SJIF Impact Factor: 6.711

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

ISSN: 2457-0400
Volume: 8.
Issue: 3
Page N. 73-92
Year: 2024

Original Article www.wjahr.com

PROGNOSTIC SCORING SYSTEM OF ANOSMIA IN COVID-19 PATIENTS

Lubna Mohammed Enad*[1] and Prof. Ehab Taha Yaseen[2]

[1]M.B.Ch. B./ AL-Yarmouk Teaching Hospital.
[2]F.I.C.M.S, F.R.C.S. Glasg. College of Medicine / Mustansiriyah University.

Article Received date: 12 January 2024 **Article Revised date:** 02 February 2024 **Article Accepted date:** 22 February 2024

***Corresponding Author: Lubna Mohammed Enad**
M.B.Ch. B./ AL-Yarmouk Teaching Hospital.

ABSTRACT

Background: Anosmia is one of the most frequent encountered symptom in the last two years due to COVID-19 infection, each patient had a different outcome. This study was an attempt to identify the predictors of prognosis of anosmia for each patient according to specific criteria gathered in one scoring system. **Aim of the study:** To create a specific scoring system to predict the prognosis of anosmia in covid-19 patients. **Patients and method:** This descriptive, prospective cross-sectional study was conducted at Otolaryngology Outpatient Clinic of Al-Yarmouk Teaching Hospital between (October 2020- October 2021), 100 patients with anosmia due to COVID-19 infection of both gender whose age >15 years with ATT(alcohol threshold test) between 4-6 have enrolled in this study, while patients with other forms of olfactory dysfunction (hyposmia , cacosmia) due to COVID-19 infection or with pre-existing smell problem, or has nasal pathology (such as polyposis, severe septal deviation…etc.) had excluded from the study. a detailed history (with psychological assessment had been done using Distress Thermometer score), full ENT examination and olfactory test (using ATT) were done. All patients have been followed up for 6 months using ATT to assess prognosis. **Results:** Age range was between (18-62) years with the mean age of 36.5±11.9. The study showed that age group ≥ 50 years, male gender, smoking, patients with associated comorbidities, low socioeconomic status and long duration of anosmia have affected the prognosis adversely. In addition to that patients who had mild form of COVID-19 infection and patients with devastating psychological distress have more chances to develop persistent anosmia. Lastly, patients with higher initial scores of ATT predicted lower improvement. **Conclusion:** Certain parameters (e.g. age, gender, smoking, duration of anosmia, etc.…) found to affect the prognosis either in a positive or negative way. Using these parameters, we create a scoring system to predict the prognosis of anosmia due to COVID-19 infection.

KEYWORDS: Anosmia, Alkohol threshold test, COVID. 19, scoring system.

INTRODUCTION

The impact of sense of smell on life

A normal sense of smell plays a vital role in the enjoyment of food and detection of environmental hazards, some occupations depend heavily on an intact sense of smell (e.g. cooks and wine tasters).

Olfactory perception has a strong association with memory and emotion, owing to projections into the limbic system. Olfactory symptoms may also be the primary manifestation of serious intracranial pathology.[1]

It's loss can cause significant psychological disturbance and also adversely affect nutrition, especially in elderly.

The sense of smell assists in the digestion process by triggering normal gastrointestinal secretions and influences the flavors of food.[2]

Although humans can survive without olfaction, the negative impact on quality of life has been well documented with some approaching clinical depression.[3]

Anatomy

The nasal cavity is the conduit for odors to reach the specialized neuroepithelium that converts binding of odorant molecules by receptors into electrical signals that extend to the brain.[3]

Nasal cavity

The nasal cavity extends from the external nares to the posterior choanae, where it becomes continuous with the nasopharynx. The nasal cavity is divided into two passage ways by the nasal septum. each side consists of a floor, roof, lateral and medial wall.

