

## Effect of Olfactory Training on Restoring Smell and Taste Senses Post Covid-19 Infection

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### **Abstract**

**Background:** COVID-19 patients frequently report smell and taste impairments that develop early in the disease and, in some cases, last long after respiratory symptoms have subsided. Olfactory training is a therapy that helps people restore their sense of smell. **Aim of the study was to evaluate the effect of olfactory training on restoring smell and taste senses in Covid-19 patients. Study design:** A quasi-experimental research design was used to achieve the study's aim. **Setting:** The study was conducted in outpatient chest clinics at Mansoura university hospital & Assiut university and Chest hospitals. A purposive sample of 200 patients was included in the study and was divided into two equal groups (study group & control group). **Tools:** Two tools were used to achieve the aim of the study. **Tool I:** - Self-administered questionnaire included 3 parts as follows, demographic characteristics, Visual Analog Scale (VAS)-Smell Score, and Self-Reported Mini Olfactory Questionnaire. **Tool II:** Patient-administered gustatory test. **Results:** Statistically significant difference between the study and control group concerning smell restoration duration ( $3.020 \pm 1.663$  and  $5.470 \pm 2.027$ ) weeks respectively, and taste restoration with p value ( $p=0.0001^{**}$ ). **Conclusion:** Olfactory training enhances smell & taste restoration post COVID 19 infection. **Recommendation:** patients with smell and taste loss post-COVID-19 infection should be advised to practice olfactory training.

**Keywords:** COVID-19, Infection, Olfactory sense, Smell, Taste & Training.

### **Introduction**

Anosmia (loss of smell) induced by COVID-19 can be caused by a variety of factors, damage to the olfactory epithelium, which contains olfactory sensory neurons. The second cause is that the olfactory bulb's morphology has been disrupted, preventing signals from reaching the brain. Furthermore, an inflammatory immune response that affects the olfactory system is a third potential cause (Koyama et al., 2021).

Direct infection of olfactory sensory neurons, infection of surrounding receptor

cells leading to morphological impairment of these cells ultimately leading to damage the olfactory sensory neurons, and inflammatory cytokines leading to olfactory dysfunction (OD) leading to sensory neurons which these factors are possible causes of damage to the olfactory epithelium (Cooper et al., 2020).

Anosmia predominates in patients with COVID-19, with rates ranging from 59 to 86 percent (Callejon-Leblic et al., 2021 & Lechien et al., 2020). For a variety of reasons, a loss of smell might impede an individual's capacity to identify environmental threats (smoke, poisons, or gas leaks). It can disturb feeding conduct and appetite because of changes in taste and

distress of not recognizing rotten food (**Lee & Lee, 2020**).

The possibility of smell recovery varies depending on the severity of the smell loss at the time of presentation, however, it appears that roughly 10% of affected patients have a permanent smell and taste loss after 6 months. Over 150,000 Americans are expected to lose their sense of smell permanently in the next 12 months as a result of COVID-19. This level of impact on health, safety, and quality of life is unprecedented, making olfactory dysfunction post-COVID a significant public health issue (**Mao et al., 2020**).

If the OD caused by COVID-19 improves on its own, no treatment may be necessary. However, if the injury lasts longer than two weeks, treatment might be necessary. Although treatments for COVID-19-related OD may be beneficial, the efficacy of current treatments in patients with COVID-19-related to OD is unknown (**Whitcroft and Hummel, 2020**).

Smell training, also known as olfactory training, is a rehabilitation program that aids in the recovery of a person's sense of smell following an illness or injury. It involves inhaling four different odors twice a day (**Hummel et al., 2017**). More than 90% of COVID-19 patients with anosmia can restore their sense of smell within the first month, and olfactory training is strongly suggested if the sense of smell does not return after this time but can be started earlier (**Mullol et al., 2020**).

Essential oils are plant extracts that are great for olfactory training. They have powerful, strong odors and, unlike perfumes, tend to have just one main scent. Rose, eucalyptus, lemon, and clove essential oils have been used to treat anosmia in studies (**Abdelhafeez & Ali Elkholi, 2022**).

However, numerous different oils can be used. Natural medicines have been increasingly popular in different medical sectors in recent years. Bronchitis, infectious colds and illnesses, sinusitis, allergies, and flu-like asthma can all be helped by inhaling essential oil vapors (**Meghana, et al, 2017**).

