# Risk factors for denture-related oral mucosal lesions in a geriatric population

**Elisenda Martori, DDS, PhD,[a] Raul Ayuso-Montero, DDS, PhD,[b] Jordi Martinez-Gomis, DDS, PhD,[c] Miguel Viñas, PhD,[d] and Maria Peraire, MD, PhD[e]**
University of Barcelona, Spain

**Statement of problem.** Denture-related mucosal lesions have been broadly studied. However, no consensus has been reached regarding the risk factors associated with these lesions, and few studies have used multivariable analysis to determine the relative significance of different risks.

**Purpose.** The purpose of this study was to determine the relationship between systemic, local, and denture factors on the risk of denture-related oral mucosal lesions in an elderly population by using multivariable analysis.

**Material and methods.** Eighty-four elderly denture wearers recruited from geriatric residences and day care centers participated in this cross-sectional study. All data were obtained by means of a questionnaire-interview, a physical examination, and complementary tests. Bivariate relationship and multiple logistic regression analyses were performed ($\alpha$=.05).

**Results.** Angular cheilitis (34%), traumatic ulcers (15%), and denture stomatitis (14%) were the 3 most common lesions, and the prevalence of at least 1 denture-related mucosal lesion was 54%. The presence of denture stomatitis was related to low saliva pH, never having smoked, and regular sugar consumption. Angular cheilitis was associated with age, complete edentulism, the presence of oral *Candida*, a lack of denture stability, and a reduced occlusal vertical dimension. The presence of traumatic ulcers was related to a resorbed residual alveolar ridge. The presence of at least 1 lesion was associated with poor masticatory efficiency, being resident in a care facility, oral *Candida*, and a lack of denture stability.

**Conclusions.** Several systemic, local, and denture-related characteristics are independent risk factors for denture-related mucosal lesions in an elderly population. (J Prosthet Dent 2014;111:273-279)

## Clinical Implications

The results of this study show that the risk factors most related to denture-associated oral lesions are sugar consumption for denture stomatitis, a reduced occlusal vertical dimension for angular cheilitis, and a resorbed residual alveolar ridge for traumatic ulcers.

In recent decades, the prevalence of edentulism and the incidence of tooth loss has decreased in Europe and other industrialized regions; furthermore, oral implants are becoming more popular.[1] However, in the coming decades, most patients with complete or partial edentulism will continue to receive conventional prosthodontic treatment.[1] Treatment with removable dentures has a positive effect on subjective oral health when a large proportion of the natural teeth are missing.[2] Nevertheless, maintenance is needed, and complications such as dental caries, periodontal diseases, and oral mucosal lesions are relatively frequent.[3] Nearly a half of denture wearers present at least 1 denture-related mucosal lesion, with the 3 most common denture-related mucosal lesions among elderly wearers of removable denture being denture stomatitis, angular cheilitis, and traumatic ulcer.[4,5]

Denture stomatitis is an inflammatory process of the oral mucosal areas that underlie a removable denture and may affect from 15% to more than 70%

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[a]Assistant Professor, Department of Prosthodontics.
[b]Assistant Professor, Department of Prosthodontics.
[c]Associate Professor, Department of Prosthodontics.
[d]Professor, Department of Pathology and Experimental Therapeutics.
[e]Professor, Department of Prosthodontics.

of denture wearers.[6] Associations have been reported between denture stomatitis and oral *Candida* infection or denture colonization, mucosal trauma, poor denture hygiene, and wearing dentures at night.[7-11] Moreover, results of studies have shown conflicting results on the role of saliva pH, smoking, and sugar consumption in patients with denture stomatitis.[7-9,12] Risk factors for denture stomatitis should be studied with multivariable techniques because some of the factors are interrelated.[13] In spite of several studies based on multivariable analysis to assess the influence of these risk factors, significant disagreement can be found among them.[3,8-10,14]

Angular cheilitis affects up to 28% of hospitalized denture wearers and can be recognized as bright erythematous fissures at one or both corners of the mouth.[5,15] Some risk factors have been associated with angular cheilitis, such as the use of dentures, high counts of mucosal yeast, and the presence of denture stomatitis.[3,5,10,16] Other associated factors reported include a loss of occlusal vertical dimension and the presence of facial wrinkles.[15] However, no information is available on the relative importance of these factors.

