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Oral health manifestations in long COVID: a Brazilian cross-sectional study

Abstract

Background: Long COVID affects multiple systems, yet oral manifestations remain incompletely characterised. The oral cavity's high ACE2 receptor expression suggests potential for persistent SARS-CoV-2 effects.

Aims: To investigate associations between oral health conditions and long COVID in individuals with previous SARS-CoV-2 infection.

Methods: Cross-sectional study of 402 participants at a Brazilian university hospital (March 2020–October 2024). Standardised oral examinations assessed periodontal disease, oral lesions, xerostomia, and bleeding. Long COVID was defined as symptoms persisting >90 days post-infection (WHO criteria). Chi-square tests and odds ratios were used to evaluate associations. Due to the exploratory nature of this study and the absence of multivariable adjustment, findings should be interpreted as hypothesis-generating.

Results: Among 293 participants with previous SARS-CoV-2 infection, 116 (39.6%) met long COVID criteria. Oral lesions (5.8% vs 3.7%, P=0.02) and xerostomia (3.8% vs 0%, P=0.01) were more prevalent in those with a history of infection. Xerostomia was numerically higher in long COVID patients (14.7% vs 9.3%) but did not reach statistical significance (P=0.083). Unexpectedly, periodontal disease was less common in long COVID patients (6.0% vs 15.6%, P=0.01). Xerostomia in long COVID was associated with memory loss, fatigue, and dry eyes. Women comprised 80.2% of long COVID cases.

Conclusion: Oral manifestations, particularly xerostomia and oral lesions, are associated with though not necessarily caused by long COVID. The paradoxical lower prevalence of periodontal disease warrants further investigation and may reflect selection bias or unmeasured confounders. The study is limited by its cross-sectional design, absence of multivariable adjustment, and reliance on self-reported infection history; causal inference is not possible. Dentists should remain aware of persistent oral symptoms in patients with a history of COVID-19.

Keywords: long covid, oral manifestations, xerostomia, periodontal disease, oral lesions, cross-sectional study, oral health

Key points

a) Highlights oral health implications of the growing long COVID population

b) Xerostomia and oral lesions are more prevalent after SARS-CoV-2 infection

c) Xerostomia clusters with systemic symptoms, including fatigue and cognitive difficulties (though the association with long COVID specifically did not reach statistical significance)

d) Paradoxically, periodontal disease was less prevalent in long COVID patients

e) Dental professionals may serve as frontline identifiers of long COVID manifestations; longitudinal studies with multivariable adjustment are needed to confirm these associations

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Introduction

Long COVID, or post-acute sequelae of SARS-CoV-2 infection, affects an estimated 10–30% of infected individuals, creating a substantial global healthcare burden.[1,2] Whilst respiratory and systemic manifestations dominate clinical attention, oral health implications remain poorly understood despite the oral cavity's role as a primary viral entry point.[3]

The oral mucosa expresses high levels of angiotensin-converting enzyme 2 (ACE2) receptors, particularly in the tongue, gingiva, and salivary glands.[4,5] This anatomical vulnerability raises essential questions: do oral manifestations persist beyond acute infection? How do these relate to broader long COVID symptomatology? What are the implications for dental practice?

Early pandemic reports documented acute oral symptoms—dysgeusia, xerostomia, mucosal lesions—but their persistence and evolution remain incompletely characterised.[6-8] Understanding these patterns matters clinically: dentists often serve as accessible primary healthcare providers, positioning them to recognise systemic disease manifestations.[9] Moreover, oral health profoundly impacts quality of life, nutrition, and social well-being.[10]

This study investigated oral health conditions among individuals with and without prior SARS-CoV-2 infection, with a focus on long

COVID cases. We hypothesised that long COVID patients would have more oral manifestations than those without persistent symptoms. Given the cross-sectional design, all findings are exploratory and describe associations rather than causal relationships.

