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Impact of COVID-19 on Taste and Smell Sensation among Population in Western Region of Saudi Arabia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: COVID-19 is pandemic disease caused by (SARS-CoV-2) first discovered in China in December 2019. It affects smell and taste sensation among large proportion of patients with COVID-19.

The aims of this study is to asses impact of COVID-19 on smell and taste sensation among COVID-19 patients in western region of Saudi Arabia.

Methods: The study design was descriptive cross sectional and our sample was be is 500 patients with COVID-19. The data was collected by using structured questionnaire which was distributed electronically and contain (sociodemographic data, diagnosed with COVID-19, status of smell and taste sensation…). The data was analyzed using SPSS program version 22.

Results: We were able to collect 404 responses to our questionnaire with response rate of 80.8 %. The mean age of total sample was 32.1 years with standard deviation of 14.34 years and 56.1 % of participants were females. Prevalence of weak or loss of smell or taste after infection with the emerging corona virus was 74.4%. Moreover, we found that patients who had weak or loss of smell or taste because of COVID-19 were older than those whose sense did not be affected. Moreover, non- Saudi Arabian were more affected by losing of smell and taste with significant difference (P=0.026). Considering medical conditions of patients, we found that patients with any medical conditions were associated with significantly higher incidence of losing smell and taste.

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Conclusion: The prevalence of losing smell and taste among patients with COVID-19 in our sample were high and was higher in older patients, male, Saudi arabian and those with other medical conditions. More investigations should be conducted to assess the same variables using retrospective study design.

Keywords: Western region; taste; smell; covid-19; pandemic, virus; Saudi Arabia.

1. INTRODUCTION

Corona virus disease 2019 (COVID-19) is a pandemic disease caused by (SARS-CoV-2) first discovered in China in December 2019. As of October 28, 2020, 43,766,712 reported cases and 1,163,459 total deaths around the world, with 345,631 cases and 5329 deaths in Saudi Arabia [1].

Loss of taste (dysgeusia or ageusia) and loss of smell (anosmia or hyposmia) appears to be one of COVID-19 symptoms which get affected due to neurovirulent SARS-CoV-2 infection attacks the gustatory or the olfactory systems [2].

Anosmia (total loss of smell) and hyposmia (reduce sense of smell) in addition to dysgeusia (distortion of taste) and ageusia (total loss of taste) was reported in many cases of COVID-19 as one of disease symptoms, although the proportion of people who came with these symptoms still unknown, we found many studies that shows olfactory dysfunction and gustatory dysfunction as one of symptoms in around half of COVID-19 patients and as primary prestation in around one-third of patients [2-6].

Early recognition of cases play important role to contain the disease which was priority of many government [4], which was difficult because rate of spread and verity of symptoms. Many studies found olfactory and gustatory dysfunction as an early symptom of the disease which may help to detect and manage patient and prevent spread of the disease [3-6]. The aims of this study are to asses impact of COVID-19 on smell and taste sensation among COVID-19 patients in western region of Saudi Arabia.

1.1 The Physiology of Senses of Smell and Taste

Smelling requires the intricate interaction between the nasal cavity which receives an odorant stimulus and its transmission via a series of interconnected neurons and brain structures which then compute various concomitant stimuli into the notion of a specific smell (Fig. 1).