Traumatic ulcer (or decubital) lesions, red or white lesions caused by improperly fitting dentures, are common after a new complete denture has been delivered.[17] The incidence of this condition is relatively high, and the prevalence of traumatic ulcers may vary from 3.5% in the general elderly population to 16% in wearers of partial removable dental prostheses and 25% in wearers of complete dentures.[4,10] Percentages increased to 92% when individuals wearing complete dentures and seeking a new one were considered.[18] Etiologic factors seem to be related to denture factors, including superficial irregularities, overextension, and occlusal instability; to local factors such as exostosis, residual ridge resorption, and a lack of submucosal supportive tissues; and to systemic factors, chiefly diabetes and immunologic disorders. However, only a few factors have been statistically associated with the presence of traumatic ulcers, including age, age of dentures, length of time of denture use, and wearing dentures at night; only 1 of the studies included multivariable analysis to assess the effects of multiple risk factors.[13,14,18]

Which risk factors are most directly associated with denture-related mucosal lesions remain unclear. The aims of the present study were to determine the relationship among systemic, local, and denture factors on denture-related oral mucosal lesions in an elderly population and to explore these risk factors with multivariable regression analysis. The null hypothesis tested was that local, systemic, or denture factors are unrelated to any denture-related mucosal lesion.

## MATERIAL AND METHODS

The population for this cross-sectional study consisted of denture wearers resident in Catalonia, northeast Spain, ages 60 years or older, either living in a nursing home (institutionalized) or regularly attending a day care center for the elderly (noninstitutionalized). The care facilities were chosen for convenience and because the centers were socioeconomically homogeneous and none of them had any special dental care program. All of the participants wore at least 1 removable dental prosthesis, none were receiving antifungal treatment, and all were cognitively able to respond to a questionnaire. A pilot study that involved 10 elderly individuals was performed to confirm the method and to standardize the examinations. The study protocol was approved by the local ethics committee according to the World Medical Association Declaration of Helsinki, and all of the participants provided written informed consent before enrollment. Data from the participants were collected from a questionnaire-interview, a clinical examination, and complementary tests.

The sample size was determined by considering a Type I error of .05 and a power of .8 to find a significant proportion of a mucosal lesion of 50% versus 75%. Therefore, 102 participants were interviewed with a questionnaire that included sociodemographic information such as age, sex, level of education, income, and the type of residence, nursing home (institutionalized) or day care center (noninstitutionalized). General health and behavioral data were collected, including the number of prescribed drugs, current medical problems, smoking habits (smoker or ex-smoker or never smoked, and the number of cigarettes/day), sugar consumption (daily or weekly, or monthly or never), and alcohol consumption (g of ethanol/day). The questionnaire also requested information about local factors regarding the oral cavity, such as the time since the last visit to a dentist, the frequency and type of dental brushing, and mouthwash use. The denture-related variables included in the questionnaire comprised a self-report of denture comfort (comfort or discomfort), self-assessed masticatory ability, evaluated by means of a scale from 0 (very bad) to 10 (excellent), age of current denture(s), cleaning frequency, and nocturnal wear.

A clinical examination was performed to assess the quality of the residual alveolar ridge, rating it good if the ridge was high and well-rounded or knife-edge shaped, and poor if the ridge was resorbed and rounded or depressed to bone level according to the Atwood classification.[19] Any soft tissue that covered the alveolar bone was evaluated, with considering it firm if the tissue was stable or somewhat movable and with considering it not firm if the soft-tissue crest was movable against the alveolar bone.[20] The type of denture (partial or complete), the denture material (acrylic resin or metal), and denture integrity (lack or breakage of any denture component) were determined by inspection. The occlusal vertical dimension was considered reduced if the difference between the mandibular rest position and the intercuspal position was more

than 4 mm at the level of the incisors. Occlusal support was assessed with the Eichner index, and the type of dynamic occlusion also was evaluated.[21] The retention of each denture was considered good if it was extremely or moderately difficult to break the peripheral seal.[20] Stability was assessed in the same way as retention but with the application of a rotational force and was classified as good if little or no movement of the denture was noted.[20] Finally, the denture plaque index was evaluated (poor or regular-excellent) by using erythrosine (Reveal; Henry Schein).[22]

Unstimulated saliva was collected by using 2 dental cotton rolls placed bilaterally under the tongue for 1 minute. The cotton was weighed before and after being placed in the oral cavity and unstimulated saliva flow rates were calculated in mL/min. Saliva pH was measured with pH paper strips (Macherey-Nagel GmbH and Co). Oral rinse specimens were obtained from all the participants. Their dentures were placed inside a sterile jar with 100 mL of physiologic serum and were ultrasonically agitated for 2 minutes (Ultrasonic Cleaner UCI-50; Raypa SL). Yeast was isolated from the clinical specimens by spreading them onto Sabouraud agar plates. The specimens were incubated at 37°C in aerobic conditions for 48 hours and then examined. The number of each colony type was counted, the number of colony forming units/mL (cfu/mL) was calculated, and the specimen was considered *Candida* infected if the score was at least 20 cfu/mL. All the tests were performed in the morning, and the participants were requested to refrain from eating, drinking, or smoking for 1 hour before the tests began.