Methods

Study design

We conducted a cross-sectional study within a larger COVID-19 vaccine response investigation at a Brazilian state university. The institutional ethics committee approved the protocol (CAAE: 30135320.0.0000.5259), and participants provided written informed consent in accordance with the Declaration of Helsinki.

Participants and setting

Between March 2020 and October 2024, we recruited adults (≥21 years) presenting for COVID-19 vaccination or follow-up. Exclusion criteria included inability to provide consent or acute illness precluding examination. The final cohort comprised 402 participants from Rio de Janeiro and surrounding metropolitan areas.

Oral examination

Two calibrated examiners (inter-examiner $\kappa = 0.81$; intra-examiner $\kappa = 0.89$) performed standardised examinations using head-mounted illumination and disposable spatulas, with full PPE.

We assessed:

Oral lesions (ulcers, canker sores, geographic tongue, lichen planus, herpetic lesions); Periodontal status (gingivitis, spontaneous bleeding, bleeding on brushing, desquamation); Xerostomia (clinical assessment and patient-reported dry mouth); Dental conditions (carious lesions, COVID-19-related tooth loss).

Periodontal disease was operationalised as clinically observed gingivitis or patient-reported periodontitis in the absence of full-mouth probing depth measurements or radiographic assessment. Accordingly, the term 'periodontal disease' in this study refers to clinically observed or patient-reported periodontal signs and should not be interpreted as meeting the full diagnostic criteria of standard periodontal epidemiological protocols.

Unstimulated saliva samples were collected over 5 minutes for future microbiome analysis (stored at −80°C).

Data collection and definitions

Structured questionnaires captured sociodemographic factors, health behaviours, medical history, COVID-19 history, and oral health symptoms. COVID-19 infection status was primarily determined by self-report, supplemented where available by PCR, antigen, or antibody test results; however, formal serological confirmation was not available for all participants, introducing the possibility of recall bias and misclassification, including asymptomatic infections in the 'no COVID-19' group. Following WHO criteria,[11] we classified participants who reported symptoms initiated during/after SARS-CoV-2 infection and persisting for >90 days as having long COVID.

We grouped oral findings as: (1) periodontal manifestations (periodontal disease, spontaneous/brushing-related bleeding, mucosal desquamation); (2) oral lesions (infections, ulcerations, geographic tongue, lichen planus); (3) xerostomia (patient-reported or observed).

Statistical analysis

Descriptive statistics included means ± SD for continuous variables and frequencies for categorical variables. Chi-square tests compared categorical variables; ANOVA assessed age differences. We calculated unadjusted odds ratios with 95% confidence intervals. Two-tailed $P<0.05$ indicated statistical significance (Epi Info™ version 7.5.2.0). Exact P-values are reported throughout; NS was not used. No correction for multiple comparisons was applied, and the study should therefore be considered exploratory.

Multivariable logistic regression adjusting for key confounders (age, sex, tobacco use, education, comorbidities, and medication use) was not performed owing to the small event numbers in several outcome cells, which preclude stable model estimation. This represents a significant methodological limitation; adjusted effect estimates are therefore not available, and the unadjusted associations presented may be subject to confounding. Future studies should incorporate multivariable adjustment.

Results

Participant characteristics

The cohort comprised 402 participants (70.2% female, mean age 55.4±13.6 years, range 21–84). Most identified as white (63.9%) and were married/partnered (47.3%). Educational attainment was high (80.4% with >13 years). Among participants, 293 (72.9%) reported previous SARS-CoV-2 infection, of whom 116 (39.6%) met long COVID criteria.

Long COVID demographics

Long COVID participants were younger (53.2±13.0 vs 56.4±13.7 years, P=0.044), more frequently female (80.2% vs 66.7%, P<0.001), and more commonly reported tobacco use (10.9% vs 3.5%, P=0.009). Fewer were married/partnered (39.6% vs 56.1%, P=0.028). Long COVID patients experienced more hospitalisations (7.8% vs 1.7%, P=0.012; OR=4.87, 95% CI 1.29–18.42) and reinfections (34.5% vs 15.8%, P<0.001; OR=2.80, 95% CI 1.61–4.89).

