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Betel and tobacco chewing habit and its relation to risk factors for periodontal disease

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Objectives: To comparatively assess periodontal status in patients who chew different products and patients who do not have this habit and to assess how this practice interacts with predisposing factors and risk indicators of disease.

Methods: Patients included in the dental care carried out in a rural community in India were considered for a cross-sectional study. The simplified oral hygiene index and the community periodontal index (CPI) were assessed. Furthermore, a validated survey with items concerning chewing habits was administered. Statistical analysis of the effects of age range, gender, chewing products and hygiene status on CPI was performed.

Results: In total, 1,023 patients met the inclusion criteria. The chewer patients (430) exhibited a significantly higher CPI than the non-chewers (593). The chewing habit increased the likelihood of a higher CPI by 6.76-fold, while excellent-good oral hygiene status decreased the probability of a higher CPI by approximately 45%. CPI did not differ significantly among chewers of different products.

Conclusion: In the population studied, a chewing habit was associated with a worse periodontal status, and this association was not modified by gender and age as predisposing factors. Oral hygiene could decrease the effect of chewing habit on periodontal health.

KEYWORDS

betel quid, chewing habit, community periodontal index, oral disease, periodontal disease, smokeless tobacco

1 | INTRODUCTION

Periodontal disease is multifactorial in origin. Infection is always present in the pathology, but many factors might influence its onset and progression (Sanz & van Winkelhoff, 2011). These factors include microbiological, genetic, immunological, environmental and behavioural factors (Clarke & Hirsch, 1995; Genco & Borgnakke, 2013; Holtfreter et al., 2015).

Periodontal disease is an event that occurs within a social context and can represent a risk when sociocultural mores include activities that are potentially harmful to the periodontal structure. The betel quid, with or without tobacco, and tobacco by itself are the main substances used for chewing habits in the south and south-east of Asia (Gupta & Johnson, 2014) and South Africa (van Wyk, 1993), and the use of the betel quid has been described in nearby regions due to migration (Yoganathan, 2002). Additionally, the habit of chewing tobacco has been extended to Europe and North America (Lee & Hamling, 2009). Betel products are the fourth most common psychoactive substance worldwide after caffeine, alcohol and nicotine (Anand, Dhingra, Prasad, & Menon, 2014). This habit produces significant modifications

of the dental surface and generates wear and stains (Anand et al., 2014). Several studies have demonstrated that the sociocultural habits of chewing betel quid with or without tobacco and tobacco by itself in different presentations have modifying effects on periodontal disease (Gupta & Ray, 2004; Javed et al., 2013; Kulkarni, Uttamani, & Bhatavadekar, 2016; Sumanth, Bhat, & Bath, 2008). However, there is limited information available about the interaction of chewing habits and other factors associated with periodontal disease. In health science, risk is defined as the probability that a hazard will cause some harmful event. A risk factor is a characteristic that increases the likelihood of developing a disease or injury. Bouchard, Carra, Boillot, Mora, and Rangé (2017) have proposed an epidemiological model for periodontal risk factors, according to the proximity of the factor in the causal chain leading to the diseases. In this context, the concept "true risk factors" is used for proximal risk. For instance, diabetes and smoking are true risk factors for periodontal diseases. Other factors (frequently mentioned in the literature), such as poor hygiene, are "intermediate risk factors" or "risk indicators," while "age" and "gender" are considered "distal risk factors" or "predisposing factors." Under the hypothesis that chewing habits are associated with a worse periodontal status, can interact with the risk indicator "hygiene status" or the predisposing factors "age and gender" and are modifiers of periodontal disease expression, the aims of this study were to comparatively assess the periodontal health of patients who routinely chew different products as sociocultural customs and patients who do not have these habits, as well as to assess the influences of gender, age and hygiene status, when the chewing habits are practised by the patients.

2 | METHODOLOGY

The study protocol was reviewed and authorised by the Clinical Research Ethics Committee of the University of Barcelona (CEIC 556) and was authorised by the director of the Hospital Kalyandurg Kanekal. The study was conducted during the dental care activities of the Vicente Ferrer Foundation, whose professionals annually perform oral health promotion activities involving prevention, prophylaxis and dental treatments when required. The principles of the Declaration of Helsinki were followed during this study. Written consent was obtained from each patient after explaining the objective of the study.

2.1 | Population characteristics and patient selection

The study population was located in the rural area of the Anantapur State of Andhra Pradesh, India. This area is characterised by low socioeconomic and educational levels and shared sociocultural aspects.

