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Photobiomodulation using red and infrared lasers for late olfactory and gustatory dysfunction recovery post-COVID-19: a follow-up case series

Fotobiomodulação com lasers vermelho e infravermelho para recuperação tardia de disfunções olfativas e gustativas pós-COVID-19: uma série de casos com acompanhamento

Fotobiomodulación con láseres rojo e infrarrojo para la recuperación tardía de disfunciones olfativas y gustativas post-COVID-19: una serie de casos con seguimiento

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ABSTRACT

Objective: To describe a series of three patients with olfactory and gustatory dysfunctions caused by post-COVID-19 syndrome who underwent treatment with photobiomodulation therapy. **Cases details:** A protocol was established by employing the infrared spectrum alone to treat olfactory alterations and its combination with the red wavelength for improving gustatory parameters. Photobiomodulation sessions were scheduled twice a week, with a minimum interval of 48 hours between them. Patient progress regarding the restoration of smell and taste was monitored via an adapted visual analog scale. After 20 sessions, two patients achieved complete olfactory recovery, one of them also with full gustatory recovery, while the remaining patient showed partial improvement in both senses. The follow-up period ranged from six months to one year. **Final considerations:** For this case series, photobiomodulation therapy demonstrated potentially beneficial in all the cases presented, however requiring further investigation.

Keywords: Low-level light therapy, Postacute COVID-19 syndrome, SARS-CoV-2, Olfaction disorders, Taste disorders.

RESUMO

Objetivo: Este estudo teve como objetivo descrever uma série de três pacientes com disfunções olfatórias e gustatórias causadas pela síndrome pós-COVID-19, que foram submetidos a tratamento com terapia de fotobiomodulação. **Detalhamentos de casos:** Foi estabelecido um protocolo empregando exclusivamente o espectro infravermelho para tratar alterações olfatórias e sua combinação com o comprimento de onda vermelho para melhorar parâmetros gustatórios. As sessões de fotobiomodulação foram realizadas duas vezes por semana, com um intervalo mínimo de 48 horas entre elas. O progresso dos pacientes quanto à recuperação do olfato e paladar foi monitorado por meio de uma escala visual analógica adaptada. Após 20

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sessões, dois pacientes alcançaram recuperação completa da função olfatória, sendo que um deles também apresentou recuperação total da função gustatória, enquanto o paciente restante apresentou melhora parcial em ambos os sentidos. O período de acompanhamento variou de seis meses a um ano. **Considerações finais:** Nesta série de casos, a terapia de fotobiomodulação demonstrou-se potencialmente benéfica em todos os casos apresentados, embora sejam necessários estudos adicionais.

Palavras-chave: Terapia com luz de baixa intensidade, Síndrome de pós-COVID-19 aguda, SARS-CoV-2, Transtornos do olfato, Distúrbios do paladar.

RESUMEN

Objetivo: Describir una serie de tres pacientes con disfunciones olfatorias y gustativas causadas por el síndrome post-COVID-19, que fueron sometidos a tratamiento con terapia de fotobiomodulación. **Detalles de los casos:** Se estableció un protocolo empleando exclusivamente el espectro infrarrojo para tratar las alteraciones olfatorias y su combinación con la longitud de onda roja para mejorar los parámetros gustativos. Las sesiones de fotobiomodulación se realizaron dos veces por semana, con un intervalo mínimo de 48 horas entre ellas. El progreso de los pacientes en cuanto a la recuperación del olfato y el gusto fue monitorizado mediante una escala visual analógica adaptada. Después de 20 sesiones, dos pacientes lograron una recuperación completa de la función olfativa, uno de los cuales también mostró una recuperación completa de la función gustativa, mientras que el paciente restante mostró una mejoría parcial en ambos sentidos. El período de seguimiento varió de seis meses a un año. **Consideraciones finales:** En esta serie de casos, la terapia de fotobiomodulación demostró ser potencialmente beneficiosa en todos los casos presentados, aunque se requieren estudios adicionales.