The lining epithelium of the nasal cavity

Three different types of epithelium within the nasal cavity, these are

1. Squamous epithelium (nasal vestibule)
2. Olfactory epithelium (superior septum, superior turbinate and upper aspect of the middle turbinate)
3. Respiratory epithelium (remainder of nasal cavity).[4]

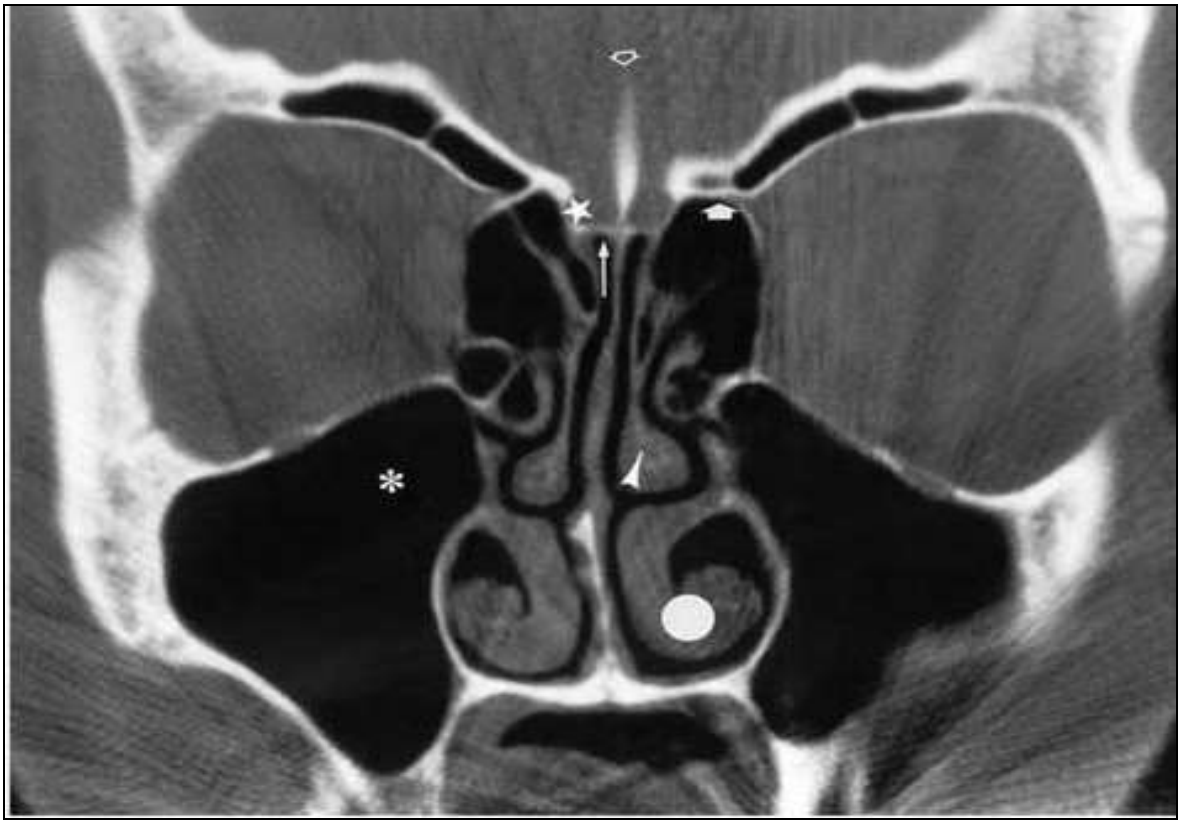


Figure (1-1): CT scan of paranasal sinuses and associated nasal structures. The * is within the right maxillary sinus, below the right eye. The inferior portion of the middle turbinate is indicated by the white arrowhead and the inferior turbinate by the circle. Note the attachment of the middle turbinate to the cribriform above. A short fat white arrow is in the left anterior ethmoid sinus and points to the anterior ethmoidal neurovascular bundle as it emerges from the left orbit and courses along the roof of the ethmoid. The central small open arrow is located in the anterior cranial fossa directly above the bony crista galli. The long thin arrow situated with the olfactory cleft points to the cribriform plate. The five-pointed star in the right olfactory fossa is adjacent to the vertical lamella of the cribriform plate.[2]