Common persistent symptoms included memory loss (n=25), fatigue (n=20), cognitive disturbances (n=17), hair loss (n=15), and dyspnoea (n=10).

These demographic differences—including younger age, higher rates of female sex, and tobacco use—are important confounders for the oral health outcomes reported and should be borne in mind when interpreting all associations below.

Oral manifestations

Previous SARS-CoV-2 infection was associated with increased oral lesions (5.8% vs 3.7%, P=0.02) and xerostomia (3.8% vs 0%, P=0.01) compared to uninfected participants (Table 1).

Among infected individuals, long COVID patients paradoxically demonstrated lower clinically observed or patient-reported periodontal disease prevalence (6.0% vs 15.6%, P=0.006; OR=0.35, 95% CI 0.15–0.83). Gingival bleeding during brushing (9.5% vs 9.3%, P=0.469) and spontaneous bleeding (11.3% vs 6.9%, P=0.104) showed no significant differences.

Xerostomia was numerically higher in long COVID (14.7% vs 9.3%) but this difference did not reach statistical significance

(P=0.083). Geographic tongue similarly trended higher (5.2% vs 1.7%, P=0.058). Dental pain and tooth loss did not differ significantly between groups.

Symptom associations with oral conditions

Among long COVID participants, xerostomia was significantly associated with:

Memory loss (P=0.007); heartburn (P=0.012); dry eyes (P=0.012); fatigue (P=0.035); muscle weakness (P=0.035). These associations are based on small cell sizes (n=17 with xerostomia), and the resulting confidence intervals are wide, reflecting statistical instability (see Table 2). Caution is advised in their interpretation.

Table 1 Oral manifestations by COVID-19 and long COVID status

(Counts added in parentheses to improve transparency. † denotes associations with wide confidence intervals indicating sparse-data instability)

Manifestation	No COVID-19 (n=109)	COVID-19 without long COVID (n=177)	Long COVID (n=116)	P-value
Oral lesions	3.7% (n=4)	5.1% (n=9)	6.9% (n=8)	0.02*
Xerostomia	0% (n=0)	9.3% (n=16)	14.7% (n=17)	0.01*
Periodontal disease	14.7% (n=16)	15.6% (n=28)	6.0% (n=7)	0.006**
Gingival bleeding	8.3% (n=9)	9.3% (n=16)	9.5% (n=11)	0.469
Geographic tongue	0.9% (n=1)	1.7% (n=3)	5.2% (n=6)	0.058

*Comparison: No COVID-19 vs any COVID-19, **Comparison: Long COVID vs COVID-19 without long COVID

Table 2 Long COVID symptoms associated with xerostomia

(Counts added in parentheses. † denotes associations with very wide CIs; interpret with caution given small cell sizes)

Symptom	With xerostomia (n=17)	Without xerostomia (n=99)	P-value	OR (95% CI)
Memory loss	41.2% (n=7)	18.2% (n=18)	0.007	3.14 (1.10–8.95)
Fatigue	35.3% (n=6)	14.1% (n=14)	0.035	3.38 (1.12–10.23)
Dry eyes	23.5% (n=4)	1.0% (n=1)	0.012	29.8 (3.21–276.4)†
Heartburn	17.6% (n=3)	2.0% (n=2)	0.012	10.3 (1.74–60.8)†
Muscle weakness	17.6% (n=3)	3.0% (n=3)	0.035	6.83 (1.35–34.4)†

†These ORs are subject to sparse-data bias given the small number of events. The wide confidence intervals reflect statistical instability and should temper interpretation.

Oral lesions were primarily associated with memory loss (62.5% vs 17.5%, P=0.007; OR=7.86, 95% CI 1.82–33.98) and loss of appetite (Table 2).