Palabras clave: Terapia por luz de baja intensidad, Síndrome post agudo de COVID-19, SARS-CoV-2, Trastornos del olfato, Trastornos del gusto.

INTRODUCTION

A severe outbreak of the SARS-CoV-2 virus emerged at the end of 2019, leading the World Health Organization (WHO) to declare COVID-19 a global pandemic on March 11, 2020 (OMS, 2020). The COVID-19 pandemic has significantly impacted human health and safety, with major global socioeconomic effects. On May 5, 2023, the WHO announced the end of the COVID-19 pandemic, which resulted in over 700 million confirmed cases and 7 million deaths worldwide (OMS, 2023; OMS, 2024). Although the pandemic has ended, its consequences have not yet been overcome. In addition to socioeconomic damage to countries, especially those in development, there is considerable concern about the long-term effects of the infection (LIPPI G, et al., 2023).

Post-COVID-19 syndrome is a condition in which individuals infected with the SARS-CoV-2 virus exhibit persistent symptoms of the respiratory infection three months after its acute phase, lasting for at least two months without another etiological explanation. This condition can affect patients regardless of disease severity, sex, or age (OMS, 2022; ASTIN R, et al., 2023). Among the most frequent manifestations are fatigue, shortness of breath, neurocognitive impairment, and sensory dysfunctions, such as olfactory and gustatory disorders (OMS, 2022; NALBANDIAN A, et al., 2023)

Anosmia, hyposmia, and parosmia refer to complete, partial loss or inability of the brain to properly recognize smells, respectively. On the other hand, ageusia is characterized by the total loss of the ability to perceive taste, hypogeusia by a diminished taste function, and dysgeusia by the distortion of taste perception (PANHÓCA V, 2023). In this context, sensory functions allow humans to understand and interact with their environment, playing a critical role in maintaining biopsychosocial well-being (VARGAS RLG and SILVA OF, 2023).

The pathogenesis leading to these sensory dysfunctions caused by COVID-19 remains unknown, although several hypotheses have been discussed. Direct or indirect damage to nerve tissue and taste receptors caused by the viral infection and subsequent local inflammation is a possible mechanism responsible for the loss or reduction of these functions. A possible neurotropism of SARS-CoV-2 has also been suggested, which could explain the involvement of olfactory and gustatory neural pathways (MASTRANGELO A, et al., 2021; VALERI S, 2022; TONIOLO S, et al., 2021).

In this regard, photobiomodulation therapy (PBMT) by employing red and infrared wavelengths stands out as a noninvasive and effective tool for restoring sensory functions impaired by post-COVID-19 syndrome. This treatment acts directly on irradiated nerve tissue and taste receptors, stimulating ATP synthesis and nitric oxide production. These biochemical processes promote cellular regeneration and repair of the structures damaged by the virus, leading to the recovery of smell and taste. As a result, studies suggest that PBMT may be a promising approach for patients facing these late sequelae, improving their quality of life (PANHÓCA V, et al., 2023; DE SOUZA VB, et al., 2022).

CASES DETAILS

Ethical considerations

This study was approved by the Research Ethics Committee of Centro Universitário FIS (CAAE: 74966123.3.000.8267, approval No. 6496119). All individuals participated in this research by signing the Informed Consent Form (ICF). After the ICF was read and reviewed, clarifications were provided regarding any potential questions related to the study's content, as well as the associated risks and benefits.

Study design

This is an observational, descriptive study type. The reports were conducted at the Dental School Clinic of Centro Universitário FIS.

Population and sample

The sample consisted of patients selected through convenience sampling, who sought care at the Dental School Clinic, reporting post-COVID-19 olfactory and/or gustatory alterations.