Innervation

Four neural systems within the human nose

1. The main olfactory system (cranial neve 1) mediates common odour sensations (e.g. rose, chocolate)
2. The accessory olfactory system (i.e., the vomeronasal system) is nonfunctional in humans.
3. The trigeminal somatosensory system (CN v) mediates both chemical and non-chemical stimuli in the form of somatosensory sensations (e.g., irritation, burning, cooling, tickling, touch). Is also responsible for inducing reflexive responses such as secretion of mucus and halting of inhalation that help to prevent chemically induced or thermally induced damage to the linings of the nose and lungs.
4. The nervus terminalis or terminal nerve (CN 0) it has been suggested by some that it may be a vestige of an ancient nerve whose function was lost or superseded by other parts of the nervous system.[2]

Olfactory neuroepithelium

It is a pseudostratified columnar epithelium supported by a highly vascularized lamina propria, throughout life, islands of respiratory like epithelial metaplasia appear within the epithelium, as a result of cumulative viral, bacterial and other insults.[2] It is located in the superior /posterior most aspect of the nasal cavity, the overall area averages 1 to 2 cm in adults, but has larger area in infants.[3]

In adults at least six distinct classes of cells can be identified within the neuroepithelium:

1. The bipolar sensory receptor neuron

2. The supporting cell
3. The duct cell of Bowman's glands
4. The microvillar cell
5. The horizontal (dark) basal cells
6. The globose (light) basal cells.[2]

Olfactory receptor neurons

They are bipolar and has club shaped peripheral knob that bears the cilia,[5] the number of olfactory receptor cells exceeds that of any other sensory system except vision, approximately 6 million receptor cell axons ultimately coalesce into 30-50 fascicles, termed the olfactory fila, which transverse the cribriform plate and pia matter to synapse with second order neurons within the glomeruli of the olfactory bulb. The ORN primarily use the neurotransmitter glutamate to excite OB neurons.[2]