A cross-sectional study was conducted, and the sample was non-probabilistic (the subjects volunteered). The patients included in the social dental care operations promoted and conducted by the Vicente Ferrer Foundation between July and September 2016 were considered. The patients were examined and interviewed at the hospitals of Kanekal, Bathalapalli and Kalyandurg, and the rural brigades of Anantapur, all under the direction of the Kalyandurg Hospital and Vicente Ferrer Foundation.

The inclusion criteria were as follows:

1. Patients of both genders between 20 and 65 years old;
2. Patients who were currently consuming chewing products;
3. Patients with a sufficient number of teeth for CPI application in each sextant.

The exclusion criteria were as follows:

1. Patients with physical or mental alterations that modified their feeding system or oral hygiene;
2. Patients with orofacial malformations or pathologies that would alter or increase the difficulty of the examination;
3. Patients who reported habitual alcohol consumption;
4. Patients who were smokers of tobacco and/or other substances regardless of the frequency;
5. Patients who declared that they chewed products only sporadically;
6. Patients with systemic conditions that could modify the course of periodontal disease, such as diabetes, cardiovascular disease and pregnancy (Amarasena, Ekanayaka, Herath, & Miyazaki, 2002; Clarke & Hirsch, 1995; Genco & Borgnakke, 2013; Wu, Xiao, & Graves, 2015);
7. Patients who did not answer all the questions and those from whom it was difficult to obtain valid information;
8. Patients who attended the dental service with severe pain and required urgent attention.
9. Patients who stated that he/she did not chew any substance but signs of chewing habits were observed during the oral examination.

The patients were divided into three age ranges (20–34, 35–44 and 45–65 years) and were classified into two groups according to their substance chewing habits, that is chewers and non-chewers. The chewers were defined as patients who claimed to chew some substance as a sociocultural habit and who had engaged in the habit for at least 2 years. The non-chewers did not have any chewing habit. Additionally, the chewer group was divided according to the chewed substance as indicated on the survey.

2.2 | Oral examination and survey used to investigate the habits of chewing substances

Four dentists were trained and calibrated in terms of their diagnoses. The oral examinations recorded the following aspects for simplicity, speed and uniformity of the measurements (Petersen & Ogawa, 2012): oral hygiene according to the simplified oral hygiene index OHI-S (Greene & Vermillion, 1964) and periodontal status according to the community periodontal index (CPI), which is based on the criteria of the World Health Organization (WHO). In OHI-S, six dental surfaces are selected from four posterior and two anterior teeth. OHI-S has

two components, the debris index and calculus index, scored from 0 to 3. Both indexes are combined to obtain OHI-S (range: 0–6), and this score is frequently dichotomised for population studies as OHI-S ≤ 1 (good hygiene) and OHI-S > 1 (poor hygiene) (Hermann et al., 2009; Mbawalla, Masalu, & Astrøm, 2010). A CPI probe that met the WHO guidelines was used (World Health Organization, 1997). According to this standard, the CPI codes were categorised as normal (CPI 0), gingival bleeding (CPI 1), calculus (CPI 2), shallow periodontal pockets (CPI 3) and deep periodontal pockets (CPI 4). The patients' scores for this index were assigned considering the CPI record of each "sextant" present in the mouth. The Kendall coefficient of concordance (KCC) was used to assess the interobserver agreement. During the training, each examiner applied the CPI and OHI-S to 20 patients. These tests were repeated at three and seven days. The interobserver KCCs varied between 0.888 and 0.925 for the CPI measurements. For the OHI-S scores, the interobserver KCCs varied between 0.822 and 0.913. During the oral examinations, the chewing habits were also confirmed via observations of signs such as stains, the remains of some chewed product, and lesions of the oral mucosa. Furthermore, a validated survey was added to the clinical sheet and included questions related to the chewing habits (i.e. the substance used, frequency and years of consumption).

2.3 | Statistical analysis

The highest CPI value observed for each patient was used for the statistical analysis. With this value, the main explorations were as follows:

1. The association between chewing habits and observed CPI scores.
2. The associations of the age range, gender and CPI scores among the chewers and non-chewers.
3. The association between the type of chewing products used and CPI scores.
4. The associations of oral hygiene aspects (i.e. the OHI-S scores and frequencies of chewing) with the age range, gender and CPI scores among the chewers and non-chewers.