Eligibility criteria

Participants were included if they were adults aged 18 years or older, had a positive test for the SARS-CoV-2 virus confirming previous infection, and presented olfactory and/or gustatory alterations persisting for more than five months after COVID-19 infection. Individuals were excluded if they had any oral potentially malignant or malignant disorder, presented bacterial, viral, or fungal infection in the oral cavity, or were pregnant.

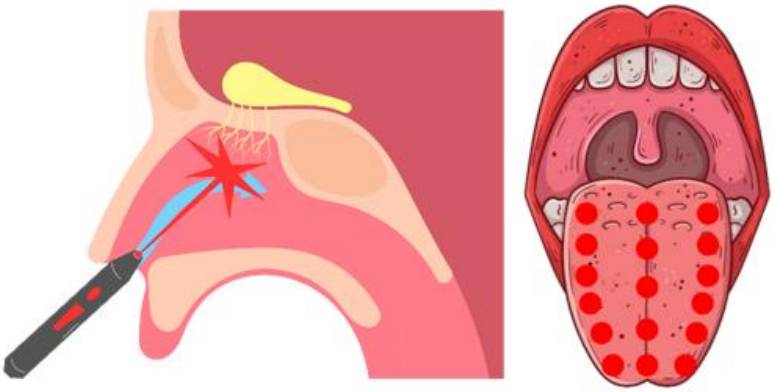
Participant awareness

The participants were informed, based on scientific evidence, about the potential of photobiomodulation therapy with red and infrared lasers in the recovery of olfactory and gustatory functions post-COVID-19. PBMT sessions were scheduled twice a week, with a minimum interval of 48 hours.

Dosimetric parameters of photobiomodulation therapy

In this case series, the authors based their approach on protocols found in the literature. For the treatment of persistent olfactory dysfunction, an infrared wavelength (808 nm) was applied to each nostril, delivering an energy dose of 18 Joules (DE SOUZA VB, et., 2022; SOARES LES, et al., 2021). For gustatory dysfunction, the application was performed pointwise in different anatomical regions of the tongue, including the dorsum, apex, and lateral borders, spaced one centimeter apart, using red (660 nm) and infrared (808 nm) wavelengths simultaneously (SOARES PC, et al., 2022) (**Figure 1** and **Table 1**).

Figure 1 - Nasal and Lingual application.



Source: Pereira ES, et al., 2025.

Table 1 - Parameters used for olfactory and gustatory dysfunctions.

Parameters	Olfactory Dysfunction	Gustatory Dysfunction
Wavelength	808 nm	680 + 808 nm
Operation mode	Continuous	Continuous
Radiant power	100 mW	100 mW
Spot size	0,028 cm^2	0,028 cm^2
Energy density	642.6 J/cm^2 (per nostril)	35.7 J/cm^2 (per point)
Duration	180 sec	10 sec
Radiant energy per point	18 J	2 J (1 J from each wavelength)
Number of irradiated points	2	17
Application mode	Contact (nostril)	Contact (tongue)

Source: Pereira ES, et al., 2025.

Assessment tool

Before the photobiomodulation protocol, an assessment was conducted based on an Adapted Visual Analog Scale (AVAS), in which patients were assigned a score to their current ability to identify smells and tastes (HUSKISSON EC, 1974). Specifically, a score of 1-2 indicated a complete absence of olfaction and gustation, whereas a score of 3-9 denoted a moderate absence of these senses. In contrast, a score of 10 represented normal olfactory and gustatory function. Following each session, spontaneous reports from the participants regarding their perceived improvement in these senses were collected via the AVAS. These reports were subsequently documented in the patients' dental records to monitor the results and symptom progression. Furthermore, as part of the evaluation of treatment effectiveness, patients were encouraged to smell and taste specific items, such as clove, lemon, cinnamon, rosemary, vinegar, and vanilla essence, between sessions. The number of sessions was determined based on the progress of the first patient reported. After the treatment, patients were monitored by the research team to assess the long-term efficacy of the therapy. To ensure continued monitoring, the same AVAS was used to track the patients' progress through the WhatsApp® messaging application once a month.