Following olfactory training, patients with post-infection OD showed better olfactory sensation. Olfactory training may be explored for patients with persistent COVID-19-related OD due to its inexpensive cost and few adverse effects (**Whitcroft and Hummel, 2020**).

Taste loss is often neglected in research compared to smell loss, as there is a common notion that taste loss is not as “real” as smell loss. Some claim taste loss is indistinguishable from smell loss (**Le Bon et al., 2020**) or is confused with smell loss, specifically with retronasal smell perception (**Hintschich et al., 2020**). For the general population, loss of taste can be difficult to distinguish from smell loss. Therefore, it may be difficult to know, based on self-report measures alone, whether or not a participant truly lost their sense of taste.

### **Significance of the study:**

COVID-19 patients frequently report smell and taste dysfunction (STD). STDs develop early in the disease course, appear to be more common in SARS-CoV-2 infection than other upper respiratory infections, and can remain long after respiratory symptoms have gone in some cases (Mastrangelo, et al, 2021 ).

Because of the physiological importance of smell in sensing environmental elements and potential hazards, it has been linked to a shorter life expectancy. Anosmia has been documented in the majority of COVID-19-affected nations (Joffily et al., 2020). So, this study was conducted in an attempt to improve smell and taste sense for those patients through using olfactory training therapy.

### **Aims of the Study**

This study aims to evaluate the effect of olfactory training on restoring smell and taste senses post Covid-19 infection.

### **Research Hypothesis**

Patients who apply olfactory training will restore smell & taste senses earlier than patients who don't apply the olfactory training.

## **Materials and Method**

### **Materials**

**Design:** A quasi-experimental research design was used to achieve the study aim.

**Settings:** The study was conducted in outpatient chest clinics at Mansoura university hospital & Assuit university hospital and Assiut Chest hospital.

**Subjects:** A purposive sample of 200 patients was divided randomly into two groups (study and control groups) of 100 patients each, who volunteered to participate in the study.

The following data were used to compute sample size using the G-Power program: effect size 0.5, -error prop 0.05, two tails, power (1-error prop) 95 percent. The difference between the two average two equal groups was determined using independent t-Tests. The study included 200 patients.

**Inclusion criteria** of the participants were adult males and females aged 18 to 60 years old, ready to engage in the study, no plans to travel before the study end, confirmed case (positive PCR), and suffering from a sudden loss of smell and taste senses after COVID-19 infection, and hospitalized or managed at home isolation

**Exclusion criteria** of the participants were, allergic rhinitis, rhinosinusitis, nasal surgical history, the patient is already on a nasal steroid, the patient is having radiotherapy for head and neck psychiatric disorders, and the patient has a history of smell and taste abnormalities before the COVID-19 infection, or experience loss of smell and taste senses less than one month.

**Tools:** Three tools were used to collect data of the study:

#### **Tool I:-Socio-demographic & clinical data structured interview schedule..**

This tool was used to assess demographic characteristics and clinical data, and included 2 parts as follows:-

**Part 1:- Demographic characteristics**, such as age, gender, residence, educational level, and health history.

**Part 2:- Clinical data:** this part included how many times of COVID 19 infection, smell and taste loss duration, history of loss of smell and taste before COVID 19 infection, and smoking habit.

#### **Tool II:- Self administered olfactory scale.**

This tool was used to assess smell sense, and included 2 parts:

##### **Part 1:- Visual Analog Scale (VAS)-Smell.**

It represents a horizontal line of 10 cm with word anchors at each end representing the extreme feelings. Patients are instructed to indicate the point on the line that best corresponds to their status for the particular characteristic being evaluated. (Abdelalim et al., 2021).

It was used by the researchers to assess the power of smell sensation. In addition to its high sensitivity, reliability and reproducibility, VAS is easy and simple to use by patients and health care providers (Klimek et al, 2017). It also does not require training, making VAS a highly valuable tool not only for everyday clinical practice, but also for real-life studies.

**Scoring system:** Visual Analog Scale (VAS)-Smell Score from 0 to 100 (0 being a complete loss of smell and 100 being a completely normal sense of smell)

All patients had weekly smell assessments from starting the research until 3 months (12 weeks) until restoration of smell sense.

Good olfactory function is reflected in high scores and vice versa.