Additionally, the CPIs of each sextant were considered to assess the local effect of chewing habits, and the highest CPI value from each sextant was considered in this analysis.

The Mann–Whitney–Wilcoxon test was used to compare independent samples; the analysis of variance (ANOVA), supplemented with a post hoc test, was used to establish differences between several independent data sets; and the Pearson chi-square test, Fisher's exact test and odds ratios were used to establish the independence or associations among variables. Additionally, multiple logistic regression was applied with the occurrence of the CPI value as the dependent variable. The CPI and OHI-S values were dichotomised as <3 (lower) and 3–4 (higher) and as "fair-poor" (score >1) and "excellent-good" (score ≤1). These dichotomisations of the CPI and OHI-S values have been used in the literature and accepted (Angeli et al., 2003; Hermann et al., 2009; Mathur, Tsakos, Parmar, Millett, & Watt, 2016). The significance level used was $\alpha < 0.05$. The statistical software used was IBM SPSS Statistics 22.

3 | RESULTS

3.1 | General description

In total, 1,613 patients were examined, and 1,023 satisfied all the inclusion/exclusion criteria. The distributions of men and women (54.3% and 45.7%, respectively) in the different age ranges did not exhibit significant differences. Considering this sample, the different analyses were associated with statistical powers that varied between 0.82 and 1.0. The distribution of patients by CPI score, chewing habit and age range is summarised in Figure 1. Of the patients studied, 57.9% (n = 593) indicated that they did not have any chewing habit. Of the chewing patients (n = 430), 40.7% chewed betel quid (BQ), 38.1% chewed betel quid with tobacco (BQ + Tb) and 21.2% chewed tobacco alone (Tb). The BQ included the betel leaf, areca nut, slaked lime and other flavouring elements (e.g. catechu resin, cardamom and others). The BQ + Tb preparations included the betel leaf and mixtures

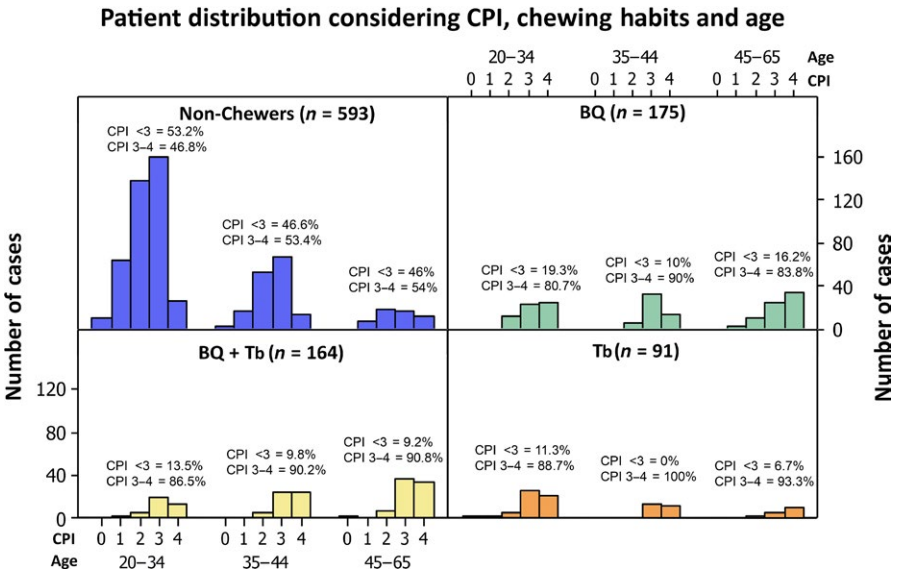

FIGURE 1 The distribution of the patients included in the study is shown. In the graph, the study groups present differences in the distribution of the CPI values according to the habit and age range of the study. In the groups that chewed betel quid (BQ), betel plus tobacco (BQ + Tb) and tobacco preparations (Tb), there is a predominance of CPI 3–4 values in all age ranges, unlike in the non-chewer group [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Analysis of distribution of patients considering CPI, gender, age range and chewing habits (n = 1023)