Discussion

Principal findings

This cross-sectional study reveals associations between long COVID and specific oral manifestations, particularly xerostomia and oral lesions. Importantly, the cross-sectional design means temporal ordering cannot be established; it is not possible to determine whether oral conditions preceded, developed concurrently with, or emerged after COVID-19 infection. Reverse causality cannot be excluded. The unexpected finding of lower clinically observed or patient-reported periodontal disease prevalence in long COVID patients challenges prevailing hypotheses and warrants careful consideration.

Xerostomia and systemic connections

Increased xerostomia in COVID-19 patients aligns with growing evidence of SARS-CoV-2 effects on salivary glands.[12,13] The virus's demonstrated tropism for ACE2-expressing salivary gland cells provides mechanistic plausibility for persistent dysfunction.[14] Notably, xerostomia's association with memory loss, fatigue, and dry eyes suggests systemic rather than isolated pathology—reminiscent of Sjögren syndrome's multi-system 'dryness'.[15] However, xerostomia is strongly medication-dependent, and the absence of multivariable adjustment for medication use means this association may be confounded. Furthermore, as the difference in xerostomia between long COVID and COVID-19 without long COVID did not reach statistical significance (P=0.083), this finding should be regarded as hypothesis-generating only.

For dental practitioners, xerostomia recognition matters clinically. Reduced salivary flow increases caries risk, compromises denture retention, and predisposes to candidiasis.[16] Patients reporting persistent dry mouth post-COVID-19 warrant a comprehensive evaluation, including medication review, salivary flow measurement, and possible rheumatologic consultation if autoimmune features emerge.

Oral lesions

The increased prevalence of oral lesions mirrors earlier pandemic observations.[17,18] Potential mechanisms include direct viral cytopathic effects, immune-mediated inflammation, opportunistic infections, or herpes virus reactivation. The association with memory loss (OR=7.86, 95% CI 1.82–33.98) is intriguing—both might reflect chronic neuroinflammation, though causal pathways remain speculative. The wide confidence interval for this OR reflects the small number of events (n=8 with lesions in the long COVID group) and should be interpreted with caution as an unstable estimate susceptible to sparse-data bias.

Dental professionals should maintain vigilance for unusual or persistent lesions in COVID-19 survivors, particularly in immune compromised individuals, where biopsy may be indicated.

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The periodontal paradox

Our most unexpected finding lower clinically observed or patient-reported periodontal disease in long COVID patients contradicts some literature suggesting COVID-19 exacerbates periodontal conditions.[19,20] Several explanations merit consideration:

First, survival bias: individuals with severe periodontitis may have experienced more severe acute COVID-19, reducing the likelihood of long COVID. Alternatively, severe periodontitis patients may have been less likely to participate.

Second, pandemic behavioural changes increased attention to oral hygiene, dietary modifications, and reduced social smoking might have improved periodontal health. Long COVID participants' younger age and lower smoking rates support this.

Third, residual confounding: our periodontal assessment combined patient-reported disease with clinical findings. Without probing depth measurements, attachment loss, or radiographic assessment, 'periodontal disease' in this study refers only to clinically observed or self-reported periodontal signs. This limits diagnostic precision and may explain the paradoxical finding. More rigorous examination using standardised protocols might reveal different patterns.

Fourth, the association might be spurious, highlighting the limitations of cross-sectional designs in establishing causality.

Given these methodological constraints, the 'periodontal paradox' finding should be interpreted with considerable caution and not overstated.

This unexpected finding underscores the importance of cautious interpretation and the need for longitudinal studies tracking periodontal status before, during, and after COVID-19 infection.

Clinical implications

These findings suggest several practical considerations, bearing in mind their exploratory nature:

a) History-taking: Routinely enquire about prior COVID-19 infection when evaluating oral complaints, particularly unexplained xerostomia or mucosal lesions.

b) Xerostomia management: Intensify preventive strategies for COVID-19 survivors with dry mouth, including fluoride therapy, frequent recalls, and dietary counselling. Consider saliva substitutes when appropriate.

c) Mucosal surveillance: Monitor oral mucosa carefully in COVID-19 survivors. Document lesions photographically and biopsy persistent/atypical presentations.

d) Interdisciplinary collaboration: Consider medical referral for patients with multiple persistent symptoms suggesting long COVID, particularly when xerostomia accompanies systemic complaints.