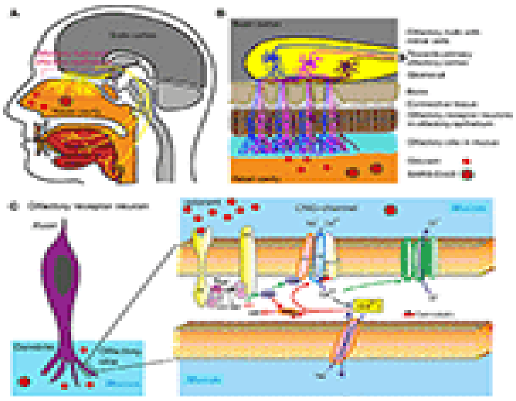

Fig. 1. Olfactory system. (A) Head sagittal section showing the olfactory and gustatory systems. (B) Olfactory bulb, olfactory epithelium with olfactory receptor neurons. (C) Left: Olfactory receptor neuron with olfactory cilia. Olfactory receptor neurons are bipolar neurons with a dendrite carrying a crust of sensory cilia. Right: Part of an isolated olfactory cilium illustrating processes upon odorant binding. The green arrows show activating, the red adapting processes. AC, Type III adenylate cyclase; AMP, adenosine monophosphate; cAMP, cyclic adenosine monophosphate; [Ca2+], intracellular Ca2+ concentration; CNG, cyclic nucleotide-gated ion channel; Golf, olfactory G protein; PDE, phosphodiesterase; R, odorant receptor

An odor is either a single molecule (e.g., hydrogen sulfide that smells of rotten eggs) or is composed of a combination of molecules termed odorants with specific chemical and structural properties which are recognized and bound with varying degrees of affinity by the so-called odorant receptors located in the nasal cavity [7] (Fig. 1A,B).

The mammalian odorant receptor (OR) gene family comprises more than 1,000 members, which represents the largest G-protein coupled receptor (GPCR) gene family in the mammalian genomes [8]. The human OR gene family encompasses 857 members [9] (https://genome.weizmann.ac.il/horde/). Thereof up to 391 encode functional olfactory receptors

(ORs), whereas 466 OR gene family members are pseudogenes, i.e., non-functional sections of DNA [9]. The Ca2+ influx in turn opens a Ca2+-activated Cl− channel leading to efflux of Cl−, further depolarizing the cell and triggering an action potential (Fig. 1C). Olfactory cells usually react only briefly to stimulation with odorants. Even if odorant molecules are continuously offered, the cells only react for a few seconds, then they become silent—they adapt. The adaptation itself is inhibited by various mediating processes that terminate the receptor flow. These processes are controlled by the Ca2+ ions which enter by cyclic nucleotide-gated ion channel (CNG) into the cilia. So this is a Ca2+-mediated feedback inhibition. The olfactory cells' CNG channels are continuously Calmodulin bound. If Ca2+ enters the cell, it binds to calmodulin and causes a change in conformation. This, in turn, leads to a closing of CNG channels: The signaling cascade is therefore interrupted. Calmodulin also mediates other adaptive mechanisms. The enzyme phosphodiesterase (PDE) is produced by Ca2+ /Calmodulin activation. Phosphodiesterase splits cAMP and reduces second messenger concentration (Fig. 1C) [10].

The reason for the large number of different odor receptors is to provide a system for discriminating between as many different odors as possible [11]. Odorants themselves are volatile substances, members of different chemical classes (e.g., alcohols, aldehydes, ketones, carboxylic acids, esters, aromatic, and sulfur-containing compounds). Upon binding and being activated by the specific odorants, all neurons expressing the same odorant receptor convene in deeper structures in the nasal cavity termed the glomeruli [12] (Fig. 1B). Because several receptor types are activated due to different chemical features of the odorant, several glomeruli are activated. The combination of glomeruli activation encodes the different chemical features of the odorant. From the glomeruli the stimulus is relayed to the olfactory bulb where olfactory neurons synapse with Mitral cells and from where the sensory information is relayed to parts of the brain such as olfactory cortex and other areas (Fig. 1B). The brain then puts the pieces of the activation pattern back together to identify and perceive the odorant. For a review on the physiology of smell see [13].

The senses of smell and taste are intrinsically linked. Flavor perception is an aggregation of taste and smell sensory information. During the process of mastication, the food mash releases odorants into the nasal cavity, which are registered through the odorant receptors. The tongue via specific receptors on taste cells that are bundled together to form taste buds can distinguish only among five distinct qualities of taste (sweet, salty, sour, bitter and umami), while the nose can distinguish among literally hundreds of thousands of odors [11].