Denture-related mucosal lesions were identified by means of clinical examination. Denture stomatitis was presumed when the mucosa under a denture-bearing surface was erythematous and was classified according to the modified version of the Newton classification.[23] Angular cheilitis was defined as distinct erythematous cracks or fissuring at one or both corners of the mouth. The presence of traumatic mucosal ulceration and its localization were recorded in an anatomic illustration. Traumatic ulcer was defined as a round or oval decubital lesion in contact with the denture.

For participants with dentures for both jaws, an average ratio of the denture-related variables was calculated to perform the analysis. The bivariate relationships between each oral mucosal lesion and the different variables were examined with the Student *t* test, the Mann-Whitney *U* test, or the Pearson $\chi^2$ test, as appropriate. Multiple logistic regression was used to explore the relative importance of the risk factors for each oral mucosal lesion as the outcome variables (forward selection strategy by using the likelihood ratio statistic). Potential risk factors were selected either because they showed a significant relationship in the bivariate analysis or because they had been reported as significant in other studies. For logistic regression analyses that involved a zero cell count, odds ratios were obtained by using the Firth bias-reducing penalized likelihood method. The statistics were analyzed with statistical software (PASW Statistics 18; SPSS Inc) and additional software for the penalized logistic models (SAS 9.3; SAS Institute Inc) ($\alpha$=.05)

## RESULTS

Of the 102 participants who were invited to participate in this study, 10 were excluded because they did not wear dentures regularly, 6 because of a lack of denture- or mucosa-related data, and 2 because they were receiving antifungal treatment. Thus, 84 participants were included in the study, 60 of whom were recruited from 7 geriatric residences, whereas the remaining 24 were recruited from 3 day care centers for elderly people. The median age was 83.7 years, and 75% of the sample was women. Sixty-three participants (75%) wore at least 1 complete denture and 53 (63%) were completely edentulous. Among the participants, 45 (54%) presented at least 1 denture-related mucosal lesion. Angular cheilitis was found in 29 participants (34%), traumatic ulcers in 13 participants (15%), and denture stomatitis in 12 participants (14%). Among the participants with denture stomatitis 5 presented as class IA, 1 class IB, 2 class IIA, and the remaining 4 presented as class IIB.

The presence of any stage of denture stomatitis was positively associated with low saliva pH, never having smoked, sugar consumption, and the presence of oral *Candida* (Table I). No significant association was found between the presence of denture stomatitis and the remaining systemic, local, and denture-related variables. Participants who wore their denture during the night showed a higher incidence of stomatitis (25%) than those who did not (10%), but this difference was not significant ($P$=.076, $\chi^2$ test). A multiple logistic regression with denture stomatitis as the dependent variable was performed to determine the independent contribution of the systemic, local, and denture-related factors to the presence of denture stomatitis. Independent variables included those that showed significant univariant association with denture stomatitis and also others reported as significant in other studies, such as the presence of *Candida* in dentures, the presence of plaque on dentures, and the stability of dentures. As a result, low saliva pH, never having smoked, and regular sugar consumption were found to be independent factors associated with denture stomatitis, whereas the presence of oral *Candida* was only marginally associated (Table I).