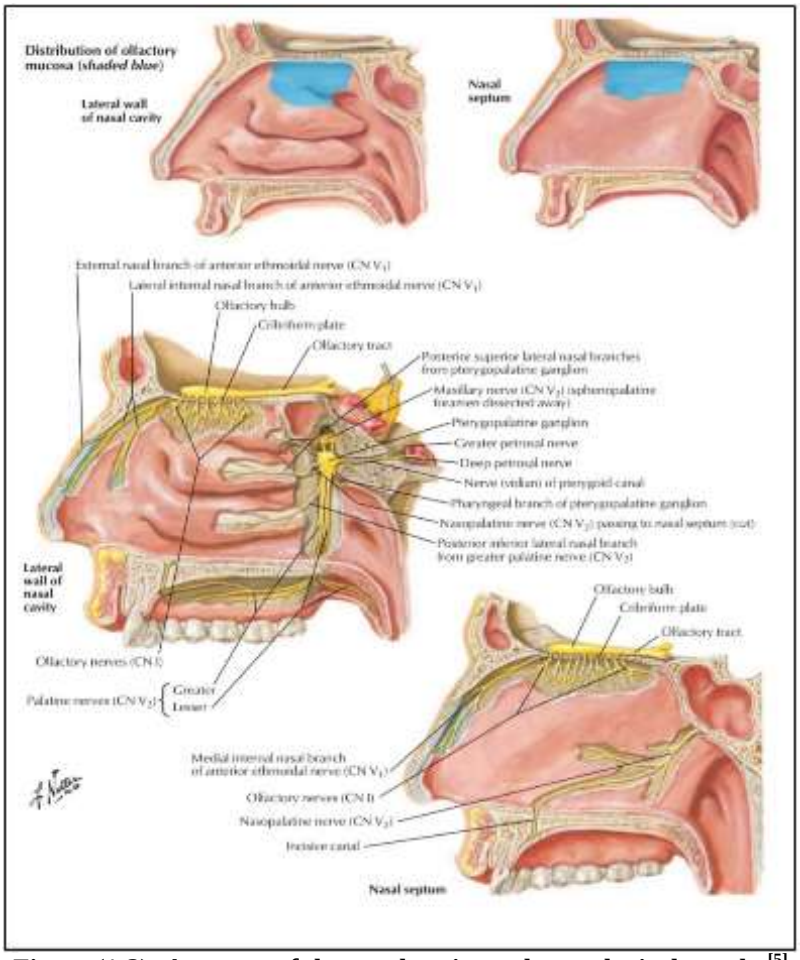


Figure (1-2): Anatomy of the nasal cavity and neurological supply.[5]

The olfactory cleft; is an opening of approximately 1 mm wide that sits 7 cm deep to the nostril, harbours the majority of the olfactory neuroepithelium which is difficult to observe even by modern endoscopic techniques.[2]

The olfactory bulb

It lies at the base of the frontal cortex in the anterior fossa, it serves as the first relay station in the olfactory pathway, where the primary olfactory neurons synapse with secondary neurons. These synapses and their post synaptic partners form dense aggregates called glomeruli.[6]

A given receptor projects to only one glomerulus and any given glomerulus appears to receive most of its input from a restricted region of the epithelium. The main afferent second order neurons are termed mitral and tufted cells.

The mitral and tufted cells, in turn send collaterals that synapse within the periglomerular and external plexiform layers, resulting in "reverberating" circuits in which negative and positive feedback occur.

It is generally believed that the olfactory system is unique among sensory systems in that information from the sensory receptors is sent directly, and primarily ipsilaterally into cortical regions without synapsing in the thalamus. however, some cortical projections from primary to secondary (i.e. Orbitofrontal) cortex do ultimately relay through the thalamus, and there are some contralateral projections via the anterior commissure.[2]