	CPI <3[a]	CPI 3–4[a]	*p value*[b]	OR (CI 95%)[c]
Chewers (Ch) and non-chewers (n-Ch)				
Ch	51	379	<.001*	7.71 (5.5–10.77)
n-Ch	302	291		
Ch females	22	169	<.001*	8.08 (4.89–13.36)
n-Ch females	142	135		
Ch males	29	210	<.001*	7.43 (4.75–11.61)
n-Ch males	160	156		
Ch females 20–34 age range	8	57	<.001*	7.21 (3.25–15.98)
n-Ch females 20–34 age range	89	88		
Ch females 35–44 age range	4	46	<.001*	13.53 (4.42–41.44)
n-Ch females 35–44 age range	40	34		
Ch females 45–60 age range	10	66	<.001*	6.6 (2.39–11.42)
n-Ch females 45–60 age range	13	13		
Ch males 20–34 age range	14	68	<.001*	6.06 (3.21–11.42)
n-Ch males 20–34 age range	121	97		
Ch males 35–44 age range	6	68	<.001*	7.3 (2.81–19.01)
n-Ch males 35–44 age range	29	45		
Ch males 45–60 age range	9	74	<.001*	5.87 (2.02–17.06)
n-Ch males 45–60 age range	10	14		
Chewers				
Females	22	169	.881	
Males	29	210		
Females 20–34 age range	8	57	.490	
Males 20–34 age range	14	68		
Females 35–44 age range	4	46	1	
Males 35–44 age range	6	68		
Females 45–60 age range	10	66	.807	
Males 45–60 age range	9	74		
Non-chewers				
Females	142	135	.934	
Males	160	156		
Females 20–34 age range	89	88	.312	
Males 20–34 age range	121	97		
Females 35–44 age range	40	34	.099	
Males 35–44 age range	29	45		
Females 45–60 age range	13	13	.583	
Males 45–60 age range	10	14		

*Significant association.
[a]CPI values were dichotomised in <3 and 3–4 values for Fisher's exact test.
[b]*p* value by Fisher's exact test.
[c]Odds ratio with 95% confidence interval (CI).

of the components indicated above plus tobacco (pure or from commercial products). The chewing tobacco (Tb) mainly came from commercial products that were combined with areca nut and slaked lime or just the slaked lime, and four patients used tobacco in their own preparations with other flavour elements. Among the male patients (n = 240), BQ + Tb was the most frequently used preparation (61.6%) followed by Tb and BQ (32.1% and 6.3%, respectively). Men in the age range of 20–34 preferred Tb, while men in the older age ranges significantly preferred BQ + Tb (p < .05). Among the females (n = 190), BQ was the most frequently used preparation (84.2%) followed by BQ + Tb and Tb (8.4% and 7.4%, respectively), and there were no differences in the chewing products used between the studied age

TABLE 2 Association among the chewing products and CPI

	CPI <3[a]	CPI 3–4[a]	*p value*[b]	OR (CI 95%)[c]
Chewer groups				
BQ chewers	27	148	.135	
BQ + Tb chewers	17	147		
Tb chewers	7	84		
Non-chewers versus	302	291		
BQ chewers	27	148	.001*	5.59 (3.66–8.84)
BQ + Tb chewers	17	147	.001*	8.97 (5.29–15.20)
Tb chewers	7	84	.001*	12.45 (5.67–27.38)
Female non-chewers versus	142	136		
Female chewers	22	168	.001*	7.97 (4.82–13.18)
Female BQ chewers	17	143	.001*	8.78 (5.04–15.30)
Female BQ + Tb chewers	2	14	.003*	7.31 (1.63–32.76)
Female Tb chewers	3	11	.051	3.83 (1.05–14.02)
Male non-chewers versus	160	155		
Male chewers	29	211	.001*	7.51 (4.81–11.74)
Male BQ chewers	10	5	.293	0.52 (0.17–1.54)
Male BQ + Tb chewers	15	133	.001*	9.15 (5.14–16.31)
Male Tb chewers	4	73	.001*	18.84 (6.72–52.79)

*Significant association.
[a]CPI values were dichotomised in <3 and 3–4 values for odds ratio (OR), Fisher's exact test and Pearson chi-square test.
[b]*p* value by Fisher's exact test and Pearson chi-square test.
[c]Odds ratio with 95% confidence interval (CI).

ranges. The mean chewing habit durations were 9.67 (*SD* 4.37) years in the patients between the ages of 20 and 34 years, 12.10 (*SD* 3.46) years in the patients between the ages of 35 and 44 years, and 22.3 (*SD* 6.33) years in the patients between the ages of 45 and 65 years. The declared frequencies of consumption ranged from three times a week to twice daily for BQ (mean = 1.1 daily), from one to four times daily for BQ + Tb (mean = 1.8 daily) and from one to eight times daily for Tb (mean = 3.8 daily). Significant differences between the chewing products with respect to the frequencies of consumption were observed ($p < .05$).

