

# Taste Perception Changes in COVID-19 Patients During and After Recovery: A Comparative Cross-Sectional Study

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## Abstract

**Background:** We compared taste changes in patients with coronavirus disease (COVID-19) during and after recovery due to reported taste loss.

**Methods:** This was a comparative cross-sectional study conducted in 2020 involving 402 COVID-19 patients referred to a healthcare facility. This study aimed to measure perceived taste intensity using filtered paper disks, both during the disease and one month after the disappearance of clinical symptoms. The collected data were analyzed using SPSS 21.

**Results:** A significant relationship was found between improvements in the perception of saltiness, sweetness, sourness, and bitterness ( $P < 0.001$ ) and sex and employment during and one month after the disappearance of clinical symptoms. However, only the enhancement of perceptions of sour taste was significantly related to education ( $P = 0.044$ ), whereas no significant relationship was observed between saltiness, sweetness, and bitterness ( $P = 0.067$ ). During COVID-19, 69.8% of cases had no perception of the four different tastes, but one month after the disappearance of clinical symptoms, 89.1% fully perceived saltiness and sweetness, 89.9% perceived sourness, and 92.6% perceived bitterness.

**Conclusion:** Taste disorders are common in COVID-19 but improve after recovery. Further clinical studies are required to determine the relationship between disease severity and taste function.

**Keywords:** COVID-19, Clinical symptoms, Healthcare, Perception, Taste

## 1. Introduction

Coronavirus (COVID-19) was first developed in China in late December 2019 and has become a global pandemic. In addition, the number of patients inside and outside Wuhan has increased exponentially, spreading to all parts of China. On January 30, 2020, the World Health Organization (WHO) declared the outbreak of COVID-19 a public health emergency [1]. Although the actual transmission mode of the disease is still controversial, human-to-human transmission has been observed through contagion virus-laden respiratory droplets. Based on this report, multitudinous cases had not been exposed to the Wuhan Animal Market in China, which was the primary point of the outbreak, and some healthcare workers were infected [2]. This disease has gradually spread to other countries [3]. General lethargy, fever, cough, and shortness of breath are the common symptoms of COVID-19. Other symptoms included muscle and joint pain,

sore throat, headache, nausea, vomiting, diarrhea, and taste and smell disorders [4].

Meta-analyses suggest that the prevalence of gustatory dysfunction ranged between 38.2–49.0% and that of olfactory dysfunction between 41.0–61.0% in COVID-19 [5]. Oral epithelial cells, including taste bud cells, have been shown to express angiotensin-receptor-2 (ACE2), the entry receptor for viruses of the Coronaviridae family including SARS-CoV-2. Increasing evidence also suggests that CoV-2 potentially uses multiple entry receptors, such as sialic acid receptors and toll-like receptors (TLR) for host cell entry [6].

Based on the public health approach, identifying components leading to health-related adverse behaviors and reduced quality of life, especially in patients with COVID-19, is of great

significance. Owing to the rapid spread of the disease, patients should be hospitalized for a while or treated in quarantine. Undoubtedly, returning to normal quality of life can create many challenges and obstacles.

The present study aimed to compare the changes in taste perceptions in COVID-19 patients during the disease and one month after the disappearance of symptoms.

## 2. Materials and Methods

All procedures were approved by the Iran National Committee for Ethics in Biomedical Research (approval code/committee, no. IR.AJAUMS.REC.1399.249).

A comparative cross-sectional study included cases of coronavirus referred to us in 2020, whose disease was confirmed by polymerase chain reaction (PCR). The sampling method was a non-random sampling method for the available samples. The sample size (n = 402) was calculated using Cochran's formula. All men and women aged 20 to 40 years, with no underlying disease, and who were physically and mentally normal (if women) were not pregnant or breastfeeding were eligible for the study. Exclusion criteria included the patient's unwillingness to continue cooperation, the patient suffering from underlying diseases, and the patient becomes pregnancy during the study period. Filtered paper discs were used to quantify the perceived taste intensity. Salinity, sweetness, sourness, and bitterness tastes

were obtained by soaking the discs in 1 M sodium chloride, 1.8 M sucrose, 0.1 M citric acid, and 0.001 M quinine. Whatman filter papers (3 cm in diameter) were soaked in solutions of sodium chloride, sucrose, citric acid, and quinine, dried at room temperature, and then placed in zippered plastic bags to prevent moisture loss.

Participants were asked to rate the intensities from 0 to 100 using a scale ranging from having no taste to having the strongest taste. Each packaged paper disc was labeled in order based on salty, sweet, sour, and bitter to report the taste. Taste intensity was scored on a scale of 0 to 100 [7]. The patient drank water at room temperature and tasted it. This test was performed by the researcher during the disease period, and the other symptoms were resolved. After the procedure, the patient was given a mint drink to eliminate the bad taste.

## 3. Results

In this study, 402 patients were examined, of whom 229 (56.7%) were male and 173 (42.8%) were female. In addition, 212 (59.4%) were employed and 190 (40.1%) were unemployed. A total of 121 participants (30%) had high school graduation certificates, 198 (49%) had a degree below high school, and 83 (20.5%) had a college education degree. Tables 1 and 2 present the demographic characteristics of the study sample. The data were analyzed using SPSS 21 software, and statistical significance was set at  $P < 0.05$ .