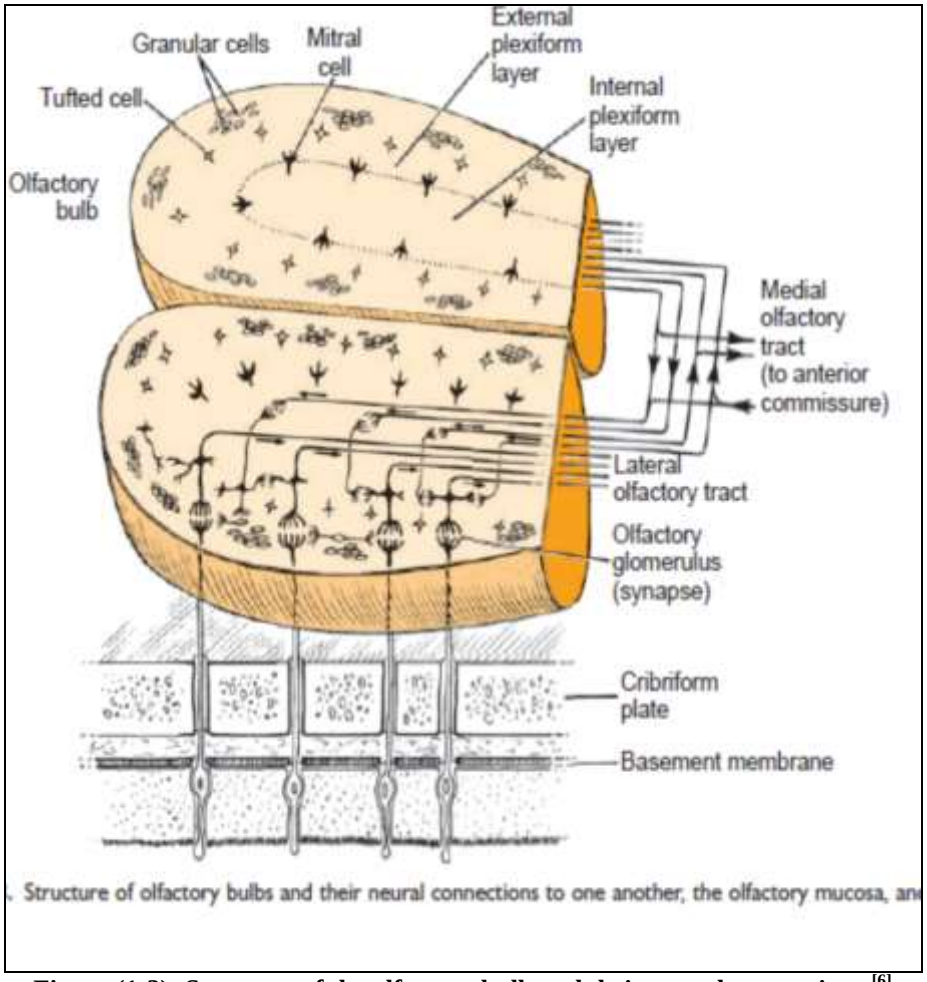


Figure (1-3): Structure of the olfactory bulb and their neural connections.[6]

Physiology of olfaction

Olfaction is mediated via cranial nerves 1 (olfactory) and V (trigeminal). the olfactory nerve is responsible for identification of odorants via specialized olfactory epithelium, and the trigeminal nerve is responsible for the perception of chemical irritants and detection of pungency.[1]

While most of air stream coming into the nose is shunted through the passages around the inferior and middle turbinates and along the septal wall, only 10-15 % of air reaches the olfactory neuroepithelium.[2]

Although molecules can reach the olfactory cleft by diffusion, essentially olfaction needs some type of nasal airflow, usually as a part of inhalation (orthonasal flow). During eating a (retronasal flow) of odorants stimulates the olfactory receptors at the top of the nose and contributes greatly to the flavor of food.[2]

Olfactory neuroepithelium and neural transduction

Before neural transduction can begin, odourants must;

1. Enter the nose during either active (e.g. sniffing) or passive (e.g. diffusion) processes.
2. Pass through the olfactory cleft.
3. Move from the air phase into the largely aqueous phase of the olfactory mucus.

During mastication odourants from the oral cavity actively move into the nasal cavity via the nasopharynx. Mucus is important in that it ensures a moist and protective environment for the olfactory neuroepithelium and aids in dispersing odourants to the olfactory receptors. From the mucus, odorous chemicals either diffuse or are transported by specialized proteins to the receptors.[2]

The olfactory receptor neurons primarily use the neurotransmitter glutamate to excite OB neurons, the process of actually transforming the chemical energy of receptor binding into a neural signal requires a complex cascade of events some of which involves the activation of G proteins.[2]

In humans receptor to glomeruli ratio is calculated to be on the order of 1:16, this receptor specific pattern is the basis of an odourant map, whereby an odourant stimulates a subset of olfactory neurons that in turn activate a specific set of glomeruli in the olfactory bulb. Therefore, an odor is coded by the multiple receptor neurons it stimulates and in turn the resulting unique pattern of glomerular activation is transmitted in unclear fashion to higher brain centers and perceived as a smell.[3]

Primary olfactory cortex is represented by the prepyriform and periamygdaloid areas of the medial aspect of the temporal lobe and is responsible for primary odour identification. the amygdala and entorhinal areas of the pyriform lobe make up the secondary olfactory cortex.