The nose, or more precisely dendrites of olfactory neurons located in the olfactory epithelium, is a structure that exposes the brain to the outside world without the protection of the blood brain barrier [14]. Olfactory neurons (the neurons expressing odorant receptors) project directly to the olfactory bulb, which is a component of the central nervous system (CNS) without an intervening synapse (Fig. 1B). This special feature is exploited in the development of intra-nasal delivery tools to introduce therapeutic molecules that would otherwise not pass through the blood-brain barrier (BBB). Pathogens are using the same route to penetrate higher brain regions through olfactory neurons and the bulb. It has long been known that pathological infections of the brain can be caused via entry through the nasal mucosa. In one extreme measure this knowledge was applied to prevent infection: In Canada, in the 1930ies, the olfactory epithelia of school children was cauterized to prevent the spread of the polio virus [15]. More recently, the infectious prion protein was found in various central parts of the olfactory system including the primary olfactory cortices of patients with Creutzfeldt–Jakob disease. And, reminiscently to the ongoing early SARS-Cov2 studies, patients with Creutzfeldt–Jakob disease first observed anosmia and changes in taste and smell as symptoms [15,16].

The taste system is more resilient to injury than the olfactory system [17]. The reason for this is that multiple nerves transmit taste information to the brain: the facial nerve, the glossopharyngeal nerve and the Vagus nerve (Fig. 1A). They all supply gustatory information and help to protect an individual from a generalized loss of taste as a result of an isolated peripheral nerve injury [17]. Furthermore, the trigeminal system contributes to taste by sensing qualities such as spicy hot, tingling, burning, and cooling [18].

2. METHODOLOGY

2.1 Study Setting

The number of populations in western region of Saudi Arabia is 6893587 people and the number of who infected with Covid-19 is 84670.

2.2 Study Design

A descriptive cross – sectional study design was conducted to fill full the predetermined objectives.

2.3 Study Population

Male and female population who diagnosed as Covid-19 patients & agreed to participate in research.

Inclusion criteria will be:

1. Male and female Patients who diagnosed as COVID-19 patient.
2. Live in western region of Saudi Arabia

2.4 Exclusion Criteria

- Male and female population who don't diagnose with COVID-19
- Who don't live in western region of Saudi Arabia

2.5 Sample Size

The sample size was 500 COVID-19 male and female patients according to sampling formula.

2.6 Data Collection Tools

The data was collected from all patients with COVID-19 by well-designed structured Questionnaires. The structured questionnaire was distributed first on 20-30 COVID-19 patients as a pilot study to discover and overcome any difficulties in questionnaire questions. The structured questionnaire was distributed electronic (online) to collect data from COVID-19 patients. The structured questionnaire was contain sociodemographic data, diagnosed with covid-19, smell and taste sensation.

2.7 Statistical Analysis

Data was analyzed using SPSS software version 22. Baseline characteristics were compared using the Chi-square test and the Fisher's exact test for qualitative variables and the Student's t test or Wilcoxon rank sum test for quantitative variables. Also, mean and standard deviation were calculated. P values below 0.05 were considered statistically significant.

3. RESULTS

In this study, we were able to collect 404 responses to our questionnaire with response rate of 80.8%. The mean age of total sample was 32.1 years with standard deviation of 14.34 years and 56.1% of participants were females. Moreover, half of the participants were from Taif region while 27.6% were from Jeddah. Furthermore, 90.6% of participants were Saudi Arabia and 72.1% of them did not have any previous medical condition however, diabetic mellitus and hypertension were the main medical conditions with prevalence of 18.7% and 12.1% respectively (Table 1).

Table 1. Demographic factors of participants (N=404)

		Frequency	Percent
Age	Mean	32.1	
	SD	14.34	
Gender	Male	177	43.9%
	Female	226	56.1%
Residency	Taif	228	57.1%
	Makkah	43	10.8%
	Jeddah	116	29.1%
	Other	12	3.0%
Nationality	Saudi	365	90.6%
	Live in Saudi Arabia	38	9.4%
Medical condition	No medical condition	281	72.1%
	Asthma	36	9.2%
	Kidney failure	5	1.3%
	Heart condition	14	3.6%
	DM	73	18.7%
	Hypertension	47	12.1%

As reported by participants in this study, the most prevalent symptoms related to infection with COVID-19 was fever, headache and cough which reported by 64.9%, 60.4% and 50% of participants respectively. Vomiting, diarrhea and eye redness represented the lowest prevalent symptoms (Fig. 2).