Variable		Number	Percentage
Gender	female	229	56.7
	male	173	42.8
Occupation	Employed	212	52.5
	Unemployed	190	47
Degree of education	High school	121	30
	Below diploma	198	49
	Above diploma	83	20.5

**Table 1: Demographic Information**

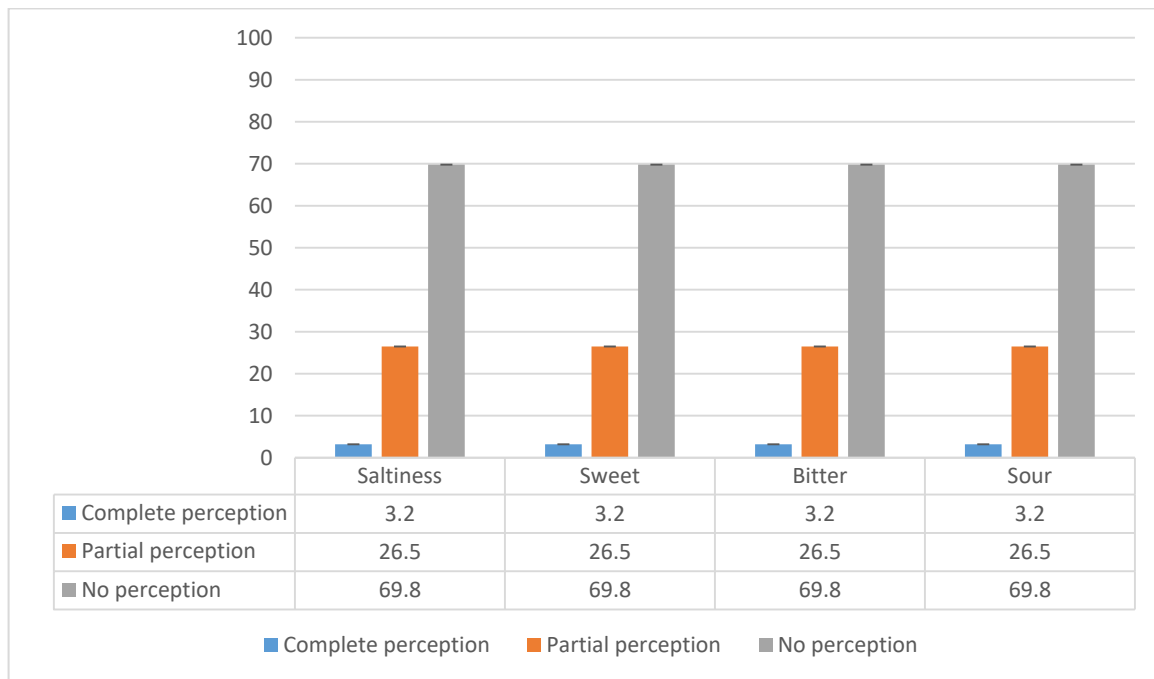
Type of taste	Demographic variables	The significance level*
Sweetness	Gender	0.00
	Occupation	0.00
	Degree of education	0.067
Salinity	Gender	0.00
	Occupation	0.00
	Degree of education	0.067
Bitterness	Gender	0.00
	Occupation	0.00
	Degree of education	0.068
Sourness	Gender	0.00
	Occupation	0.00
	Degree of education	0.044

\*Chi-square statistical test

**Table 2: The relationship between tastes and demographic information**

While suffering from corona disease and among the 402 examined patients, 13 (3.2%) fully understood the taste of saltiness, and 107 (26.5%) of these patients could partially taste saltiness. Moreover, 282 participants (69.8%) had no understanding of salty taste. Thirteen (3.2%) of these patients fully understood the taste of sweets, and 107 (26.5%) could partially taste sweets. Moreover, 282 (69.8%) of these patients had no understanding

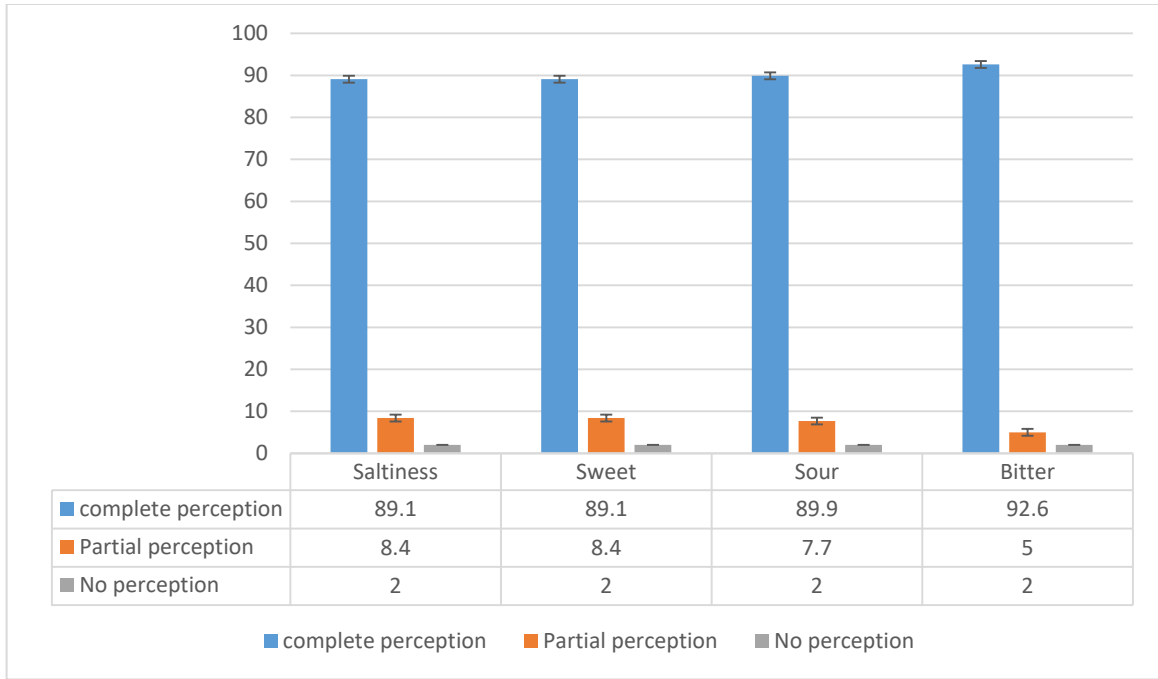
of sweet taste. Thirteen patients (3.2 %) fully understood the bitter taste and 107 (26.5%) had a partial bitter taste. Moreover, 282 participants (69.8%) had no understanding of the bitter taste. Thirteen patients (3.2 %) understood the taste of sourness completely, 107 (26.5%) understood the taste of sourness partially, and 282 (69.0%) of these patients had no understanding of the sour taste (Figure 1).