Projections from the olfactory pathways to the thalamus, the forebrain and the limbic system are thought to mediate the association between odour perception, memory and emotional stimuli.[1]

Classification of olfactory disorders

Olfactory disorders are classified according to standard schemata

1. Anosmia; inability to detect qualitative olfactory sensations (absence of smell function).
2. Partial anosmia; an ability to perceive some, but not all odours.
3. Hyposmia or microsmia; decreased sensitivity to odours.
4. Hyperosmia; increased sensitivity to common odours.
5. Cacosmia or parosmia; distorted smell perception to odour stimulation.
6. Phantosmia; dysmosic sensation perceived in the absence of an odour stimulus.
7. Olfactory agnosia; an inability to recognize an odour sensation, even though olfactory processing, language and general intellectual functions are essentially intact.
8. Heterosmia; a condition where all odours smell the same.
9. Presbyosmia; a decline in smell sense with age
10. Osmophobia; a fear of certain smells.[2]

Causes of olfactory dysfunction

In general, loss of olfactory function can be subdivided into two classes;

1. Conductive or transport impairments from obstruction of the nasal passages (e.g. chronic nasal inflammation, polyposis, etc.)
2. Sensorineural impairment from damage to the olfactory neuroepithelium, central tracts, and connections (e.g. viruses, airborne toxins, tumours, seizures, etc.)

In some circumstances, it is difficult to classify an olfactory disorder into one of these classes, since blockage of airflow to the receptors and damage to to the receptors or other elements of olfactory epithelium can be simultaneously involved.

Clinical evaluation of smell function

History

Several focused questions can help establish the nature of the olfactory disturbance;

1. Onset (sudden olfactory loss can be consistent with possible head trauma, ischemia, infection or psychiatric condition) while (gradual loss may indicate a progressive and obstructive lesion in or around the nasosinus region.
2. Duration of impairment
3. Pattern of occurrence (intermittent loss or persistent)
4. Unilateral or bilateral
5. Any associated nasal obstruction, discharge, headache
6. Drug history
7. Medical history
8. Family history
9. History of smoking, cocaine or ethanol abuse.[2]

Examination

This should include a general assessment of the head and neck and more detailed otolaryngological and neurological examinations.

We start by inspection for any signs of trauma such as scars, healing wounds or distorted nasal architecture.

Inspection of nasal passages by simple nasal speculum to view the peripheral nasal cavity for signs of polyps, congestion, deviation of septum or inflammation.

Nasal endoscopy employing both flexible and rigid scopes is needed to ensure a thorough assessment of the olfactory meatal area.

Neurological evaluation should focus on cranial nerve function with particular attention to the optic nerve, trigeminal nerve and facial nerve.[2]

Investigations

Olfactory testing

Three criteria have been described as necessary to maximize odour recognition in olfactory testing

1. Odours must be familiar to the patient.
2. There should be a long standing association between the odour and it's name.
3. Help should be given to recall the name.

Threshold testing identifies the concentration at which an odorant is reliably perceived, a simple threshold test can be performed using butanol or phenylethyl alcohol, which are used because of their minimal trigeminal stimulation effects.

Varying dilutions of the olfactory stimulant are presented to the patient in a random order. The lowest concentration that can be perceived is documented.

This is repeated until the lowest concentration that is reliably perceived is determined.

Formal olfactory testing allows monitoring of the progression or resolution of dysosmia, particularly following surgical or other therapeutic intervention.[1]

Electrophysiological methods
These are available to assess olfactory function, the electro-olfactogram (EOG) measures the electrical potential evoked in the olfactory mucosa when an odourant is presented in the nasal cavity and reflects the generator potential of the olfactory neurons. The technique has a role in the investigation of olfactory processing but it is technically demanding and has high inter-individual response variability.

Finally, olfactory function can be assessed using the retronasal route by placing taste powders, in the mouth and using forced choice questionnaires to identify the powders. given a truly anosmic patient would only be able to detect sweet, sour, bitter, salty tastes.[1]

Imaging
There are multiple ways of medically imaging patients with smell disturbance.

MRI (magnetic resonance imaging) is better to evaluate soft tissue, and is the technique of choice to image the olfactory bulbs, tracts, and cortical parenchyma.

