the magnitudes of force during bruxism. loads of normal functional activity (Suit, Gibbs and Benz, 1976). According to a recent study, a higher frequency of bruxism was observed in groups with NCCL than in groups without this parafunction (Zuza *et al*., 2019). However, it was also seen in another study that teeth grinding is considered a factor of exacerbation of NCCL, rather than a causal factor itself and that the combination of bruxism, acidic foods, consumption of drinks and abrasion can potentially lead to progression of the NCCL (Imfeld, 1996). In a Chinese study, which analyzed the prevalence of NCCL in an older population, the results indicated that elderly people who bite hard objects have a higher risk of NCCL, since biting hard objects can produce large occlusal loading forces and cause strong stress in the cervical region, which can cause tooth enamel to collapse (Lai *et al*., 2015). An experimental study confirmed that in abnormal occlusion, the pressure in the cervical region increases, while in normal occlusion the pressure was lower. As the tooth flexes, tensile and shear stresses are generated in the cervical region of the tooth, causing the bonds between the hydroxyapatite crystals to break, leading to the formation of cracks and eventually, thus, a new, less resistant crystal structure is formed and more easily attacked by other chemical or mechanical factors, favoring enamel loss and cervical wear (Lee & Eakle, 1996).

When dealing with occlusal disorders, it was possible to highlight this risk factor in the literature as occlusal trauma, malocclusions and occlusal interferences. This general term was chosen based on what was most often cited in the literature. Results of a case-control study observed a greater chance of influence of premature contacts with the progression of cervical lesions (Alvarez-Arenal *et al*., 2019, 1). In the other, was showed that all occlusal factors that proved to be risk factors such as protrusive interferences and friction or simply having a significant association in the univariate analysis, can transmit early stress to the JCE thus initiating a NCCL, without the need for the simultaneity of other factors or situations that increase the frequency and severity of injuries with aging. These factors and situations include changes in the composition and microstructure of enamel and dentin, more frequent vertical cracks and microfractures in older enamel, greater gingival

recession and bone loss with greater root surface and exposed cementum, long-term exposure to cervical stress factors and longer action time of other factors not related to the occlusion. (Alvarez-Arenal *et al*., 2019, 2).

The influence of brushing, which is considered an abrasion event, remains controversial on the possibility of progression of NCCL. According to some authors, under normal and proper use, brushing with toothpaste would cause minimal lifelong dentinal wear (Shellis & Addy, 2014). Other studies claim that the high prevalence of lesions on the buccal surface of the teeth automatically implies the influence of brushing on the formation of NCCL (Khan et al., 1999), which is in line with a Chinese study, in which it was found that the force of brushing was a risk factor for the presence of NCCL and in this same study, the interactive effect of the groups with heavy brushing, inadequate technique and consumption of fresh fruits at least once a day was considered an evident risk factor for patients with NCCL (Yang *et al*, 2016). On the other hand, a systematic review (Heasman et al., 2015) suggested that data to support the association between toothbrushing and NCCL remain largely inconclusive and that long-term projects need to be undertaken to confidently determine whether this factor consists of predisposition, or is only associated with the aforementioned alterations.

An interesting finding about the selected studies is that most showed that the multiple effects of the interaction of risk factors for the development of NCCL were evidently greater than with just a single risk factor. The interactive effects of several factors on patients may be involved in the occurrence and progression of NCCL. Thus, a comprehensive prevention and treatment strategy should consider the interactive effects of multiple risk factors, in line with the theory of the disease being multifactorial.

5. Conclusion

Regarding prevalence, there was a slight predilection of 2% for females and for those over 51 years of age, however, the most cited risk factor in the scientific literature was the acidic diet. The association of the diagnosis with the knowledge of the causes of the lesions makes the professional capable of transmitting necessary information for the instruction of patients susceptible to NCCL.

References

Akmal, N. L. H. B. I., Adimulapu, H. S. & Duraisamy, R. (2020). Association Between Cervical Abrasion and Age and Its Influence on Gender - A Retrospective Study. *Int. J. Res. Pharm. Sci*, 11 (SPL3), 441-446.

Alvarez-Arenal, A., Alvarez-Menendez, L., Gonzalez-Gonzalez, I., Alvarez-Riesgo, J. A., Brizuela-Velasco, A., & deLlanos-Lanchares, H. (2019). Non-carious cervical lesions and risk factors: A case-control study. *J Oral Rehabil*, 46(1), 65-75.