Limitations

This study has several important limitations that are essential to acknowledge.

Most critically, the cross-sectional design precludes causal inference. Temporal ordering of events cannot be established: oral conditions may have preceded COVID-19 infection, and reverse causality cannot be excluded. All associations described are therefore observational and hypothesis-generating only.

A significant analytical limitation is the absence of multivariable logistic regression. Long COVID participants differed significantly from those without long COVID in age, sex, tobacco use, hospitalisation rates, and reinfection history—all important confounders for xerostomia, periodontal disease, and oral lesions. For example, xerostomia is strongly medication-dependent, and periodontal disease is age and smoking-dependent. Without adjustment for these factors, the reported associations may be substantially biased. Multivariable analyses were not performed due to the small event numbers in several outcome cells, which preclude stable estimation. Future research should address this limitation with larger samples and adjusted analyses.

COVID-19 infection history was primarily self-reported, introducing recall bias and potential misclassification, including possible asymptomatic infections in the 'no COVID-19' comparison group. The impact of this misclassification on reported associations may be non-trivial.

The periodontal assessment did not employ standardised epidemiological protocol (no probing depths, attachment loss measurements, or radiographs). 'Periodontal disease' therefore refers to clinically observed or patient-reported periodontal signs, and the diagnostic precision is limited accordingly.

Several key associations involve very small event numbers (e.g., n=17 with xerostomia; n=8 with oral lesions in long COVID). The resulting odds ratios, including OR=29.8 for dry eyes and OR=7.86 for memory loss with oral lesions, have very wide confidence intervals reflecting statistical instability (sparse-data bias). These estimates should not be overinterpreted.

Single-site Brazilian recruitment may limit generalisability, particularly to populations with different socioeconomic profiles or healthcare access. Confounding factors, including medications, comorbidities, and behavioural characteristics, were not fully controlled.

Future research

Priority areas include: longitudinal cohorts following individuals from pre-infection through recovery; multivariable analyses adjusting for age, sex, medications, smoking, and comorbidities; mechanistic studies investigating viral persistence and immune responses; intervention trials testing preventive/therapeutic approaches; larger multicentre studies across diverse populations; detailed periodontal assessments using standardised protocols including probing depths and radiographic evaluation; salivary biomarker investigations; and exploration of potential autoimmune mechanisms.

Conclusion

Oral manifestations, particularly xerostomia and oral lesions, are more prevalent in individuals with prior SARS-CoV-2 infection. Among infected individuals, long COVID is associated with xerostomia clustering with systemic symptoms, suggesting multi-system involvement. However, given the cross-sectional design, the absence of multivariable adjustment, and the reliance on self-reported infection history, causal relationships cannot be inferred and all findings should be regarded as hypothesis-generating. The paradoxical lower prevalence of clinically observed or patient-reported periodontal disease challenges prevailing hypotheses and highlights the complexity of COVID-19's long-term effects.

Dental professionals should remain aware of persistent oral symptoms in patients with a history of COVID-19. Recognition of

these patterns may facilitate appropriate management and medical referral. Confirmation of these associations in longitudinal studies with rigorous methodology and multivariable adjustment is essential before firm clinical conclusions can be drawn.

Author contributions

Study design and supervision: SG, LCP

Data collection: MBAS, MM, ECBL, MESMO

Statistical analysis: LCP

Manuscript drafting: SG, JGM RB

Critical revision: All authors

Final approval: All authors

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Ethics statement

This study received institutional ethics committee approval (CAAE: 30135320.0.0000.5259). All participants provided written informed consent. The study adhered to the principles of the Declaration of Helsinki.

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Conflict of interest

The authors declare that there are no conflicts of interests.

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