Computed tomography (CT), on other hand, has proven to be the most useful and cost effective technique to assess sinonasal tract inflammatory disorders and is superior to MRI in the evaluation of the bony structures (e.g. ethmoid, cribriform plate, olfactory cleft).[2]

COVID -19 DISEASE[7]
Coronavirus disease (COVID 19) is an infectious disease caused by the SARS-CoV-2 virus.

Most people infected with the virus will experience mild to moderate respiratory illness and recover without requiring special treatment. However, some will become seriously ill and require medical attention. Older people and those with underlying medical conditions like cardiovascular disease, diabetes, chronic respiratory disease, or cancer are more likely to develop serious illness. Anyone can get sick with COVID-19 and become seriously ill or die at any age.

The virus can spread from an infected person's mouth or nose in small liquid particles when they cough, sneeze, speak, sing or breathe. These particles range from larger respiratory droplets to smaller aerosols.

Virology
Coronavirus virology — Coronaviruses are enveloped positive-stranded RNA viruses.

Epidemiology
Geographic distribution — Since the first reports of cases from Wuhan, a city in the Hubei Province of China, at the end of 2019, cases have been reported in all continents.

Route of person-to-person transmission — Direct person-to-person respiratory transmission is the primary means of transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It is thought to occur mainly through close-range contact (i.e., within approximately six feet or two meters) via respiratory particles; virus released in the respiratory secretions when a person with infection coughs, sneezes, or talks can infect another person if it is inhaled or makes direct contact with the mucous membranes.

Symptoms
People with COVID-19 have had a wide range of symptoms reported – ranging from mild symptoms to severe illness. Symptoms may appear 2-14 days after exposure to the virus. Anyone can have mild to severe symptoms. People with these symptoms may have COVID-19

- Fever or chills
- Cough
- Shortness of breath or difficulty breathing
- Fatigue
- Muscle or body aches
- Headache
- New loss of taste or smell
- Sore throat
- Congestion or runny nose
- Nausea or vomiting
- Diarrhea

Incubation period; varies from 2 to 14 days.

Investigations
Real time reverse transcription polymerase chain reaction (RT-PCR).

Positive result will confirm the diagnosis in addition to positive CT scan finding.

Classification of COVID-19 infection according to severity
Based on the severity of presenting illness that includes clinical symptoms, laboratory and radiographic abnormalities, hemodynamics, and organ function. The National Institutes of Health (NIH) issued guidelines that classify COVID-19 into five distinct types.

- **Asymptomatic or Presymptomatic Infection**: Individuals with positive SARS-CoV-2 test without any clinical symptoms consistent with COVID-19.
- **Mild illness**: Individuals who have any symptoms of COVID-19 such as fever, cough, sore throat, malaise, headache, muscle pain, nausea, vomiting, diarrhea, anosmia, or dysgeusia but without shortness of breath or abnormal chest imaging
- **Moderate illness**: Individuals who have clinical symptoms or radiologic evidence of lower respiratory tract disease and who have oxygen saturation (SpO2) ≥ 94% on room air

- **Severe illness**: Individuals who have (SpO2) ≤ 94% on room air; a ratio of partial pressure of arterial oxygen to fraction of inspired oxygen, (PaO2/FiO2) <300 with marked tachypnea with respiratory frequency >30 breaths/min or lung infiltrates >50%.
- **Critical illness**: Individuals who have acute respiratory failure, septic shock, and/or multiple organ dysfunction. Patients with severe COVID-19 illness may become critically ill with the development of acute respiratory distress syndrome (ARDS) which tends to occur approximately one week after the onset of symptoms.[8]

SARS-CoV-2 entry mechanism in the host organism

SARS-CoV-2 uses its spike protein to bind to ACE2, and this link is formed with the aid of transmembrane serine protease 2 (TMPRSS2). TMPRSS2 is a protease present on the surface of the target cell, which plays an important role in the virus entry pathway, as it cleaves a specific point of the spike protein, thus allowing a connection between the C-terminal domain (CTD) of Pico protein and ACE2. Recent studies have shown that another transmembrane protease, TMPRSS4, is able to perform the same function as TMPRSS2, therefore being an alternative protease for SARS-CoV-2. In addition to transmembrane proteases, there is also the intracellular protease known as Cathepsin-L, which can also be responsible for the entry of the virus.