3.2 | CPI scores of the chewers and non-chewers considering gender, age range and chewing products

The general distributions of chewers and non-chewers according to CPI score and age are summarised in Table 1. The patients with a chewing habit were significantly more likely to have CPI values of 3–4. Similar results were produced when each age range and gender were analysed separately. These observations were corroborated by the ANOVA, which revealed significant differences in the CPI scores of the non-chewers compared with those in the BQ, BQ + Tb and Tb chewers. Tukey's HSD post hoc test indicated that the non-chewers had significantly lower CPI scores than the chewers ($p < .05$). There were no differences in the CPI scores according to the age ranges among either the chewers or non-chewers (gender-independent). Considering gender, only the non-chewer men exhibited a difference that indicated a possible association between a higher age range and a CPI of 3–4. Considering only the chewers, the CPIs of the BQ, BQ + Tb and Tb chewers exhibited no significant differences. The same result was observed when this analysis was performed considering gender and each age range separately. Overall, the effects of chewing habits on the CPI values were independent of the chewed substance (Table 2).

3.3 | CPIs of the chewer and non-chewer groups in relation to the observed hygiene and declared hygiene frequency

During the clinical inspections, 91.3% ($n = 934$) of the patients presented with an OHI-S that was considered "fair-poor." Of these patients, 45.1% ($n = 421$) reported a chewing habit, and these patients were significantly associated with CPI values of 3–4. The latter result was confirmed by the Mann–Whitney test, which indicated that the CPI values were higher among the chewing group with "fair-poor" hygiene ($p < .05$). Regarding the patients with "excellent-good" hygiene, 89.8% ($n = 80$) indicated that they did not chew substances, and these patients were significantly associated with CPI values <3. By contrast, the chewer patients with "excellent-good" hygiene

TABLE 3 Analysis of distribution of chewer and non-chewer patients considering oral hygiene status (OHI-S), hygiene frequency, gender, chewing habits and CPI (n = 1,023)

CPI and hygiene by OHI-S					CPI and hygiene by frequency				
	CPI <3[a]	CPI 3-4[a]	*p value*[b]	OD[c] (CI 95%)		CPI <3[a]	CPI 3-4[a]	*p value*[b]	OD[c] (CI 95%)
CPI and Hygiene					Hygiene frequency				
OHI-S "fair-poor"	300	634	<.001*	3.11 (1.99–4.86)	Once a day	269	599	<.001*	2.63 (1.86–3.73)
OHI-S "excellent-good"	53	36			Twice a day or more	84	71		
OHI-S "fair-poor"					Hygiene "once a day"				
Females	132	289	.672		Females	121	273	.883	
Males	168	345			Males	148	326		
OHI-S "excellent-good"					Hygiene "twice a day or more"				
Females	32	15	.089		Females	43	31	.420	
Males	21	21			Males	41	40		
OHI-S "fair-poor"					Hygiene "once a day"				
Chewers	49	372	<.001*	7.27 (5.15–10.26)	Chewers	44	357	<.001*	7.54 (5.25–10.83)
Non-chewers	251	262			Non-chewers	225	242		
OHI-S "fair-poor"					Hygiene "once a day"				
Female chewers	21	166	<.001*	7.13 (4.23–12.02)	Female chewers	19	160	<.001*	7.6 (4.4–13.12)
Female non-chewers	111	123			Female non-chewers	102	113		
OHI-S "fair-poor"					Hygiene "once a day"				
Male chewers	28	206	<.001*	7.41 (4.68–11.73)	Male chewers	25	197	<.001*	7.51 (4.63–12.19)
Male non-chewers	140	139			Male non-chewers	123	129		
OHI-S "excellent-good"					Hygiene twice a day or more				
Chewers	2	7	.027*	6.16 (1.2–31.61)	Chewers	7	22	<.001*	4.94 (1.96–12.43)
Non-chewers	51	29			Non-chewers	77	49		
OHI-S "fair-poor"					Hygiene once a day				
BQ	26	145	.146		BQ	21	140	.458	
BQ + Tb	16	144			BQ + Tb	16	136		
Tb	7	83			Tb	7	81		

*Significant association.

[a]CPI values were dichotomised in <3 and 3–4 values and OHI-S in "fair-poor" and "excellent-good" for Pearson chi-square test and Fisher's exact test.

[b]p value by Fisher's exact test and Pearson chi-square test.