##### **Part 2:- Self-Reported Mini Olfactory Questionnaire.**

This tool was developed by (Zou et al., 2019) to reflect complaints about olfactory problems in daily life, and consisted of 14 true/false items, which were formulated as personal statements. Score zero was given to no answers while score one was given for yes answers; the low score reflected good sensation function and vice versa.

#### **Tool III: Patient-administrated gustatory test**

This test was developed by (Vaira et al., 2020) and consists of four different solutions: salty, sweet, acidic, and bitter solutions, each diluted with one liter of water before usage. Patients were instructed to put a teaspoon of each solution in their mouths, and score the quality of their taste perception on a scale of 0 (no flavor) to 10 (excellent taste) or (normal taste). Higher scores indicate a good sense of taste and vice versa.

#### **Olfactory training:**

A colorful Arabic brochure was developed by researchers after reviewing the recent national and international literature. It included an explanation about the natural essential oils that help to activate the smell sense again as Clove oil, Peppermint oil, lemon oil, and coffee.

Smell training is actively sniffing the same four scents twice a day, spending around 20 seconds on each scent so that the entire smell-training session lasts approximately 80 seconds, short sniffs rather than deep inhales are recommended.

Experts in the nursing and chest diseases checked the content of the olfactory training protocol and corrections were done accordingly.

The researchers instruct patients to ensure the olfactory training protocol is followed correctly and thus facilitate the best possible outcome of the therapy—furthermore, they follow up with patients weekly to ensure adherence to the protocol.

### **Method**

#### **Validity and Reliability of the study tools:**

- Content validity of the olfactory training and tools were checked by panel of 5 experts (3 professors in fields of chest diseases and 2 professors in nursing) for clarity, relevance, comprehensiveness, understanding, and easiness for application. Minor modifications were required, correction was carried out accordingly.

- Visual Analog Scale (VAS)-Smell Score reliability: test-retest showed stability between time 1 and time 3, with Pearson's correlation coefficient given as  $r = 0.87$ .

- Self-Reported Mini Olfactory Questionnaire internal consistency is excellent, with Cronbach's  $\alpha$  reported at 0.936

- Patient-administrated gustatory test reliability has been shown to be good with correlation coefficient given as ( $r = 0.98$ ).

#### **Pilot study:**

- Before data collection, a pilot study of 20 patients (10%) was applied to analyze all tools for clarity, objectivity, relevance, feasibility, and applicability. Patients who participated in the pilot study were not included in the current study.

#### **Data collection**

The data collection was done through the following phases:

#### **Assessment phase:**

- Official permission was obtained from the heads of the outpatient chest clinics at Mansoura university hospital & Assuit university and Chest hospitals to conduct the study.
- The study tools and Arabic, colored brochure included olfactory training protocol were prepared.
- The researcher interviewed the patients who were complaining from loss of smell and taste post COVID 19 infection.
- Oral consent was taken from patients who were agreeing to participate after reassured about the confidentiality and the information will be used for the purposeful research.
- Categorization of patients to two groups were done randomly.
- Socio-demographic & clinical data structured interview schedule(tool I) was applied which is concerned by patient's demographic data and clinical data assessment while tool II concerned with visual analoge smell score and the self reported mini olfactory questionnaire were performed to assess the base line data regarding smell sense.
- Patient administered gustatory test (tool III) was also performed to assess the base line data regarding the taste sense.

### **Implementation phase:**

- Data were collected during the period from first of February 2021 to the end of January 2022, during morning shifts at the outpatient chest clinics at Mansoura university hospital & Assuit University and Chest hospitals.
- The aim of the study was explained to the patients before starting data collection. Patients also informed about what will be done for them.
- The researchers divided the participants into two equal-sized groups randomly throughout this phase (study group and control group) (100 patients for each group).
- The first group of patients (100 patients) received routine hospital care and instructions (there were not any participation from the researchers for educating patient for olfactory training and they considered as a control group).
- The second group of patients received the routine hospital care and instructions in addition to the olfactory training; each patient received the instructions in one session. Each session takes 15 - 30 minutes.
- Each session contain 3 - 4 patients. After each session there were 5 - 10 minutes for discussion and gave feedback. Reinforcement of teaching was performed according to patient's needs to ensure their understanding.
- Each patient in the group obtained a copy of the olfactory training (brochure); the researcher used pictures for illustration, diagram to educate the patients.
- Furthermore, researchers used phone calls or whatsapp to measure the adherence to instructions and performing the technique of olfactory training correctly.
- To record each patient's progress, both groups were evaluated weekly for smell with Tool II and taste with Tool III.