**Figure 1:** Examining the ability of patients to understand tastes while suffering from corona disease.

One month after disappearing clinical symptoms and among the 402 patients examined, 360 (89.1%) of these patients fully understood the salty taste, 34 (8.4%) understood the taste of saltiness relatively, and 8 (2%) had no understanding of the taste of saltiness. Of these patients, 360 (89.1 %) fully understood the taste of sweets and 34 (8.4%) understood it. A total of 363 (89.9%) patients could fully understand the taste of sourness, 31 (7.7%) patients understood the taste of sourness relatively, 8 (2%) patients had no understanding of the taste of sourness, and 8 (2%) patients had no understanding of the taste of sweets. A total of 374 patients (92.6 %) understood the bitter taste completely, 20 (5%) understood the bitter taste relatively, and eight (2%) patients had no perception of a bitter taste (Figure 2).

One month after the disappearance of clinical symptoms and among the 402 patients examined, 360 (89.1%) completely understood the salty taste, 34 (8.4%) understood the taste of saltiness relatively, and 8 (2%) had no understanding of the taste of saltiness. Of these cases, 360 (89.1 %) completely understood the taste of sweets, and 34 (8.4%) understood the taste of sweets. A total of 363 (89.9%) patients could completely understand the taste of sourness, 31 (7.7%) understood the taste of sourness fairly, eight (2%) had no understanding of the taste of sourness, and eight (2%) had no understanding of the taste of sweets. A total of 374 people (92.6%) fully understood the bitter taste, 20 (5%) understood the bitter taste relatively, and 8 (2%) had no perception of a bitter taste (Figure 2).

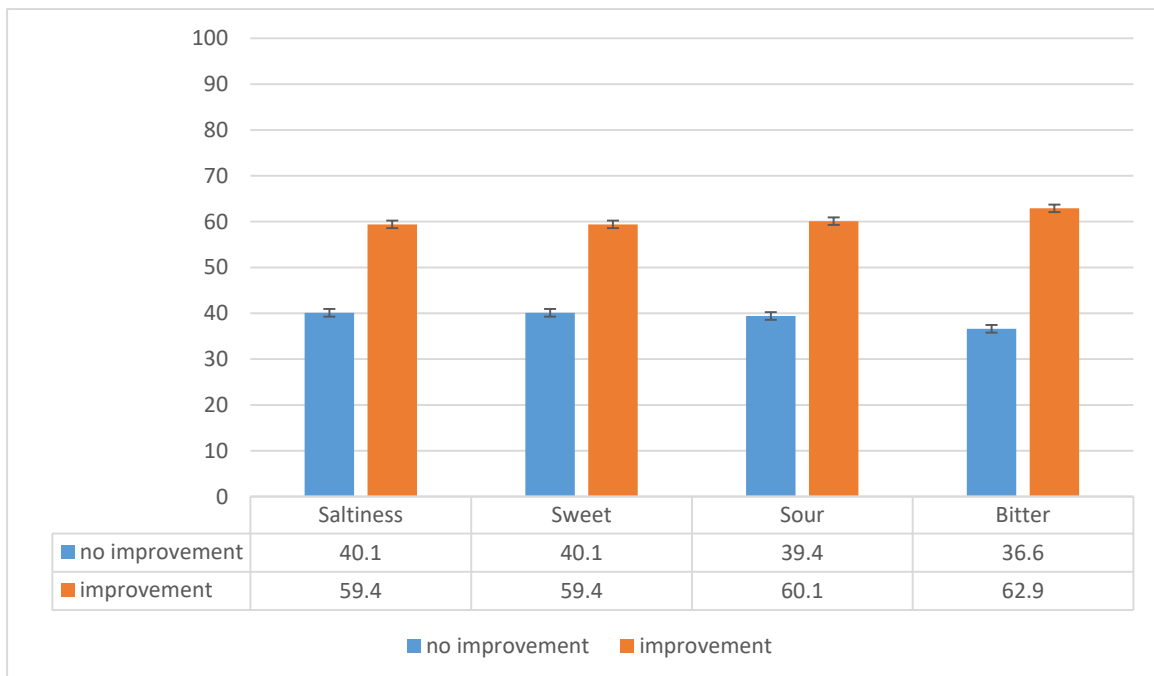


**Figure 2:** Examining the ability of patients to understand tastes one month after disappearing clinical symptoms.

We also examined the recovery variables, which means to reach the patient from a state of not understanding the taste to a state of complete understanding of the desired taste.