Alvarez-Arenal, A., Alvarez-Menendez, L., Gonzalez-Gonzalez, I., Jiménez-Castellanos, E., Garcia-Gonzalez, M., & deLlanos-Lanchares, H. (2019). The Role of Occlusal Factors in the Presence of Noncarious Cervical Lesions in Young People: A Case-Control Study. *Oper Dent*, 44 (1), 12-22.

Alaraudanjoki, V., Laitala, M. L., Tjäderhane, L., Pesonen, P., Lussi, A., Ronkainen, J., & Anttonen, V. (2016). Influence of Intrinsic Factors on Erosive Tooth Wear in a Large-Scale Epidemiological Study. *Caries Res*, 50 (5), 508-516.

Aw, T. C., Lepe, X., Johnson, G. H., & Mancl, L. (2002). Characteristics of noncarious cervical lesions: a clinical investigation. *J Am Dent Assoc*, 133 (6), 725-33.

Bartlett, D. W., Lussi, A., West, N. X., Bouchard, P., Sanz, M., & Bourgeois, D.. (2013). Prevalence of tooth wear on buccal and lingual surfaces and possible risk factors in young European adults. *J Dent*, 41 (11), 1007-1013.

Bhundia, S., Bartlett, D., & O'toole, S. (2019). Non-carious cervical lesions-can terminology influence our clinical assessment? *British dental journal*, 227 (11), 985-988.

Chiriac, A., Mercut, V., Alexandru, D., Popescu, S., Mercut, R., Popescu, F., Luchiancenco, D. & Resceanu, I. (2019). Applications of Factorial Analysis in the Study of Risk Factors and their Chemical Influence for Erosive Dental Wea. *Revista de Chimie*, 70 (2), 693-699.

Grippo, J. O., Simring, M., & Coleman, T. A. (2012). Abfraction, abrasion, biocorrosion, and the enigma of noncarious cervical lesions: a 20-year perspective. *J Esthet Restor Dent*, 24 (1), 10-23.

Heasman, P. A., Holliday, R., Bryant, A., & Preshaw, P. M. (2015). Evidence for the occurrence of gingival recession and non-carious cervical lesions as a consequence of traumatic toothbrushing. *J Clin Periodontol*, 42 (16), 237-55.

Imfeld, T. (1996). Dental erosion. Definition, classification and links. *European journal of oral sciences*, 104 (2), 151-155.

Ispas, A., Craciun, A., Negucioiu, M., Popa, D., Lascu, L., & Constantiniuc, M. (2016). The degree of involvement of etiological factors in different types of non-carious lesions. *Human and Veterinary Medicine*, 8 (2), 119-123.

Jordão, H. W. T., Coleman, H. G., Kunzmann, A. T., & McKenna, G. (2020). The association between erosive toothwear and gastro-oesophageal reflux-related symptoms and disease: A systematic review and meta-analysis. *J Dent*, 95:103284.

Khan, F., Young, W. G., Shahabi, S., Daley, T. J. (1999). Dental cervical lesions associated with occlusal erosion and attrition. *Aust Dent J*, 44 (3), 176-86.

Kolak, V., Pešić, D., Melih, I., Lalović, M., Nikitović, A., & Jakovljević, A. (2018). Epidemiological investigation of non-carious cervical lesions and possible etiological factors. *J Clin Exp Dent*, 10 (7), 648-656.

Lai, Z. Y., Zhi, Q. H., Zhou, Y., & Lin, H. C. (2015). Prevalence of Non-carious Cervical Lesions and Associated Risk Indicators in Middle-aged and Elderly Populations in Southern China. *The Chinese Journal of Dental Research*, 18 (1), 41-50.

Lee, W.C., & Eakle, W. (1996). Stress-induced cervical lesions: review of advances in the past 10 years. *J Prosthet Dent*, 75 (5), 487-494.

Marochi, C., & Queiroz, V. (2001). Lesões não-cariosas. In: Gomes J, editor. *Estética em clínica odontológica*, 151-94.

Medeiros, T. L. M., Mutran, S. C. A. N., Espinosa, D. G., do Carmo Freitas Faial, K., Pinheiro, H. H. C., & D'Almeida Couto, R. S. (2020). Prevalence and risk indicators of non-carious cervical lesions in male footballers. *BMC Oral Health*, 20 (1), 215.

Mitic, A. D., Gasic, J. Z., Barac, R. G., Radenkovic, G. S., Sunaric, S. M., Popovic, J. Z., & Nikolic, M. M. (2020). Ultrastructural changes in the cemento-enamel junction caused by acidic beverages: An in vitro study. *Microsc Res Tech*, 83 (2), 91-98.