[c]Odds ratio with 95% confidence interval (CI).

BQ, betel quid chewers; BQ + Tb, betel quid and tobacco chewers; Tb, tobacco chewers.

TABLE 4 Analysis of sextants by CPI considering chewer and non-chewer patients (n = 6,138)

	CPI <3[a]	CPI 3–4[a]	*p value*[b]	OR (CI 95%)[c]
Sextants between chewers and non-chewers				
Sextant 1 (chewers)	147	282	<.001*	5.07 (3.88–6.64)
Sextant 1 (non-chewers)	431	163		
Sextant 2 (chewers)	308	121	<.001*	5.91 (3.99–8.77)
Sextant 2 (non-chewers)	557	37		
Sextant 3 (chewers)	127	302	<.001*	5.98 (4.55–7.86)
Sextant 3 (non-chewers)	425	169		
Sextant 4 (chewers)	99	330	<.001*	7.37 (5.55–9.79)
Sextant 4 (non-chewers)	409	185		
Sextant 5 (chewers)	281	148	<.001*	3.94 (2.87–5.42)
Sextant 5 (non-chewers)	524	70		
Sextant 6 (chewers)	98	331	<.001*	7.41 (5.57–9.85)
Sextant 6 (non-chewers)	408	186		
Dental arcades from chewers				
Maxillary sextants	582	708	<.001*	
Mandibular sextants	478	812		
Dental arcades from non-chewers				
Maxillary sextants	1413	366	.004*	
Mandibular sextants	1341	438		

*Significant association.
[a]CPI values were dichotomised in <3 and 3–4 values for odds ratio (OR) and Fisher's exact test.
[b]p value by Fisher's exact test.
[c]Odds ratio with 95% confidence interval (CI).

were associated with CPI values of 3–4. Concerning the non-chewer patients, those with "fair-poor" hygiene were associated with CPI scores of 3–4, while those with "excellent-good" hygiene were associated with CPI scores <3, and the odds ratio adjusted by gender was 1.74 (95% confidence interval 1.07–2.82).

Regarding the hygiene frequency reported by the patients, 84.85% (n = 868) indicated that they performed oral hygiene at least once daily, and the remaining patients reported practising oral hygiene two or more times per day. Oral hygiene performed only once per day was significantly associated with CPI scores of 3–4. Additionally, 46.19% (n = 401) of these patients reported chewing some substance, and this subgroup of patients was significantly associated with CPI scores of 3–4. Considering the patients who declared that they engaged in oral hygiene practices more than once a day (n = 155), 16.7% (n = 26) indicated that they chewed some substance. Table 3 presents the results of a statistical analysis of the patients according to hygiene (OHI-S and frequency), CPI and chewed substances.

3.4 | CPI analysis of the sextants within the different groups

The sextants 1, 3, 4 and 6 of the chewers exhibited a predominance of CPI 3–4 scores, whereas the non-chewers exhibited a predominance of CPI scores <3 in all sextants. The same analysis that separately considered gender and each age range produced similar results. The CPI analysis of each sextant revealed a significant association between CPI 3–4 scores and chewers in all sextants, and the odds ratio indicated stronger effects in sextants 4 and 6. Additionally, higher prevalences of CPI 3–4 scores were associated with the mandibular teeth in both the chewers and non-chewers (Table 4). Finally, the analysis of the effects of chewing products in each sextant only revealed a strong association of CPI scores of 3–4 in the second and fifth sextants using BQ + Tb products (p < .05).

Multiple logistic regression was used to observe the effect of the main variables studied (age range, gender, chewing products and hygiene status) on CPI. The main finding was that chewing habit increased the likelihood of CPI scores of 3–4 by 6.76-fold (confidence interval: 4.72–9.67; p < .00), keeping the other variables fixed. On the other hand, the oral hygiene excellent-good decreased in approximately 45% the probability to obtain CPI scores of 3–4 (odds ratio: 0.55; confidence interval: 0.34–0.88). This latter result did not match that described above with respect to chewing habits and observed hygiene.