One month after disappearance clinical symptoms and among the 402 patients examined in the study, 240 (59.4%) of these patients recovered their ability to perceive the taste of salt. 360

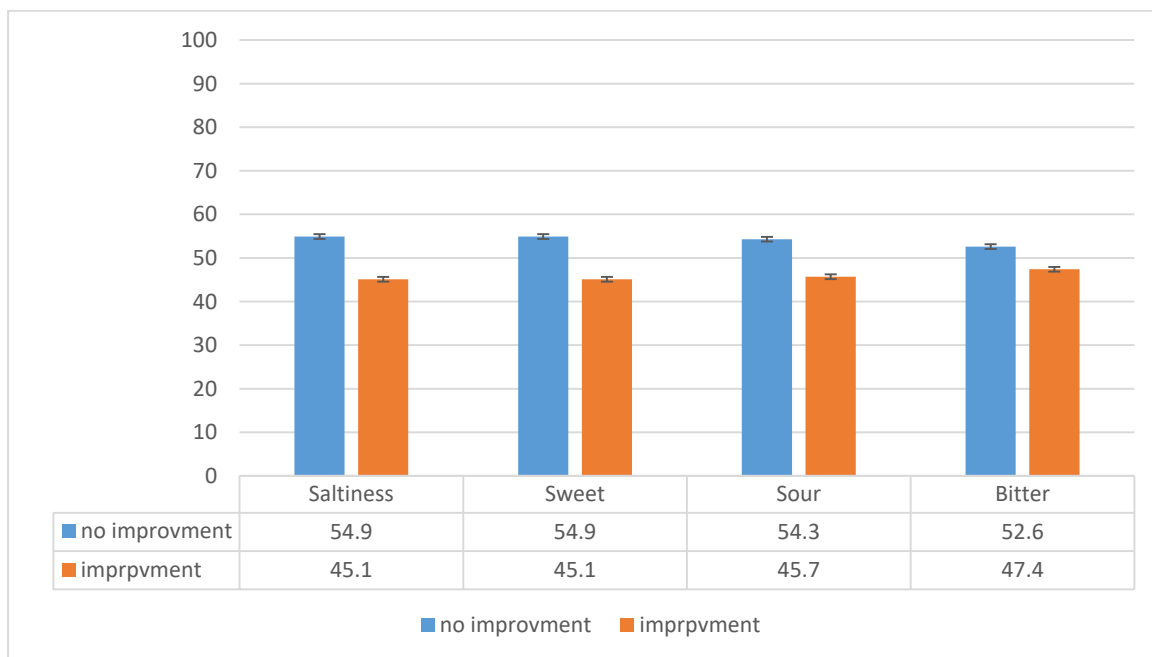
patients (89.1 %) understood the taste of sweets completely, 34 patients (8.4 %) understood the taste of sweets partially, and 8 patients (2 %) had no understanding of sweet taste. 243 people (60.1%) of these patients recovered their ability to perceive sour taste. 254 people (62.9%) of these patients recovered their ability to perceive bitter taste (Figure 3).



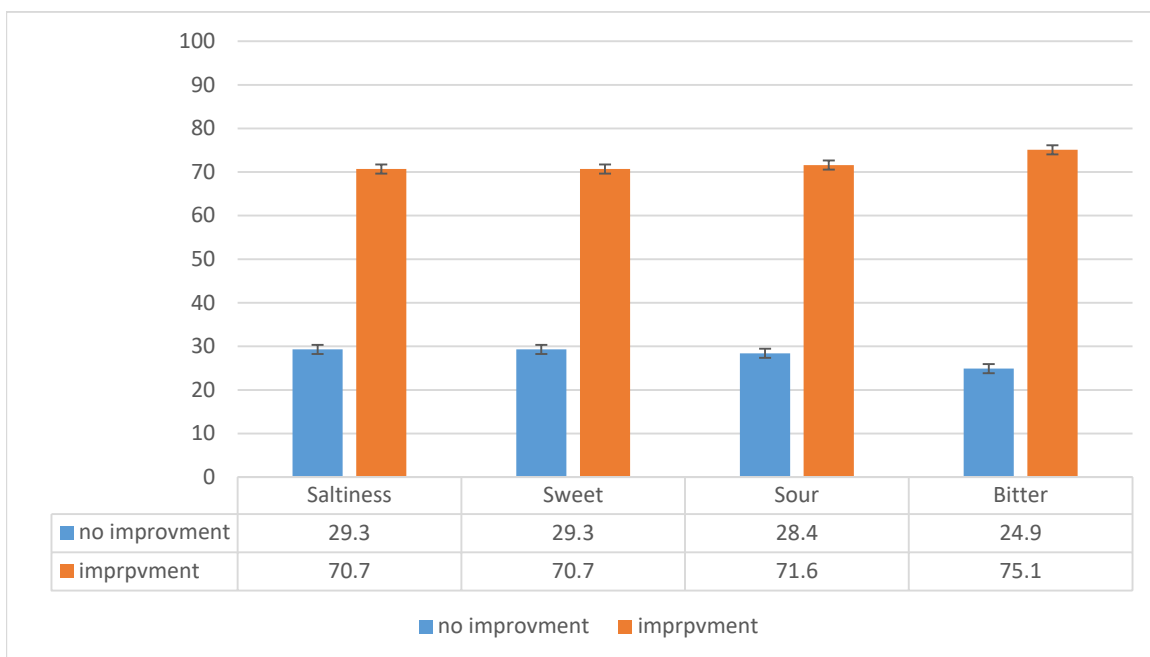
**Figure 3:** Investigating the improvement of taste perception in the studied patients.

After describing the findings of the study, the relationships between the variables were analyzed using statistical analysis. Of the 229 men in this study, 162 (70.7%) achieved a 0–100 percent improvement in salt taste perception. Of the 173 women in this study, 78 (45.1%) achieved 0–100 percent improvement in salt taste perception. Of the 229 men in this study, 162 (70.7%) achieved a 0–100 percent improvement in the perception of the taste of sweets. Of the 173 women in this study, 78 (45.1%) achieved 0–100 percent improvement in sweet taste perception.

Of 229 men in this study, 164 (71.6 percent) achieved a 0 to 100 improvement in their perception of sour taste. Of the 173 women in this study, 79 (45.7%) achieved a 0–100 improvement in their perception of sour taste. Of 229 men in this study, 172 (75.1%) achieved a 0 to 100 improvement in the perception of bitter taste. Of the 173 women in this study, 82 (47.4%) achieved an improvement of 0 to 100 in the perception of bitter taste (Figure 4 & 5).