### **Follow up phase**

- The researchers monitored all patients in both groups weekly through phone, WhatsApp, or Google form through

duration of 12 weeks, using Tool II (part 1 and 2) to track smell sense and Tool III to track taste.

- Each patient was monitored for three months or until they have fully recovered their senses of smell and taste.

### **Ethical considerations:**

All research ethics principles were fulfilled according to the **World Medical Association Declaration of Helsinki (2013)**. Before the conduction of the pilot study as well as the actual study, official permission and consent were obtained from the dean of the Faculty of Nursing, as well as the director of the chest diseases department and outpatients' clinics after explaining the nature and purpose of the study. The subject of the study is entitled to refuse to participate and/or withdraw from the study at any time without any reason. During data collection, the research topic was not considered to pose any health hazards. Participants were assured of being highly confidential with all their data.

### **Statistical Analysis**

SPSS for Windows version 25.0 was used to conduct all statistical tests (SPSS, Chicago, IL). The mean and standard deviation of continuous data were calculated using a normal distribution (SD). Frequencies and percentages are used to present categorical data. Independent t-tests of two variables with continuous data were used to make comparisons. When comparing variables using categorical data, Chi-square tests are performed. The interrelationships between quantitative variables were evaluated using Spearman correlation analysis. After normality, and ANOVA were performed on the whole regression model, multiple linear regression analysis was utilized to find independent predictors of taste recovery. The threshold for statistical significance was established at  $p < 0.05$ .

### **Results**

**Table 1: Shows distribution of demographic characteristics and medical data of the study and control groups of patients (N=200)**

This table shows that nearly half of the study group patients were female compared to slightly less than three-fifths of the control group. In addition, slightly less than half of the both two groups were middle educated. The majority of both groups had COVID-19 one time and didn't lose smell & taste before the COVID-19 infection. Concerning smoking habits, nearly two-thirds of both groups are non-smoker. Finally, There was no statistical significant difference between the study and control groups of patients regarding demographic characteristics and meical data of patients.

**Table 2: Presents smell & taste restoration after 12 weeks of follow up period among the studied patients (n=200)**

The results shows that there was a highly statistical significant difference between the study and control group concerning smell restoration duration, smell sensation power with p.valu <0.0001\*\* . Concerning taste restoration, there was a highly statistical significant difference between the study and control group related to salt, sugar, and bitter taste with p.valu <0.0001\*\*, also, there is a significant difference between the two groups related to acidic taste with p.valu <0.009\*.

**Figure 1: Depicts distribution of sequence of first recognized odors amonge the study group of patients (n=100).**

The findings shows that the sequence of the first recognized odors among the study group was lemon, then mint, then coffee, then lemon & mint together. Finally, clove odor was recognized firstly by only four patients.

**Table 3: Shows Multilinear regression of the relation between smell and taste restoration among the study group of patients:**

Table 4 shows that there was ahightly statistical significant effect of smell restoration on restoration of bitter taste, while no significant effect of smell restoration on salt, sugar &or acidic taste .

## Discussion

The most common symptoms described by patients after developing

COVID-19 are loss of smell and taste. Despite high self-reported recovery rates, new studies have revealed that up to 7% of patients lose their sense of smell and taste more than a year after onset, leaving millions of people with severe olfactory impairment worldwide. Smell training is still the best first-line of treatment (**Denis et al. 2021**).

The current study showed that, more than half of the patients in both the study and control groups were women. **Taquet et al. (2021)** agreed with our findings, reporting that more than half of COVID-19 survivors were female. **Jin et al., (2020)** on the other hand, found that males and females had the same prevalence.

Concerning smoking habits, non-smokers made up about two-thirds of both groups. **Al-Ani&Acharya (2020)** agreed with existing findings on patient age but disagreed on gender and smoking habit, claiming that the majority of patients were in the 30+ age group and had practically comparable genders and the majority of them were smokers.

The present study results revealed that there was a highly statistical significant difference between study and control group of COVID-19 patients concerning smell restoration duration as the smell restoration duration of the study group was shorter than the control group, smell sensation power score was higher among the study group than the control ones and finally, smell questions score were high than the control group. From the researchers' point of view these results were logic as because of using the volatile oil and olfactory training that stimulated the olfactory nerve and enhance the patients' smell restoration.