In this study, we found that 48.1% of the sample had chronic loss or impairment of the sense of smell or taste while prevalence of weak or loss of smell or taste after infection with the emerging corona virus was 74.4%. According to Fig. 3, we found that most of patients had completely lost both of smell (36.4%) and taste (32.1%) while 32.4% and 29.6% of patients had partially decreased sense of taste and smell by 30%.

Moreover, 47.9% of participants indicated having symptoms of decreased taste and smell senses after presence of symptoms however, 15.8% before presence of other symptoms. After, taste and smell senses had been affected, half of the participants indicated that their conditions did not be affected however, 25% indicated that it became worsen. The duration of losing senses varied among patients without any predominance where 24.9% had symptoms for 1-2 weeks and 24.6 % for less than one week and 25.9% for more than one week. Moreover, 51.7% of participants indicated that sense of smell or taste had gradually returned completely.

Moreover, we found that patients who had weak or loss of smell or taste because of COVID-19 were older than those whose sense did not be affected. It seems that males were more affected by losing of senses of smell and taste however, this difference is not significant. Moreover, non-Saudi Arabian were more affected by losing of smell and taste with significant difference (P=0.026). Considering medical conditions of patients, we found that patients with any medical conditions were associated with significantly higher incidence of losing smell and taste. The main diseases related with high prevalence of losing senses were diabetic mellitus, hypertension ad asthma (Table 3).

Table 2. Characteristic of losing smell and taste senses

		Count	Column N %
Do you have a chronic loss or impairment of the sense of smell or taste?	Yes	194	48.1%
	No	209	51.9%
Have you noticed a weak or loss of smell or taste after infection with the emerging corona virus?	Yes	300	74.4%
	No	103	25.6%
When did you notice a loss of smell or taste?	Not related to symptoms	0	0.0%
	Before symptoms	48	15.8%
	With symptoms	110	36.3%
	After symptoms	145	47.9%
Has your health condition worsened or improved after noticing a loss of the sense of smell and taste?	Became worse	78	25.0%
	Not changed	162	51.9%
	Became better	72	23.1%
Loss of sense of smell and taste persisted for a period of:	Less than 1 week	76	24.6%
	1-2 week	77	24.9%
	2-3 week	36	11.7%
	3-4 week	40	12.9%
	More than 1 month	80	25.9%
How did the sense of smell or taste return to you after recovering from the virus infection?	It came back completely and suddenly	58	18.3%
	It has gradually returned completely	164	51.7%
	It came back lightly and so far it has not returned completely	95	30.0%
	She's still not	0	0.0%