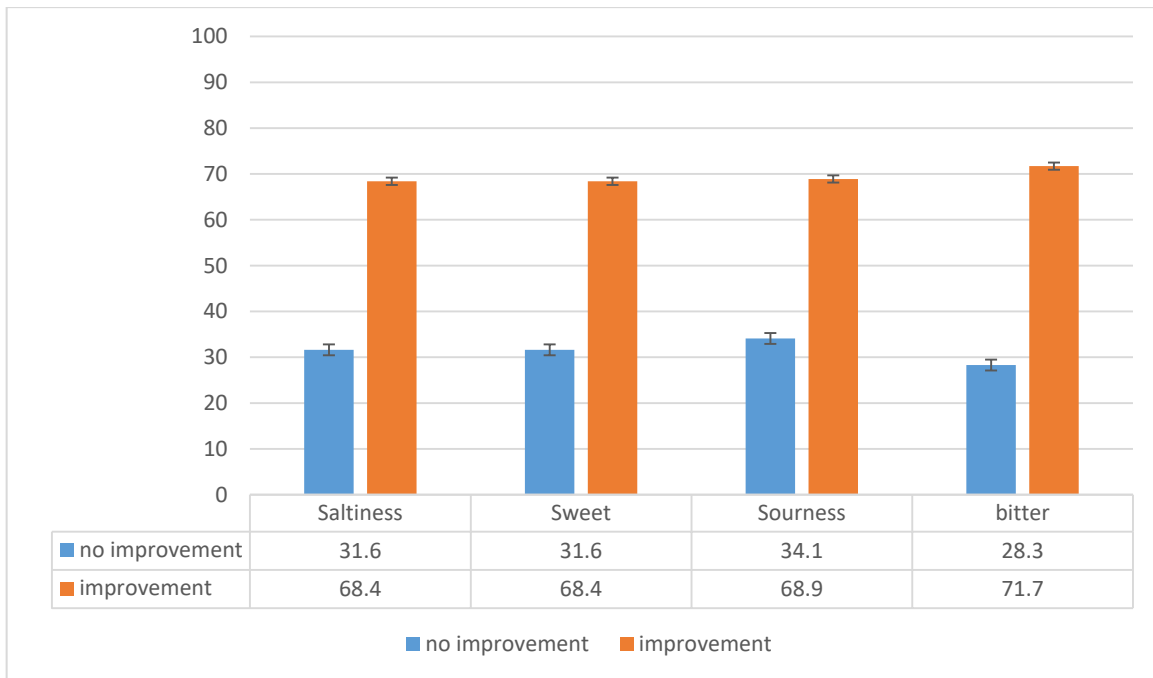
**Figure 4:** Investigating the relationship between female gender of patients and its effect on the recovery of taste perception.



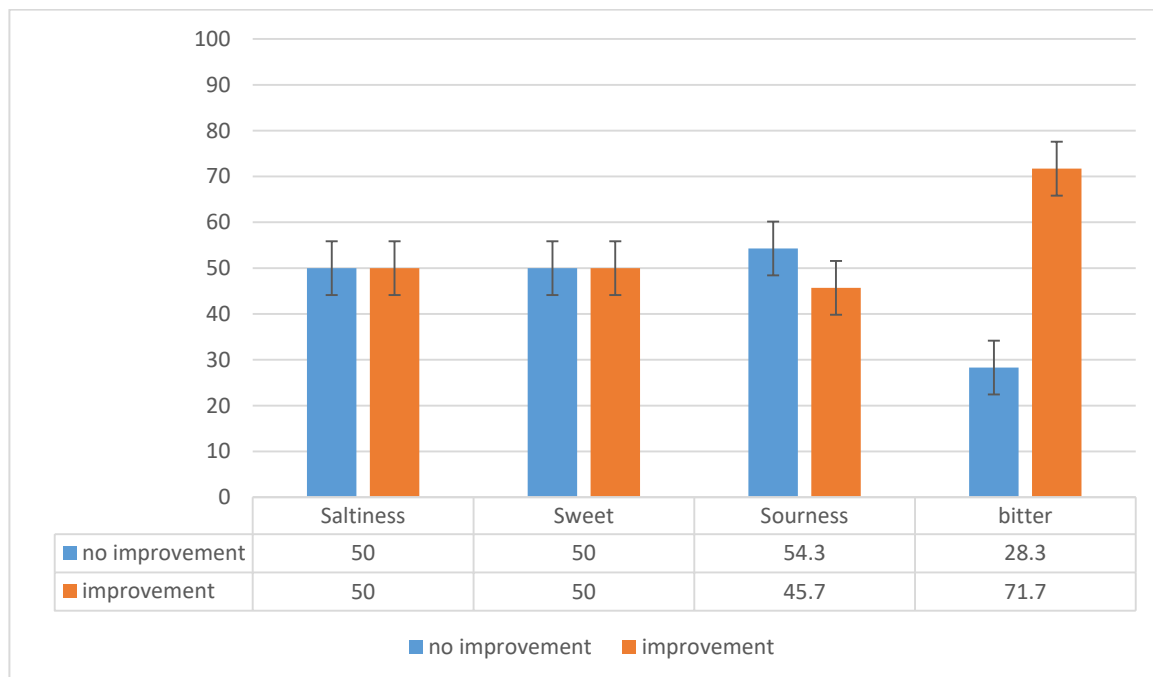
**Figure 5:** Investigating the relationship between male gender of patients and its effect on the recovery of taste perception.