**Gellrich et al., (2017)** were agreeing with our study results as they revealed that "one of the treatment methods, which have been used for decades for patients with smell loss, is olfactory training. So far, there have been no treatment methods comparable to smell training for taste loss that can be called "taste training". Smell training uses essential oils, most often used are rose, lemon,

eucalyptus, and clove, although there are various other choices available to be used.

Also, **Huang, et al, (2021)& Sorokowska, et al, (2017)** supported our findings as they reported that olfactory training improves olfactory function since it is an emerging no pharmacologic therapy option involving odor exposure. This finding was supported by **Poletti, et al, (2016)** who monitored patients for five months and mentioned that nearly half of patients achieved a significant and clinically meaningful improvement in smell sense. Additionally, **Hopkins et al, (2020) and Patel, (2017)** reported that “Olfactory training is recommended to patients with loss of smell more than two weeks.

**Concerning taste restoration**, the present study results reported that there was highly statistical significant difference between study and control group of COVID-19 patients related to salt, sugar and bitter taste, while there was a statistical significant difference between two groups related to acidic taste. This finding was in the line with, **Singh, et al, (2021)** who reported that there was a significant improvement in taste function (bitter, sweet, salty, and sour) among the study group compared with the control group. Following the outbreak of COVID-19, millions of people have lost their senses of taste and smell. The development of “taste training” may significantly help the recovery of their senses. A difference from the olfactory system is that, in the case of the oral cavity, it is possible to include both volatile and non-volatile/low-volatile chemical compounds for the “taste training” (**Koyama et al., 2021**).

On the contrary, **Adamczyk et al., (2021)** disagree with the current study results as they reported that sweet taste is the only taste that was impaired significantly among COVID-19 patients.

The present study showed that more than half of COVID-19 patients restored their smell and taste by using lemon. From the researchers’ point of view lemon is the most available and cheaper that can be easily

available at every house in our community. This finding was agreed by **Whitcroft& Hummel (2020)** who reported that frequent and intentional inhalation of a set of scents (lemon, rose, clove, and eucalyptus) is usually recommended twice a day, each time for at least 20 seconds for 3 months (if possible) since this method is effective, lost cost, and has few side effects”.

Also, **Marwah and Marwah, (2020)** were in the same line with the present study finding, as using lemon in treating loss of smell and taste in COVID 19 patients as she reported that using olfactory training had been shown to be effective”.Furthermore, **Whitcroft & Hummel (2020)** recommended that olfactory training as a treatment for persistent smell & taste loss associated with COVID-19.

Additionally the present study results showed that there was a highly statistically significant effect of bitter taste (coffee) on COVID 19 patient smell restoration. From the researchers’ point of view it can be accepted results as Caffeine in coffee reduced the reversibility of the sense of smell and taste in people with Covid-19. **Bulbuloglu & Altun, (2021)** were agreeing with the current study results as they reported that using coffee intermittently regained some of sense of smell quickly.

Also, **Hosseini, et al, (2020)** and **Altundag et al., (2020)** were agreeing with the study results as they revealed that coffee consumption helps in improving restoring taste and smell since it helps the patient identifying the different odors as well as their intensity.

### **Conclusion**

Olfactory training had a positive effect on enhancing smell restoration (duration, sensation power and olfactory function) and also promoting taste restoration post COVID 19 infection.

### **Recommendations**

*In line with the findings of the study, the following recommendations are made:*

- Patients with smell and taste loss post-COVID-19 infection should be advised to practice olfactory training.
- Nurses and other healthcare staff members should consider patient education as one of their critical duties and improve their awareness of the importance of olfactory training in restoration of smell and taste senses.