Clinical case 1

Patient, a 21-year-old female with no systemic health issues, attended the Dental School Clinic in March 2023 and reported post-COVID-19 loss of smell and taste. The patient stated that she was unable to perceive the odors and flavors of her regular diet. During anamnesis, the patient presented the results of an antigen detection test for SARS-CoV-2, confirming a previous infection, dated October 2020. After the anamnesis, the Adapted Visual Analog Scale was introduced, and the patient was assigned scores of 1/10 for olfactory function and 2/10 for current gustatory perception. Photobiomodulation therapy was performed by utilizing the Therapy EC device (DMC®, São Carlos/SP, Brazil) to restore smell and taste, which was administered twice a week with a minimum interval of 48 hours between sessions. The PBMT protocol for anosmia was carried out using an infrared wavelength (808 nm) applied to each nostril, delivering a total energy dose of 18 J over 3 minutes (**Figure 2**).

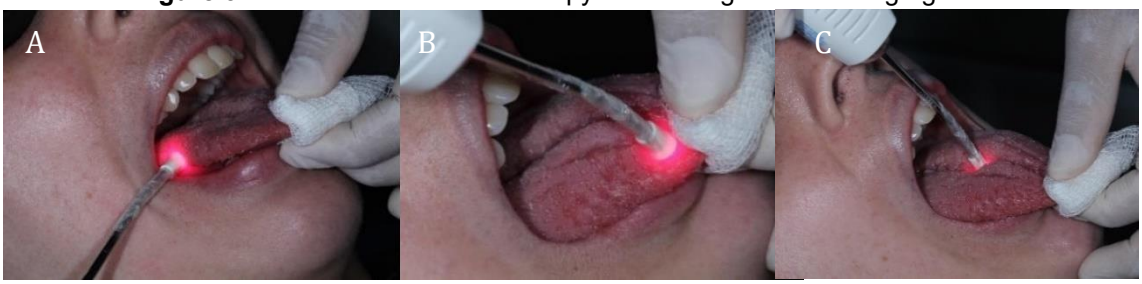
Figure 2 - Intranasal photobiomodulation therapy for anosmia.



Source: Pereira ES, et al., 2025.

For ageusia, the therapy involved the simultaneous application of red (660 nm) and infrared (808 nm) wavelengths in a point-specific manner to anatomical regions of the tongue, including the dorsum, apex, and lateral borders, which were pre-dried with sterile gauze. Each point received an energy dose of 2 J, consisting of 1 J from the red wavelength and 1 J from the infrared wavelength, with 1 centimeter between application points. The exposure lasted 10 seconds per point, totaling 17 irradiated areas (**Figure 3**).

Figure 3 - Photobiomodulation therapy on the tongue for treating ageusia.



(A) Irradiation on the dorsum of the tongue; (B) Irradiation on the lateral border of the tongue; (C) Irradiation on the apex of the tongue.

Source: Pereira ES, et al., 2025.

To assist in the perception of the treated senses, aromatic tests were proposed between sessions. After the 20th session, the patient reported a complete improvement in the initial condition, assigning a score of 10/10 for both olfactory and gustatory functions on the AVAS. Upon completion of the photobiomodulation treatment, the patient continued monthly follow-up for a year and scored 10/10 for both senses at the end.

Clinical Case 2

Patient, a 42-year-old female, presented with persistent olfactory and gustatory dysfunctions since December 2020, confirmed by a positive RT-PCR test for SARS-CoV-2. Her medical history included the use of metformin and antidepressants, as well as previous surgeries (orbital pleomorphic adenoma removal and septoplasty). At baseline, AVAS scores were 3/10 for olfaction and 6/10 for gustation. After 20 PBMT sessions, she achieved partial improvement (7/10 for both senses), which was maintained during 12 months of follow-up. Complete recovery was not observed.