Of the 212 employed patients in this study, 145 (68.4%) achieved a 0–100 improvement in salt taste perception. Of the 190 unemployed participants in this study, 95 (50%) achieved a 0–100 percent improvement in salt taste perception. Of 212 employed patients in this study, 145 (68.4%) achieved a 0–100 percent improvement in sweet taste perception. Of the 190 unemployed participants in this study, 95 (50%) achieved a 0–100 percent improvement in the perception of the taste of sweets. Of the 212 employed patients in this study, 146 (68.9

percent) achieved a 0–100 improvement in the perception of sour taste. Of the 190 unemployed participants in this study, 97 (51.1 percent) achieved a 0 to 100 improvement in the perception of sour taste. Of 212 working patients in this study, 152 (71.7%) achieved a 0 to 100 improvement in the perception of bitter taste. Of the 190 unemployed participants in this study, 102 (53.7%) achieved a 0 to 100 improvement in the perception of bitter taste (Figure 6 &7).



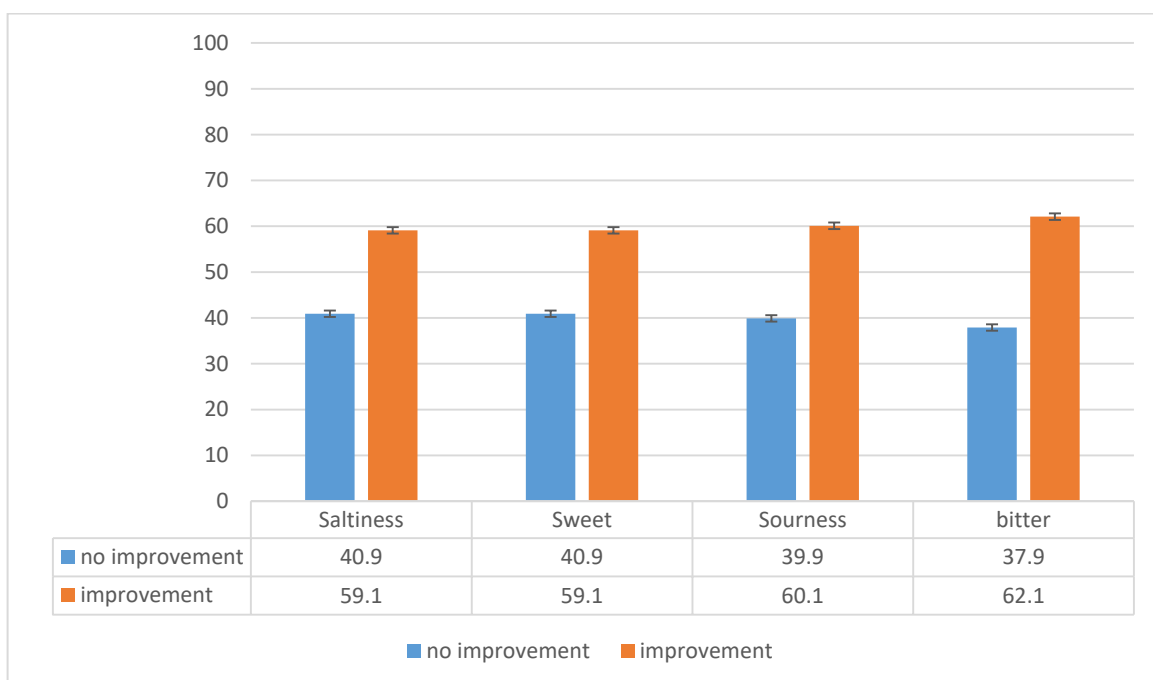
**Figure 6:** Investigating the relationship between patients' employment and its effect on recovery of taste perception.



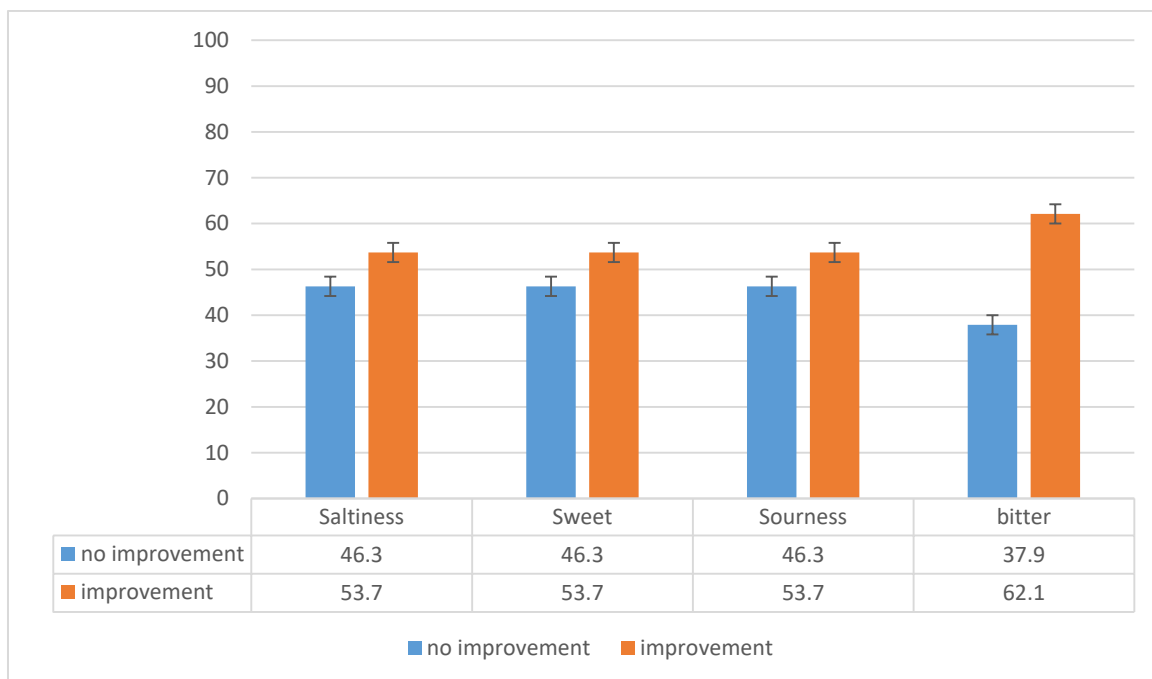
**Figure 7:** Investigating the relationship between patients' unemployment and its effect on recovery of taste perception.