The presence of angular cheilitis was positively associated with age, complete edentulism, being institutionalized, more than 10 years having passed since the last visit to a dentist, wearing a complete denture (vs a partial removable dental prosthesis), wearing an acrylic resin denture (vs metal), a lack of stability of the denture, and showing a reduced (>4 mm) occlusal vertical dimension. No statistically significant association of the presence of angular cheilitis was noted

TABLE I. Results of univariate and multiple regression analysis on factors associated with denture stomatitis

| Variable (risk factor) | Presence of Denture Stomatitis (n=12) | Absence of Denture Stomatitis (n=72) | Univariate Analysis, *P* | Multivariable Analysis OR (95% CI) |
|---|---|---|---|---|
| Saliva pH, mean (SD) | 5.8 ±0.5 | 6.2 ±0.5 | .018[a] | 0.057 (0.01-0.48) |
| Never smoking, no. (%) | 12 (100) | 51 (71) | .031[b] | 152.8 (2.28 to >999) |
| Regular sugar consuming, no. (%) | 10 (83) | 35 (49) | .026[b] | 6.917 (1.17-40.9) |
| Oral *Candida,* no. (%) | 12 (100) | 47 (65) | .015[b] | NS |
| Wearing dentures at night, no. (%) | 5 (42) | 19 (26) | .278[b] | NS |
| *Candida* in denture, no. (%) | 12 (100) | 61 (86) | .166[b] | NS |
| Plaque in denture, no. (%) | 8 (67) | 54 (75) | .543[b] | NS |
| Lack of denture stability, no. (%) | 7 (64) | 41 (57) | .676[b] | NS |

OR, odds ratio; CI, Wald confidence interval; SD, standard deviation; NS, not significant.
ORs and 95% CIs are based on Firth penalized-likelihood logistic regression.
[a]Mann-Whitney *U* test.
[b]$\chi^2$ test.

TABLE II. Results of univariate and multiple regression analysis on factors associated with angular cheilitis

| Variable (risk factor) | Presence of Angular Cheilitis (n=29) | Absence of Angular Cheilitis (n=55) | Univariate Analysis, *P* | Multivariable Analysis OR (95% CI) |
|---|---|---|---|---|
| Mean (SD) age, y | 86.3 ±7.8 | 82.3 ±7.6 | .026[a] | 1.12 (1.03-1.20) |
| Being institutionalized, no. (%) | 26 (90) | 34 (62) | .007[b] | NS |
| Complete edentulism, n (%) | 24 (83) | 29 (53) | .007[b] | 5.32 (1.34-21.0) |
| >10 Years since the last visit to the dentist, no. (%) | 17 (59) | 16 (29) | .008[b] | NS |
| Complete denture, no. (%) | 26 (90) | 37 (67) | .024[b] | NS |
| Acrylic resin material, no. (%) | 28 (97) | 40 (73) | .008[b] | NS |
| Lack of denture stability, no. (%) | 23 (79) | 25 (46) | .004[b] | 3.54 (1.03-12.2) |
| Reduced occlusal vertical dimension, no. (%) | 19 (66) | 18 (33) | .004[b] | 3.13 (1.00-10.2) |
| Plaque in denture, no. (%) | 25 (86) | 37 (67) | .061[b] | NS |
| Lack of denture retention, no. (%) | 23 (79) | 32 (59) | .065[b] | NS |
| Oral *Candida,* no. (%) | 23 (79) | 36 (66) | .187[b] | 4.50 (1.17-17.3) |
| Age of denture >15 y, no. (%) | 13 (45) | 19 (35) | .39[b] | NS |

OR, odds ratio; CI, confidence interval; SD, standard deviation; NS, not significant.
ORs and 95% CIs are based on Forward selection (likelihood ratio) logistic regression.
[a]Student *t* test.
[b]$\chi^2$ test.

with plaque in the dentures (*P*=.061) or with a lack of retention of the dentures (*P*=.065). The presence of oral *Candida* and the longevity of the dentures were selected in the model because they had been reported as significant in other studies. Stepwise logistic regression (forward likelihood ratio) showed that age, edentulism, the presence of oral *Candida*, a lack of denture stability, and reduced occlusal vertical dimension were the variables related to the presence of angular cheilitis (Table II).

Traumatic mucosal ulcers were observed in 12 participants, mainly in the buccal sulcus. The presence of ulcers was positively associated with a resorbed residual ridge (*P*=.02, $\chi^2$ test) and mucosa not being firm (*P*=.018, $\chi^2$ test). Age, the age of the dentures, a lack of denture occlusal support (Eichner index other than A1), a lack of denture stability, wearing dentures at night, mucosal mobility, and residual ridge resorption were included as covariates in the stepwise logistic regression (Table III). Only having a resorbed residual ridge appeared in the logistic regression model (odds ratio, 16.6).