Clinical case 3

Patient, a 29-year-old female, with a history of hypothyroidism controlled with levothyroxine, reported reduced smell and taste perception since October 2020 (confirmed by a positive RT-PCR test). Initial AVAS scores were 6/10 for olfaction and 5/10 for gustation. After 20 PBMT sessions, she experienced complete olfactory recovery (10/10) and partial gustatory recovery (8/10). These results remained stable during a 6-month follow-up period (**Table 2**).

Table 2 - Comparative overview of case series outcomes following photobiomodulation therapy.

Clinical Case	Age/Sex	Relevant Medical History	Olfactory (Before → After)	Gustatory (Before → After)	Follow-up
Case 1	21/F	None	1 → 10	2 → 10	12 mo
Case 2	42/F	Metformin, antidepressant; septoplasty	3 → 7	6 → 7	12 mo
Case 3	29/F	Hypothyroidism (levothyroxine)	6 → 10	5 → 8	6 mo

Source: Pereira ES, et al., 2025.

DISCUSSION

Post-COVID syndrome refers to a collection of symptoms and health issues that persist beyond the acute phase of COVID-19. It can manifest in various forms and affect different systems of the human body. Although certain metabolic and structural changes have been identified in post-COVID syndrome patients, their etiology remains unknown (BOWEN R & ARANY PR, 2023). According to the systematic review and meta-analysis conducted by Chen C, et al. (2022), the global prevalence of post-COVID syndrome is 0.53%, encompassing both hospitalized and non-hospitalized patients. Importantly, none of the participants in this study reported requiring hospital care due to SARS-CoV-2 infection.

During the anamnesis conducted in this study, all patients reported experiencing a certain degree of reduced quality of life due to alterations in their sense of smell and taste. According to Neto DB, et al. (2022), these senses serve as critical warning mechanisms against potential dangers, such as detecting spoiled food, fire smoke, and toxic gases. Additionally, Seighali N, et al. (2024) reported a high incidence of mental health issues, including depression, anxiety, and sleep disturbances, among post-COVID-19 individuals. Thus, olfactory and gustatory dysfunctions have significant psychosocial impacts on affected individuals, underscoring the need for comprehensive mental health support and interventions to address these sequelae.

SARS-CoV-2 exhibits significant neurotropism, with the ability to invade the central nervous system through receptors such as ACE2, Neuropilin-1 (NRP1), and CD147. The presence of a furin cleavage site on the spike protein facilitates viral entry into neural cells, particularly excitatory neurons and glial cells. Clinical and neuroimaging evidence points to the frontal lobe as a primary region affected, with patients presenting symptoms such as delirium, akinetic mutism, and executive dysfunction, along with EEG abnormalities and frontal hypometabolism on PET scans. These findings reinforce the neurotropism of SARS-CoV-2, demonstrating its capacity to selectively affect brain structures, especially frontal circuits (VALERI S, 2022; TONIOLO S, et al., 2021)

Photobiomodulation has shown promising applications in oral medicine, providing non-invasive, drug-free treatment for various conditions. Studies indicate that this therapy can reduce inflammation, alleviate pain, and accelerate tissue healing in disorders such as oral lichen planus and benign migrating glossitis (PANDESHWAR P, et al., 2016). Mohamed RK, et al. (2024) compared PBM with standard corticosteroid therapy for managing oral lichen planus, using a 980 nm diode laser at 300 mW in multiple sessions over five weeks. Their findings indicated that PBM was as effective as corticosteroids in reducing pain and improving clinical outcomes, with no associated adverse effects. In contrast, Roccon A, et al. (2023) assessed the effects of a single PBM session using a 980 nm laser at 0.5 W, demonstrating significant pain reduction over 30 days without adverse events. Saad I (2020) evaluated the effectiveness of low-level laser therapy (LLLT) as a palliative treatment for symptomatic benign migrating glossitis. The protocol used a diode laser with a wavelength of 660 nm, applied continuously for 2 minutes over the lesion. The results indicated a significant reduction in pain, burning sensation, and lesion size in the group treated with LLLT.