Of the 121 patients with a high school graduation certificate in this study, 65 (53.7%) achieved a 0 to 100 improvement in salt taste perception. Of 198 patients with less than a high school graduation certificate in this study, 117 (59.1%) achieved a 0 to 100 improvement in salt taste perception. Of the 83 patients with degrees higher than the high school graduation certificate presented in this study, 58 (69.9%) achieved a 0–100 improvement in salt taste perception. Of the 121 patients with a high school graduation certificate in this study, 65 (53.7%) achieved a 0 to 100 improvement in sweet taste perception. Of 198 patients with less than a high school graduation certificate in this study, 117 (59.1%) achieved a 0 to 100 percent improvement in sweet taste perception. Of the 83 patients with degrees higher than the high school graduation certificate presented in this study, 58 (69.9%) achieved a 0–100 improvement in sweet taste perception. Of the 121 patients with a high school graduation

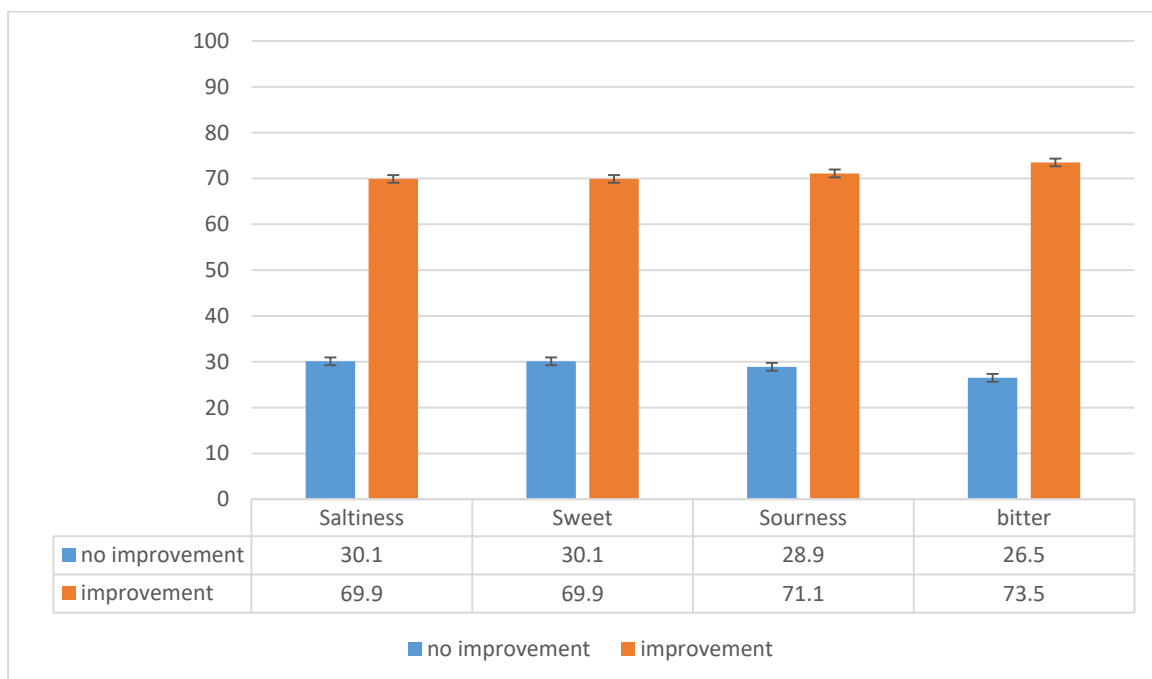
certificate in this study, 65 (53.7%) achieved a 0 to 100 improvement in their perception of sour taste. Of 198 patients with less than a high school graduation certificate, 119 (60.1%) achieved a 0-100 improvement in sour taste perception. Of the 83 patients with degrees higher than the high school graduation certificate presented in this study, 59 (71.1%) achieved a 0–100 improvement in their perception of sour taste. Of the 121 patients with a high school graduation certificate in this study, 70 (57.9%) achieved a 0 to 100 improvement in the perception of bitter taste. Of 198 patients with less than a high school graduation certificate in this study, 123 (62.1%) achieved a 0 to 100 improvement in their perception of bitter taste. Of the 83 patients with degrees higher than the high school graduation certificate presented in this study, 61 (73.5%) achieved a 0–100 improvement in the perception of a bitter taste (Figures 8-10).



**Figure 8:** Investigating the relationship between patients' education level (less than High school graduation certificate) and its effect on recovery of taste perception.



**Figure 9:** Investigating the relationship between patients' education level (High school graduation certificate) and its effect on recovery of taste perception.



**Figure 10:** Investigating the relationship between patients' education level (More than High school graduation certificate) and its effect on recovery of taste perception.

#### 4. Discussion

As COVID-19 is associated with an impaired sense of taste, coping with this disorder can play a major role in increasing patients' quality of life. The findings demonstrated that there was a statistically significant difference in the prevalence of COVID-19 with impaired taste function in comparison with healthy individuals. Alterations in the volume and composition of saliva can disturb taste sensation [8].