The presence of at least 1 mucosal lesion was found in 45 participants

Table III. Results of univariate and multiple regression analysis on factors associated with traumatic ulcers

| Variable (risk factor) | Presence of Traumatic Ulcers (n=13) | Absence of Traumatic Ulcers (n=71) | Univariate Analysis, *P* | Multivariable Analysis OR (95% CI) |
|---|---|---|---|---|
| Mean (SD) age, y | 84.7 ±8.7 | 83.5 ±7.7 | .632[a] | NS |
| Resorbed residual ridge, no. (%) | 13 (100) | 39 (55) | .002[b] | 16.60 (1.22-225) |
| Not firm mucosa, no. (%) | 6 (46) | 12 (17) | .018[b] | NS |
| Age of denture >15 y, no. (%) | 4 (33) | 28 (39 | .688[b] | NS |
| Lack of denture occlusal support, no. (%) | 3 (23) | 13 (18) | .687[b] | NS |
| Lack of denture stability, no. (%) | 7 (58) | 41 (58) | .97[b] | NS |
| Wearing dentures at night, no. (%) | 10 (77) | 50 (70) | .633[b] | NS |

OR, odds ratio; CI, Wald confidence interval; SD, standard deviation; NS, not significant.
ORs and 95% CIs are based on Firth penalized-likelihood logistic regression.
[a]Student *t* test.
[b]Pearson $\chi^2$.

Table IV. Results of univariate and multiple regression analysis factors associated with denture-related mucosal lesion

| Variable (risk factor) | Presence of Denture-related Mucosal Lesion (n=45) | Absence of Denture-related Mucosal Lesion (n=39) | Univariate Analysis, *P* | Multivariable Analysis OR (95% CI) |
|---|---|---|---|---|
| Being institutionalized, no. (%) | 37 (82) | 23 (59) | .019[a] | 4.58 (1.2-16.8) |
| Lack of denture stability, no. (%) | 31 (71) | 17 (43) | .013[a] | 3.99 (1.2-12.8) |
| Lack of denture retention, no. (%) | 34 (77) | 21 (54) | .024[a] | NS |
| Acrylic resin material, no. (%) | 40 (36) | 28 (72) | .047[a] | NS |
| Plaque in denture, no. (%) | 38 (84) | 24 (62) | .017[a] | NS |
| Complete edentulism, no. (%) | 33 (73) | 20 (51) | .037[a] | NS |
| Oral *Candida,* no. (%) | 37 (82) | 22 (56) | .010[a] | 4.86 (1.4-16.8) |
| Resorbed residual ridge, no. (%) | 33 (73) | 19 (49) | .021[a] | NS |
| Masticatory efficiency, mean (SD) | 6.8 ±1.9 | 8.2 ±1.9 | .002[b] | 0.55 (0.4-0.8) |
| Saliva pH, mean (SD) | 6.0 ±0.5 | 6.3 ±0.5 | .013[c] | NS |
| Mean (SD) age, y | 85.1 ±7.7 | 82.1 ±7.8 | .075[b] | NS |
| Women, no. (%) | 34 (76) | 29 (74) | .899[a] | NS |
| *Candida* in denture, no. (%) | 42 (93) | 31 (82) | .101[a] | NS |
| Complete denture, no. (%) | 37 (82) | 26 (67) | .101[a] | NS |

OR, odds ratio; CI, confidence interval; SD, standard deviation; NS, not significant.
ORs and 95% CIs are based on Forward selection (likelihood ratio) logistic regression.
[a]$\chi^2$.
[b]Student *t* test.
[c]Mann-Whitney test.

(53.6%) and was positively related to being institutionalized, a low saliva pH, edentulism, a resorbed residual ridge, the presence of oral *Candida,* poor masticatory efficiency, a lack of denture stability, a lack of denture retention, acrylic resin dentures, and the presence of plaque in the dentures (Table IV). After multiple logistic regression, the most related variables were poor masticatory efficiency, being institutionalized, the presence of oral *Candida*, and a lack of denture stability (Table IV).