4 | DISCUSSION

This study analysed how different products used for chewing habits affect the periodontal health of a rural population in India and how such habits could interact with other factors, including gender, age and hygiene status. The principal observed effect was the significantly

higher CPI values among the patients in the chewer group than in the non-chewer group (Tables 1 and 3). In this regard, our results agree with the reports from different studies that have been performed in Taiwan (Jeng, Lan, Hahn, Hsieh, & Kuo, 1996), Sri Lanka (Amarasena, Ekanayaka, Herath, & Miyazaki, 2003; Amarasena et al., 2002), Thailand (Chatrchaiwiwatana, 2007), Bangladesh (Akhter, Hassan, Aida, Takinami, & Morita, 2008), India (Choudhury, Choudhury, Alam, Markus, & Tanaka, 2003; Mehta, Sanjana, & Barretto, 1955) and other regions in which betel quid with or without tobacco is consumed. Compared with reports for tobacco chewers, our results agree with studies from the United States (Robertson et al., 1990), Yemen (Al-Tayar, Tin-Oo, Sinor, & Alakhali, 2015) and India (Anand, Kamath, Shekar, & Anil, 2012; Parmar, Sangwan, Vashi, Kulkarni, & Kumar, 2008), among others.

Gender is considered a non-modifiable predisposing factor or distal risk because it is in the rear area of the causal chain (Bouchard et al., 2017). Several prevalence studies have shown that male gender greatly increases the risk of periodontal disease (Albandar, 2002; Eke et al., 2015; Hermann et al., 2009). In our study, no significant differences in the CPI scores were observed between the males and females among either the chewers or the non-chewers (Table 1). Socioeconomic and sociocultural factors (including chewing habits) associated with the particular lifestyle of the population studied could explain the observed results. These factors have been suggested as relevant elements within the chain of risks that affect the prevalence of periodontal disease (Genco & Borgnakke, 2013; Holtfreter et al., 2015). Additionally, it is interesting to consider the significant difference detected in the preferences for chewed substances according to gender; although BQ was preferred by the females and BQ + Tb was preferred by the males, no differences in the CPI scores were detected between the genders in the chewer group (Table 1).

Age has been described as a non-modifiable predisposing factor (Bouchard et al., 2017), a confounding factor for periodontal disease (Genco & Borgnakke, 2013) and an important variable in reports related to periodontal status (Holtfreter et al., 2015). As observed in the results, the chewing habits of the males seemed to generate a transverse consequence on periodontal status that was independent of the age range and modified the effect of this variable as observed in non-chewer males. However, the result of multiple logistic regression analysis makes this finding questionable. In regions in which chewing habits are sociocultural customs, such as southern Asia, northern Oceania and India, these practices begin at an early age (Philip, Parambil, Bhaskarapillai, & Balasubramanian, 2013; Singhvi et al., 2016; Talonu, 1989). This fact helps to explain the significantly higher CPI scores of the chewer patients than those of the non-chewer patients in the younger group (20–34 years; Table 1). Nevertheless, no specific antecedents were found in the literature concerning the initiation of chewing habits in the region included in our study. Only the patients who expressed declarations regarding this issue were considered (with its inherent limitations).

Oral hygiene is a modifiable risk indicator and plays an important role in the prevention and treatment of periodontal disease (van der Weijden & Slot, 2011). In the group studied, the observed effects of chewing habits and hygiene status on CPI were ambiguous. Table 3 shows that the effect of the chewing habit was not affected by hygiene status or its frequency; even the chewer patients with "excellent-good" hygiene or hygiene frequencies of "twice a day or more" exhibited significant associations with CPI scores of 3–4 (Table 3). These results agree with those of Parmar et al. (2008), who reported that the oral hygiene statuses of chewers are significantly deteriorated compared with those of non-chewers. However, multiple logistic regression analysis showed a different behaviour of these variables when they are considered in conjunction with other data. According to the latter finding, excellent-good oral hygiene decreased the probability to obtain a CPI of 3–4. A specific study design may be necessary to confirm these results because, according to this finding, habitual oral hygiene practice could limit the deleterious effect of the chewing habit.