Jia song (2020) conducted a retrospective study in which 1,206 laboratory-approved COVID-19 patients were followed up by telephone one month after discharge from a hospital in Wuhan. Loss of taste and smell is the first symptom in patients. 80% of patients recovered from smell and taste dysfunction within 2 weeks. The results indicated that one out of every 10 hospitalized patients had a smell disorder and one in five patients lost their sense of taste [9]. Rizzo, et al. (2020) who followed 202 patients for one month similarly observed a rapid return



of sensations. Results demonstrated that 49% of patients fully recovered during the follow-up period and 41% improved [10]. Menni, et al. showed that 59% of COVID-19-positive patients lost their smell and taste [11]. The results of these studies were consistent with those of the present study. Pierron, et al. (2020) represented that changes in smell or taste reported by the patients are a better indicator for COVID-19 diagnosis, compared with other indicators identified by hospitalization and emergency departments [12]. However, considering the loss of smell and taste as the only criteria for recognizing COVID-19, it does not make a proper sense. Since tasting is different from smelling and scientists know some of the mechanisms involved in smell dysfunction, they have insignificant information about how the coronavirus affects the sense of taste. In most people, smell and taste may improve within a few weeks. Reiter et al. (2020) found that patients with COVID-19 showed dysfunction in smelling (72%) and tasting (84%), and fully recovered from these symptoms after one month [13].

Based on these findings, the prevalence of COVID-19 is associated with impaired taste function. The results showed that 70.15% of patients failed to perceive the four tastes, but one month after the disappearance of clinical symptoms, among 402 patients, 89.1% perceived the taste of salinity and sweetness, 89.9% perceived sourness, and 92.6% perceived bitterness. Therefore, taste disorders are considered important symptoms of COVID-19, which usually improve after recovery. As taste dysfunction can affect the quality of life of patients, further clinical studies are required to accurately assess the relationship between disease severity and these symptoms. Salcan, et al. (2021) reported that 67 had smell and taste disorders among 94 patients, among whom 50.7% had smell disorders and 45 had taste disorders and 44.7% patients had both smell and taste disorders. The results showed that the odor scores of 55 patients with odor disorder in the second evaluation were significantly higher than those in the

first evaluation, and the taste disorder period was significantly shortened compared to the first measurement [14]. Altin, et al. showed that 67.1% of patients lost their smell or taste, 35.8% did not have a sense of smell, 1% lost their taste, and 24.6% lost both smell and taste [15]. In a study conducted by Beltran, et al., impairment in smell and taste was significantly more observed in COVID-19 patients than in patients with influenza [16].

In general, the results of the former studies demonstrated that patients with COVID-19 have encountered smell and taste problems during the disease, while they improved after recovering from the symptoms, which is consistent with the results of the present study.

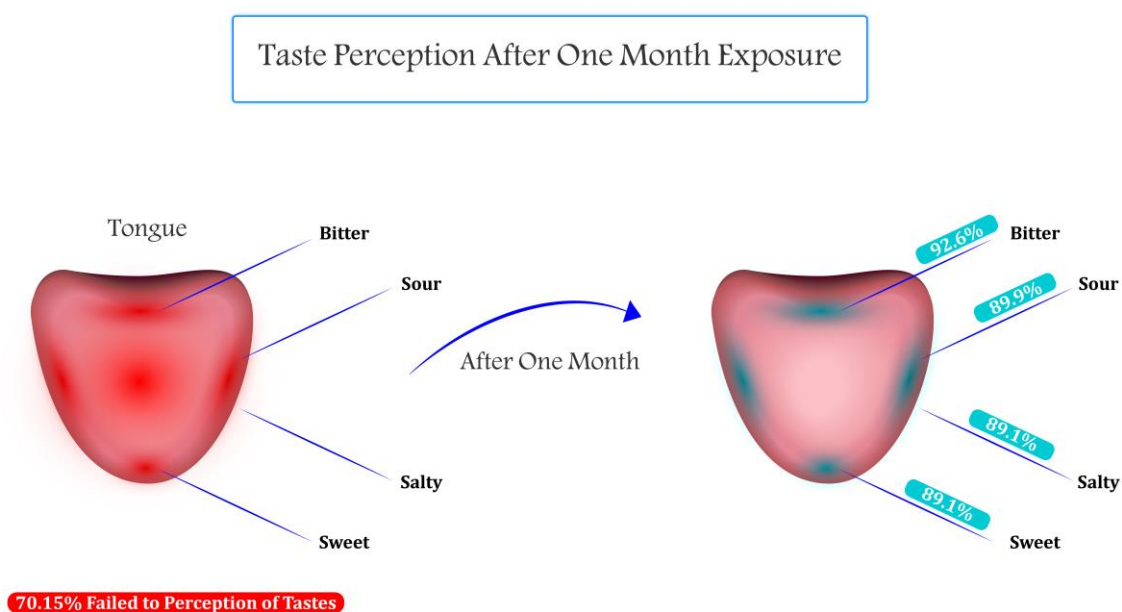
During this study, our research team faced some obstacles that should be mentioned, and removing these problems would be helpful for future studies. In future studies, the period of taste changes should be examined and followed for a few months. In addition, it would have been better to examine the sense of smell because of the connection between the sense of smell and the perception of taste, which we did not examine. Furthermore, people over the age of 40 should be considered to gain a better understanding of different age groups in society. Eventually, follow-up should be performed with longer time intervals in future studies.

Among the advantages and innovations of this research, we can mention the investigation of the sense of taste, including four main flavors, which have not been investigated in similar studies.

### 5. Conclusion

Overall, we can conclude that taste changes can occur during disease and can affect the quality of life of patients if these changes are not resolved over time and need therapeutic intervention.

### Graphical Abstract



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**Conflict of Interest:** The authors declare no conflicts of interest.

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