PBMT has also been shown to be effective in the treatment of various sequelae related to COVID-19 (BOWEN R & ARANY PR, 2023; PEREIRA PC, et al., 2023; WILLIAMS RK, et al., 2022). A review conducted by Hanna R, et al. (2021) highlighted the importance of this therapy in regulating the “cytokine storm” induced by COVID-19. This therapy reduces levels of inflammatory mediators, modulates levels of pro inflammatory cytokines, and increases levels of anti-inflammatory mediators.

Intranasal irradiation by using the infrared spectrum reaches the olfactory bulb, increasing cell viability under oxidative stress, stimulating Schwann cells, inducing axonal regeneration, and consequently accelerating the functional recovery of nerve cells, thereby improving the sense of smell (LEE JH, et al., 2021). In the context of gustatory dysfunction, the combined application of red and infrared spectrum in the treatment of gustatory function regulates biochemical processes. The red light acts on the epithelial layer, stimulating the repair of taste buds, while infrared light penetrates deeper, affecting neural pathways involved in taste perception. Considering the neurotropic nature of SARS-CoV-2 and its variants, which exhibit affinity for nervous tissue, the combined use of both wavelengths targets both epithelial and neural components associated with post-COVID taste impairment (VALERI S, 2022).

The literature does not present a consensus regarding dosimetry, frequency, intervals, number of sessions, or the ideal device for treating olfactory and gustatory impairments caused by COVID-19 employing photobiomodulation. Consequently, various protocols have been proposed (PANHÓCA VH, et al., 2023; SALES DS, et al., 2023; SHABAAN AA, et al., 2023; DE SOUZA VB, et al., 2022; CAMPOS L, et al., 2022; SOARES PC, et al., 2022; OLIVEIRA PC, et al., 2021). For olfactory sensory dysfunctions, the unanimous approach among authors was the application of laser therapy in direct contact with the intranasal mucosa (PANHÓCA VH, et al., 2023; SALES DS, et al., 2023; SOARES LES, et al., 2021; OLIVEIRA PC, et al., 2021). De Souza VB, et al. (2022) and Oliveira PC, et al. (2021), in their respective studies, employed the infrared spectrum to treat olfactory sequelae throughout 10 sessions, resulting in satisfactory outcomes. Consequently, this study selected the infrared wavelength as the preferred approach based on these promising results (DE SOUZA VB, et al., 2022; OLIVEIRA PC, et al., 2021).

However, the energy delivered per nostril, as well as the frequency and intervals between sessions varied significantly across the studies, highlighting their heterogeneity. Soares LES, et al. (2021) assigned the participants to three distinct groups. In the first group, participants underwent 10 laser sessions, scheduled twice a week, with a 48-hour interval between each session. The second group received 5 laser sessions, also twice a week, with the same 48-hour interval. Finally, participants in the third group completed 10 laser sessions, but with a shorter interval of 24 hours between each session. In all groups, the treatment applied the red spectrum at 660 nm, on contact mode, with 100 mW of power, and 18 J of energy on the nasal mucosa, corresponding to 3 minutes of irradiation per nostril.

Alternatively, De Souza VB, et al. (2022) used a recover device at 100 mW of power applied to the intranasal cavity with an infrared wavelength (808 nm) for 5 min, delivering a total energy of 30 J in each nostril and a total 1000 J/cm² energy density, with the treatment protocol involved 10 sessions conducted over 25 days, with at least a 48-hour interval between each session. For this study, 18 joules per nostril were applied to the infrared spectrum, totaling a 642,6 J/cm² energy density, twice a week, with a 48-hour interval between sessions, based on the studies previously mentioned. The total of 20 PBMT sessions was determined taking into consideration the progression observed in the initial case reported in this study.