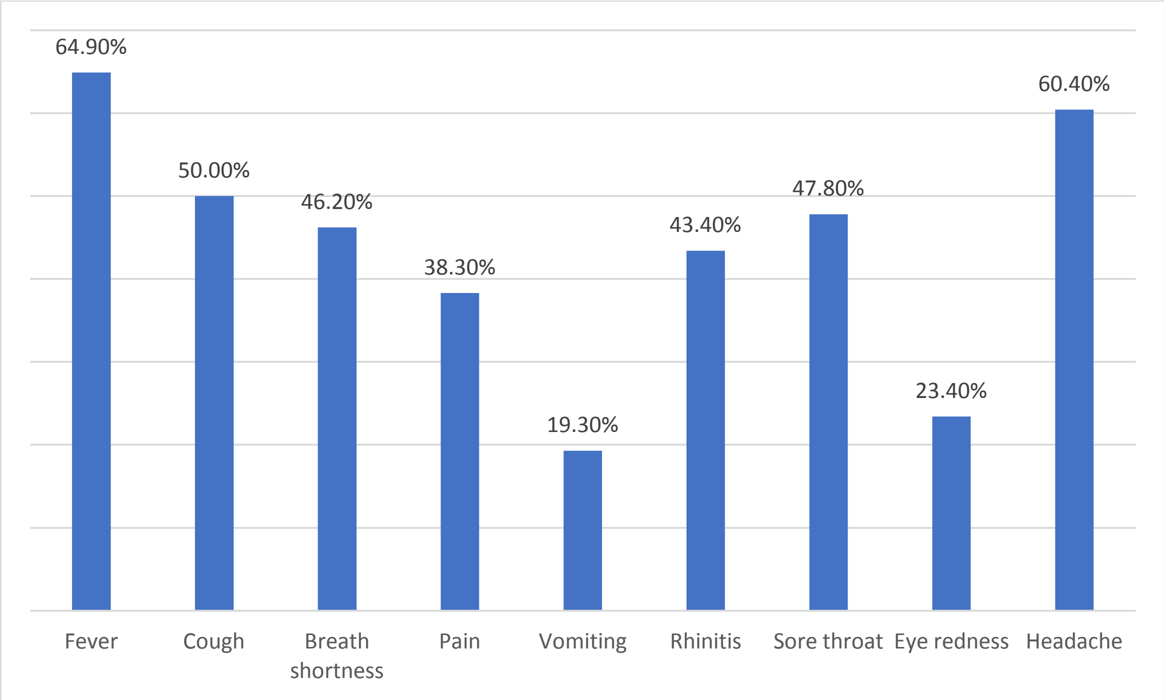

Fig. 2. The prevalence of some symptoms related to infection with COVID-19

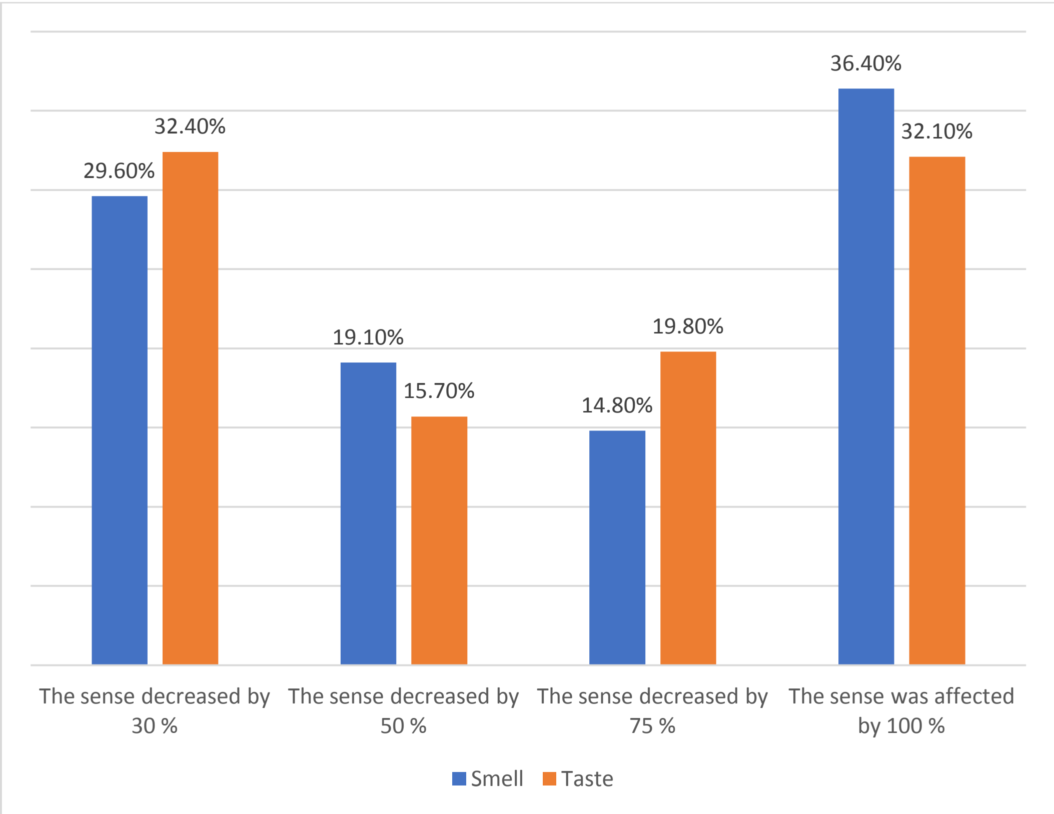

Fig. 3. The precent of the impact of COVID-19 on smell and taste senses

Table 3. The relation between losing of smell or taste and demographic factors

		Have you noticed a weak or loss of smell or taste after infection with the emerging corona virus?				
		Yes		No		
		Count	Row N %	Count	Row N %	P-value
Age		33.2		28.86		0.008*
Gender	Male	138	78.0%	39	22.0%	0.151
	Female	162	71.7%	64	28.3%	
Nationality	Saudi	266	72.9%	99	27.1%	0.026*
	Live in Saudi Arabia	34	89.5%	4	10.5%	
Medical condition	No medical condition	191	68.2 %	89	31.8 %	0.000*
	Asthma	32	88.9 %	4	11.1 %	0.037*
	Kidney failure	4	80 %	1	20 %	0.774
	Heart condition	13	92.9 %	1	7.1 %	0.108
	DM	68	93.2 %	5	6.8 %	0.000*
	Hypertension	43	91.5 %	4	8.5 %	0.004*

4. DISCUSSION

Since its inception more than a year ago, the coronavirus epidemic has had dire consequences. In addition to the increasing number of deaths, the current writing now exceeds 2.4 million 490,000 people in the United States, with a stunning economic impact between the direct cost of healthcare for COVID patients and the indirect cost to the global economy [19]. There has been an increasing number of reports of persistent symptoms caused by the virus and persistent medical comorbidities - so-called quality of the disease's consequences for life [20,21]. While previous reports showed that the majority of the smell and taste defects associated with COVID improve or disappear within weeks, about a third or more of them suffer from persistent deficiency [22-25]. Unfortunately, in patients with persistent odor deficiency, there are no definitive treatments to effectively restore function. A number of treatments have been explored specifically for impaired sense of smell after the virus, but current evidence only supports the potential benefits of olfactory training [26-28]. In this study, we aimed to to asses impact of COVID-19 on smell and taste sensation among COVID-19 patients in western region of Saudi Arabia.

In this study, we found that prevalence of weak or loss of smell or taste after infection with the emerging corona virus was 74.4%. Other studies reported lower prevalence of losing of smell and taste as study of Lee Y, who found that acute anosmia or ageusia was observed in 15.3% (488/3,191) patients in the early stage of COVID-19 and in 15.7% (367/2,342) patients with asymptomatic-to-mild disease severity [29]. Moreover, study of Al-Zaidi found that prevalence of losing of smell was 89.23% and taste loss reported by 83.08% of patients with COVID-19 [30] as well as other studies including study of Lechien J [31] and study of Vaira L [32]. In our study, incidence of losing of smell and taste was associated with older age which is in contract with many previous studies [29,33]. Moreover, in our study, we found that prevalence of losing of smell is higher in males without non-significant difference. Other studies as study of Al-Zaidi found that female's gender was more affected by losing of smell and taste than males with little difference [30] as well as some other studies [34,35]. Moreover, we found that loss of smell is associated with history of other medical conditions as diabetic mellites and hypertension which is in agreement with other studies [30,31].

Moreover, we found that most of patients had completely lost both of smell (36.4%) and taste (32.1%) while 32.4% and 29.6% of patients had partially decreased sense of taste and smell by 30%. In a study of Vaira L, 17.7% and 10.4% of patients had complete loss of smell and taste [32], the study also indicated that 60% had symptoms for less than one week which is in disagreement with our study.

This study had some limitations. The first limitation is depending on self-reported questionnaire which may lead to some personal bias where some participants may not be honest in answering the questions. Moreover, the questionnaire contained some questions which deal with previous experience which may cause some recall bias.

More investigations should be conducted to assess the same variables using retrospective study design.

5. CONCLUSION

This study was designed to assess the impact of COVID-19 on the sense of smell and taste. The prevalence of losing smell and taste among patients with COVID-19 in our sample were high and was higher in older patients, male, Saudi arabian and those with other medical conditions. More investigations should be conducted to assess the same variables using retrospective study design.

CONSENT

As per international standard or university standard, patient's consent has been collected and preserved by the authors.

ETHICAL APPROVAL

The research was approved by the ethical committee at Taif University and managers of included hospital. The collected data would be confidential and used only for scientific purposes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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