O'toole, S., & Bartlett, D. (2017). The relationship between dentine hypersensitivity, dietary acid intake and erosive tooth wear. *J Dent*, 67, 84-87.

Parkinson, C. R.; Shahzad, A.; & Rees, G. D. (2010). Initial stages of enamel erosion: an in situ atomic force microscopy study. *Journal of structural biology*, 171 (3), 298-302.

Radentz, W. H., Barnes, G. P., & Cutright, D. E. (1976). A survey of factors possibly associated with cervical abrasion of tooth surfaces. *J Periodontol*, 47(3), 148-54

Rajendran, R., Kunjusankaran, R. N., Sandhya, R., Anilkumar, A., Santhosh, R., & Patil, S. R. (2019). Comparative evaluation of remineralizing potential of a paste containing bioactive glass and a topical cream containing casein phosphopeptide-amorphous calcium phosphate: An in vitro study. *Pesquisa brasileira em odontopediatria e clinica integrada*, 19:e4668.

Rusu Olaru, A., Popescu, M. R., Dragomir, L. P., Popescu, D. M., Arsenie, C. C., & Rauten, A. M. (2019). Identifying the Etiological Factors Involved in the Occurrence of Non-Carious Lesions. *Curr Health Sci J*, 45 (2), 227-234.

Sawlani, K., Lawson, N. C., Burgess, J. O., Lemons, J. E., Kinderknecht, K. E., Givan, D. A., & Ramp, L. (2016). Factors influencing the progression of noncarious cervical lesions: A 5-year prospective clinical evaluation. *J Prosthet Dent*, 115 (5), 571-7.

Seong, J., Bartlett, D., Newcombe, R. G., Claydon, N. C. A., Hellin, N., & West, N. X. (2018). Prevalence of gingival recession and study of associated related factors in young UK adults. *J Dent*, 76, 58-67.

Shellis, R.P., & Addy, M. (2014). The interactions between attrition, abrasion and erosion in tooth wear. *Oral Sci*, 25, 32-45.

Shrestha, D., & Rajbhandari, P. (2018). Prevalence and Associated Risk Factors of Tooth Wear. *Journal of the Nepal Medical Association*, 56 (212), 719-723.

Silva, M. A., Damante, J. H., Stipp, A. C., Tolentino, M. M., Carlotto, P. R., & Fleury, R. N. (2001). Gastroesophageal reflux disease: New oral findings. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 91 (3), 301-10.

Smith, W. A. J.; Marchan, S.; & Rafeek, R. N. (2009). The prevalence and severity of non-carious cervical lesions in a group of patients attending a university hospital in Trinidad. *J Oral Rehabil*, 35 (2), 128-134.

Suit, S. R., Gibbs, C. H., & Benz, S. T. (1976). Study of gliding tooth contacts during mastication. Journal of periodontology, 47 (6), 331-334.

Teixeira, D. N. R., Zeola, L. F., Machado, A. C., Gomes, R. R., Souza, P. G., Mendes, D. C., & Soares, P. V. (2018). Relationship between noncarious cervical lesions, cervical dentin hypersensitivity, gingival recession, and associated risk factors: A cross-sectional study. *J Dent*, 76, 93-97.

Turssi, C. P., Kelly, A. B., & Hara, A. T. (2019). Toothbrush bristle configuration and brushing load: Effect on the development of simulated non-carious cervical lesions. *J Dent*, 86, 75-80.

Yang, J., Cai, D., Wang, F., He, D., Ma, L., Jin, Y., & Que, K. (2016). Non-carious cervical lesions (NCCLs) in a random sampling community population and the association of NCCLs with occlusive wear. *J Oral Rehabil*, 43(12), 960-966.

Yan, W., & Yang, D. (2014). The prevalence, characteristics and risk factors in non-carious cervical lesion: a survey on 295 people in Guangzhou area. *Journal of Oral Hygiene & Health*, 2, 125.

Yoshizaki, K. T., Francisconi-Dos-Rios, L. F., Sobral, M. A., Aranha, A. C., Mendes, F. M., & Scaramucci, T. (2017). Clinical features and factors associated with non-carious cervical lesions and dentin hypersensitivity. *J Oral Rehabil*, 44 (2), 112-118.

Zuza, A., Racic, M., Ivkovic, N., Krunic, J., Stojanovic, N., Bozovic, D., Bankovic-Lazarevic, D., & Vujaskovic, M. (2019). Prevalence of non-carious cervical lesions among the general population of the Republic of Srpska, Bosnia and Herzegovina. *Int Dent J*, 69 (4), 281-288.