Soares PC, et al. (2022), in a case report, used the same device as the one presented in this study, which delivered 100 mW of power with a red and infrared spectrum simultaneously and an energy density of 10,16 J/cm² was applied pointwise, irradiating the tongue dorsum (24 points) and bilaterally on the lateral border of the tongue (12 points on each side), with a one-centimeter distance between points (total of 40 points). The sessions were held twice a week, totaling 52 days of treatment. After 16 sessions, the patient showed partial recovery of taste perception. Similarly, in this case series, seventeen points on the tongue were irradiated (2 J per point) with an energy density of 35,7 J/cm² (per point). The tongue dorsum was treated at five points, while the lateral borders of the tongue were irradiated bilaterally at six points on each side, maintaining a one-centimeter distance between them. Before irradiation, the mucosa was dried to minimize interference from saliva and enhance light penetration into the tissues (total of 17 points). As in the previously cited study, photobiomodulation sessions were conducted twice a week, totaling 20 sessions.

According to Luo D, et al. (2024), factors frequently associated with a higher incidence of persistent symptoms include female sex, advanced age, greater disease severity during the acute phase of infection, the presence of multiple comorbidities, prolonged hospitalization, and a high body mass index. This case series,

comprising three patients who reported persistent olfactory and gustatory dysfunction, consisted entirely of female individuals, as similarly observed in other studies (LUO D, et al., 2024; PASSOS JDC, et al., 2024; SALES DS, et al., 2023; DE SOUZA VB, et al., 2022; CAMPOS L, et al., 2022; SOARES PC, et al., 2022; SOARES LES, et al., 2021).

Following the completion of the study, all patients reported significant improvements in both senses treated with photobiomodulation therapy. However, when compared, one of the three participants achieved the lowest score on the Adapted Visual Analog Scale. Upon reviewing this patient's dental records, it was observed that she was taking antidepressant medication and had undergone septoplasty surgery. This information suggests that these factors may influence the restoration of sensory functions. This aligns with findings from a retrospective cohort study conducted by Mikhail C, et al. (2021), which evaluated taste thresholds among a sample of 30 depressed Egyptian adults on antidepressants and reported a high prevalence of gustatory dysfunction. Thus, the lower score is suggestive explained by the side effects associated with this class of medications.

Moreover, in a comparative study involving 93 patients, Al Qahtani AS, et al. (2020) analyzed post-septoplasty complications in individuals with nasal septum deviation and reported olfactory disturbances in 13.8% of cases. This evidence could suggest prior damage to certain olfactory structures, possibly exacerbated by nerve injury caused by SARS-CoV-2 infection, led to the reduced efficacy of PBMT for olfaction in this patient.

This is one of the few studies available in the literature that followed patients after photobiomodulation treatment for the restoration of olfactory and gustatory dysfunctions post-COVID-19, with the aim of evaluating the long-term effectiveness of the therapy over a period ranging from 6 months to 1 year. Notably, all the participants in this study maintained their previous scores throughout the entire follow-up period.

Researchers are aware of the limitations of this case series. Since it is prolonged treatment, the lack of availability for patients represents a notable challenge. Additionally, some patients reported difficulty in assigning scores on the AVAS. Thus, the subjective nature of this instrument also represents a limitation of the present study. Taking this into consideration, the results were carefully interpreted.

Given these considerations, this case series highlights the potential of photobiomodulation therapy as an alternative treatment for the late sequelae of smell and taste resulting from COVID-19. Moreover, we emphasize the need for further studies using objective outcome measures, larger sample sizes, and extended follow-up periods to determine whether the therapeutic effects of photobiomodulation on these sensory alterations are sustained over time.

This case series demonstrated notable improvements in olfactory function following infrared PBMT, and promising outcomes in gustatory recovery through the combined use of red and infrared wavelengths. While these preliminary findings are encouraging, further clinical trials are essential to validate our results and support the development of evidence-based, standardized protocols for the treatment of post-COVID sensory dysfunctions.

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