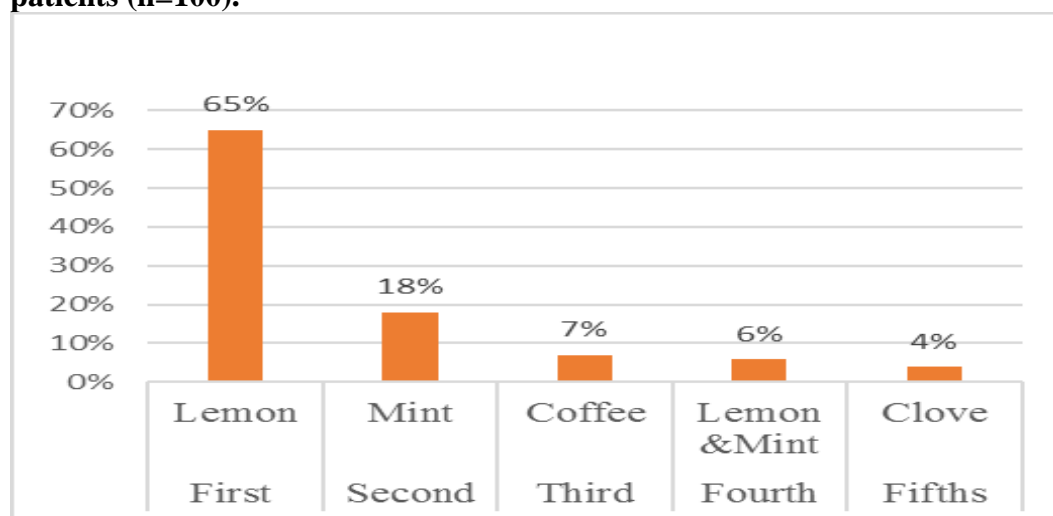
**Table 1: Demographic characteristics and clinical data of the study and control groups of patients (N=200)**

Items	Study N=100	Control N=100	P.value
Gender			
• Male	48	44	X <sup>2</sup> =0.322 p=0.335
• Female	52	56	
Age group			
• 18:>25 years	14	16	X <sup>2</sup> =2.058 p=0.357
• 25:>40 years	38	46	
• 40:60 years	48	38	
Mean age ± SD	41.51 ± 13.234	37.410 ±9.553	t= 2.512 p=0.112
Residence			
• Rural	46	49	X <sup>2</sup> =0.180 p=0.389
• Urban	54	51	
Educational level			
• Illiterate	12	9	X <sup>2</sup> =2.921 p=0.571
• Read & write	14	12	
• Middle	47	42	
• University	17	20	
• Postgraduate	10	17	
Occupation			
• Not work	30	40	X <sup>2</sup> =3.240 p=0.198
• Medical field	27	18	
• Non-medical field	43	42	
COVID-19 infection			
• One time	96	93	X <sup>2</sup> =4.825 p=0.090
• Two times	2	7	
• Three times	2	0	
<b>Smell &amp; taste loss duration (Months)</b>			
• 1:< 2	88	85	X <sup>2</sup> =6.547 p=0.067
• 2:< 3	3	11	
• 3 or more	9	4	
<b>History of loss of smell&amp; taste before COVID-19 pandemic</b>			
• Yes	1	4	X <sup>2</sup> =1.846 p=0.184
• No	99	96	
Smoking habit			
• Smoker	36	32	X <sup>2</sup> =0.357 p=0.327
• Non-smoker	64	68	

**Table 2: smell & taste restoration after 12 weeks of follow up period among the studied patients (n=200)**

Variables	Study group Mean (SD)	Control group Mean (SD)	Significance P.value
<b>Smell restoration</b>			
Smell restoration duration (weeks)	3.020 (1.663)	5.470 (2.027)	t=-9.342 ,p=0.001**
Smell sensation power score	98.300 (6.204)	33.680(35.297)	t=18.031 , ,p=0.001**
Smell questions	0.380 (0.647)	17.020 (4.121)	t=-3.881 ,p=0.001**
<b>Taste restoration</b>			
Salt	9.840 (0.486)	7.700 (6.160)	t=3.463 ,p=0.001**
Sugar	9.650 (1.290)	8.395 (1.344)	t=1.204 ,p=0.001**
Acidic	9.870 (0.393)	8.210 (1.308)	t=0.342 ,p=0.009*
Bitter	9.900 (0.44)	6.970 (5.540)	t=5.274 ,p=0.001**

**Figure1: Distribution of sequence of first recognized odors among the study group of patients (n=100).**



**Table 3: Multilinear regression of the relation between smell and taste restoration among the study group of patients:**

Items	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Salt	-2.852-	1.716	-.312-	-1.662	.098
Sugar	.152	1.922	.027	.079	.937
Acidic	-.423-	.878	-.140-	-.481	.631
Bitter	6.558	1.358	.668	4.828	0.001**

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