## DISCUSSION

Some variables were found to be associated with the presence of denture-related oral mucosal lesions, and, therefore, the null hypothesis was rejected. In this study, the prevalence of

denture stomatitis was 14%, and the risk factors for denture stomatitis were low saliva pH, regular sugar consumption, and never having smoked. The prevalence was similar to that found in a Thai population and in an institutionalized elderly population in Oslo but was lower than that reported in other studies of elderly denture wearers or patients who sought dental care at a college of dentistry.[4,7,8,10,11,24]

The cause of denture stomatitis is believed to be multifactorial, and the most reported factors include denture trauma, wearing dentures at night, denture hygiene, *Candida* infections, and predisposing systemic conditions. The relationship between *Candida*-associated denture stomatitis and a low saliva pH and regular sugar consumption also were reported.[12] Although the presence of *Candida* in the oral cavity was significantly associated with denture stomatitis, this association became insignificant after adjusting for sugar consumption and saliva pH in multiple logistic regression analysis. Therefore, salivary pH and sugar consumption seem to be more directly related to denture stomatitis than the presence of oral *Candida*. The results of this study also confirm that the frequency of denture cleaning and denture cleanliness seem to have little effect on the presence of denture stomatitis, as reported in other studies.[9,23]

Unexpectedly, never having smoked was significantly related to the presence of stomatitis, in contrast to other observations, and this association remained significant after adjusting for plaque or *Candida* in dentures, wearing dentures at night, and a lack of denture stability.[3,8,13,23] In fact, several studies have reported a lower prevalence of recurrent aphthous stomatitis in smokers than in nonsmokers and an increase in the incidence of aphtha lesions after smoking cessation.[25,26] Smoking for a long time could have increased the keratinization of the oral mucosa and protected against trauma or microorganisms because tobacco has demonstrated antimicrobial activity. Because of the small sample size of this study, this relationship should be interpreted with caution.

The prevalence of angular cheilitis was shown to be similar to that found in a Finnish study of long-term hospitalized patients who wear a denture but notably higher than that reported in other studies, probably because of the type of population selected in the present study.[4,5] Among the variables significantly related to the presence of angular cheilitis, complete edentulism, age, oral *Candida*, a lack of denture stability, and a reduced occlusal vertical dimension were the best predictors of angular cheilitis in the multiple logistic regression analysis. These results confirm the relationship between angular cheilitis and the presence of *Candida* and/or yeast in the oral cavity.[16] To the best of the authors' knowledge, this was the first study that demonstrated a direct relationship between systemic, local, and denture-related variables and the presence of angular cheilitis by using a multiple regression analysis. As a consequence, elderly people with edentulism should wear a stable denture with a correct vertical dimension of occlusion and avoid *Candida* to prevent angular cheilitis.

Different studies have reported the variable prevalence of denture-related traumatic ulcers, which range from 3% to 92% in an elderly population of denture wearers.[4,18] Other studies have found a prevalence rate of 10% to 25%, similar to that found in the present study.[4,13] Individuals with a resorbed and low residual ridge have more risk of traumatic ulcers. No association was found between any denture-related variables and the presence of traumatic ulcers. Patients with a resorbed residual ridge should be advised of the higher risk of experiencing denture-related traumatic ulcers than other patients with a round and high residual ridge.

The variables most significantly related to the presence of at least 1 denture-related mucosal lesion were low masticatory efficiency, being institutionalized, the presence of oral *Candida*, and a lack of stability of the dentures. Poorer masticatory efficiency has been reported in denture wearers than in participants with natural dentition and is related to a lower occlusal force.[27-29] The higher prevalence of oral mucosal lesions in the institutionalized group agrees with the results of another study.[30] Therefore, to minimize denture-related mucosal lesions and to improve masticatory efficiency, older institutionalized people should receive dental care to improve the denture stability and reduce the presence of oral *Candida*. However, the study was transversal, and no causal relationship could be demonstrated. Future research should aim to demonstrate the relationship in a randomized and controlled study.

The present study has some limitations. First, the institutions were chosen for convenience and may not represent the overall population. Therefore, the prevalence of mucosal lesions cannot be extrapolated directly to other populations. A further limitation is that the sample size was small and that this could limit the power to detect weaker associations (a Type II error). Finally, the large number of analyses performed could increase the likelihood that one or more associations may have occurred simply by chance. However, the correlation level among the individual predictor variables did not exceed .33; therefore, no collinearity problem would be expected.

## CONCLUSIONS

Several systemic local and denture-related characteristics were independent risk factors for denture-related mucosal lesions in this elderly population. The most significant were age, being institutionalized, regular sugar consumption, low saliva pH, the presence of oral *Candida*, a resorbed residual alveolar ridge, a reduced occlusal vertical dimension, and a lack of denture stability.

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Corresponding author:
Dr Jordi Martínez-Gomis
Campus de Bellvitge
University of Barcelona
C/Feixa llarga s/n, E-08907
L'Hospitalet de Llobregat
Barcelona
SPAIN
E-mail: jmartinezgomis@ub.edu



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