The general results revealed no significant differences in the comparisons of the CPI scores of those who chewed BQ, BQ + Tb or Tb (Table 2). However, the analysis by gender revealed an effect of the chewing product on the CPI scores among the female chewers of Tb and male chewers of BQ (Table 2). These minority groups represent only 6.7% of chewers, and, consequently, the effect of chewing habits on periodontal health was independent of the chewed products used by the population studied. This result does not agree with other reports in the literature in which different effects of two chewing products have been observed (Javed et al., 2013; Sumanth et al., 2008). Nevertheless, our results agree with those of another study that compared periodontal inflammatory conditions between habitual gutka chewers and betel quid chewers (Javed, Vohra, Al-Kheraif, Malmstrom, & Romanos, 2015). The common components detected in the chewed substances could have influenced these results. For example, calcium hydroxide (slaked lime) was present in all the chewed products, and calcium hydroxide is a strong alkali that can irritate the oral mucosa (Dunham, Muir, & Hamner, 1996; Javed, Chotai, Mehmood, & Almas, 2010). Another common element observed in the chewing products was the areca nut, which has been demonstrated to alter gingival keratinocytes and fibroblasts (Chang et al., 1998; Jeng et al., 1999) and modify the antimicrobial function of neutrophils (Lee et al., 2014). Furthermore, the effect of tobacco used locally (chewed tobacco) causes hyperaemia in the gingiva (Mavropoulos, Aars, & Brodin, 2001) and increases the levels of periodontitis and gingival bleeding (Amarasena et al., 2002, 2003). Therefore, a more detrimental effect on periodontal status could theoretically be generated by the joint use of slaked lime, areca nut and tobacco (BQ + Tb and commercial Tb chewers) compared with BQ alone. However, no differences among these chewer groups were observed in our study.

The analysis of the effects of chewing habits on periodontal status considering each sextant revealed greater CPI scores in the mandibular sextants, especially in the fourth and sixth sextants (Table 4). Antecedents regarding local effects on periodontal status caused by chewing habits were not found. However, the literature describes that the chewing substances are commonly placed between mandibular teeth and the buccal mucosa (Reichart & Phillipsen, 1998), which likely explains our finding. Moreover, BQ + Tb generated a significantly worse effect on sextant 5. The habit of chewing this product generates

parasympathetic stimulation and increases the rate of salivary secretion (Boucher & Mannan, 2002; Mehta et al., 1955). The above actions contribute to supragingival calculus formation on the lingual surfaces of the mandibular anterior teeth, and greater accumulations of calculi are frequent in this area (Jin & Yip, 2002). Other antecedents to consider are the higher levels of calcium that have been described in the saliva of long-term tobacco chewers (Khan et al., 2005) and the characteristically high levels of fluoride in the drinking water of India (Jagtap, Yenkie, Labhsetwar, & Rayalu, 2012). The presence of these elements in the saliva could facilitate calculus formation (Jin & Yip, 2002). Specific studies are needed to confirm this conjecture.

Several limitations must be considered regarding this study. The activities of the Vicente Ferrer Foundation range from prevention to the application of treatments when needed; therefore, although several inclusion/exclusion criteria were applied, the interpretation of the results should be performed with caution because the sample included volunteer patients with different treatment needs. The CPI score was used because it provides an objective classification system for a suitable cross-sectional view of the periodontal status of the population. However, this scoring system could be insufficient for measurements of the cumulative damage to periodontal tissues (Leroy, Eaton, & Savage, 2010) and, thus, could have led to underestimations of the extents and severities of periodontal destruction that have previously occurred in the mouths of the volunteers. Moreover, this report did not consider aspects such as the method of hygiene or other risk factors for periodontal disease. Randomised stratified studies that consider these aspects are needed to complement and deepen the results reported in our study.

Within the inherent limitations of this report, we concluded that in the studied population, the chewing habits were associated with a higher prevalence of CPI 3–4 scores. This observation was independent of the chewing products used by the patients and was not influenced by factors such as age or gender. The CPI values were greater in all sextants of the chewers than in the non-chewers, but sextants 4 and 6 were observed to be the most detrimentally affected. The habitual oral hygiene practice could decrease the effect of chewing habits on periodontal health. Chewing habits have deep-seated cultural roots in populations in which it is customary, and educational or sanitary initiatives must be sensitive to the community's belief systems. From the clinical perspective, sanitary personnel must be aware that chewers will present with worse periodontal health, and this type of patient will have had a modified periodontal condition from an early age (among other oral complications). Finally, due to the specific sociocultural aspects of the community studied, complementary prevalence studies including other distal, intermediate or proximal risk factors for periodontal disease are needed. This information could contribute to regional public decisions and the direction of the actions of international aid agencies.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

All authors contributed to the work substantially. Giovanonni L. and Chimenoz E. conceived and designed the study; Lozano de Luaces V. and Balasubbaiah Y. recruited patients and examiners (dentists); Valdivia I., Varela H. and Chimenos E. performed the analysis and interpretation of the data; and Varela H. and Valdivia I. performed the statistical analysis. All authors have been significantly involved in revising the article and have read and approved the final version of the manuscript.

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