Compared to SARS-CoV, beside the greater stability of hotspots, SARS-CoV-2 CTD also has more van der Waals bonds, hence it binds with greater affinity to ACE2. Some tissues express ACE2, such as lungs, heart, oral and nasal mucosa, testicles, intestines, lymphoid organs and brain, as a result, they are more susceptible to the invasion of SARS-CoV-2.

Nevertheless, the main entry route inside the organism is through the nasal mucosa.[9]

Possible mechanism of anosmia in COVID-19 infection

Conductive anosmia occurs due to nasal obstruction, which is common in many viruses, and may be accompanied by rhinorrhea and rhinitis symptoms.

Studies suggest however that the loss of smell in COVID-19 occurs, in most cases, regardless of these symptoms. Thus, this hypothesis, in the case of SARS-CoV-2, can be ruled out as the main mechanism causing anosmia. Injury to the olfactory epithelium is the mechanism identified as the most likely cause of olfactory disorders caused by SARS-CoV-2, which can be aggravated by damage to the central nervous system.[9]

Injury to the olfactory epithelium

Analyzes based on RNA sequencing showed considerable expression of ACE2 and TMPRSS2 in Sustentacular cells (SUS), Bowman cells and a small fraction in stem cells. In contrast, the presence of ACE2 in olfactory receptor neurons has not been confirmed.

It is known that the virus invades cells through ACE2 in conjunction with TMPRSS2, that said, SARS-CoV-2 has as its main target non-neuronal cells. Moreover, the average recovery of smell is 2 weeks, a time span not compatable with the regeneration of neuronal cells, substantiates this hypothesis.

In experiments with hamsters, infected with SARS-CoV-2 via nasal instillation, massive damage to the olfactory epithelium was found, only two days after infection. On the fourth day after infection, most of the epithelium had disappeared. After fourteen days, the epithelium showed signs of recovery, but it had not yet returned to normal. It was verified that regions where the damage was more intense, the axons of the olfactory receptor neurons were practically in contact with the external environment. The main observations in this experiment were: the infection and desquamation of the olfactory epithelium, the preference for the virus for sustentacular cells rather than neuronal cells and the intense recruitment of immune cells.

Damage to sustentacular cells and Bowman cells directly affects the perception of odors, not by transmission of the virus to olfactory receptor neurons (ORN), but by impairing some of its functions that are necessary for the functional metabolism of these neurons. Damage to Bowman cells would cause an interruption in the production of nasal mucus, necessary for the dissolution of odorous particles. Moreover, damage to sustentacular cells would result in a suppression of the removal of volatile products, through the cytochrome P450 route, a halt in the endocytosis of protein complexes that bind to odorants, after the transduction of signals to the ORNs and interruption of the supply of additional glucose to the cilia of the ORN and a electrolyte and water imbalance. For this reason, damage to sustentacular cells would certainly influence odor perception, characteristic of anosmia and hyposmia. Furthermore, the infection of the sustentacular cells also generates a loss of the cilia of the olfactory receptors, which is illustrated in the impossibility of transmitting the odorous stimulus and, thus, detecting smells. MRI studies exhibit a correlation between bulb size and olfactory dysfunction, reflecting a lower sensory activity in the olfactory epithelium, which leads to less synaptogenesis in the olfactory bulb, decreasing its volume. This reduction in olfactory epithelial activity is a result of damage to non-neuronal cells, further corroborating this hypothesis. The re-establishment of normosmia would be due to the rapid regeneration of sustaining cells from stem cells.

Olfactory epithelium damage can be aggravated by an inflammatory response, leading to cell death, known as pyroptosis. The immune system is activated after pathogen recognition, causing an increase in the secretion of pro-inflammatory cytokines and

chemokines: Interleukin-6 (IL-6), Interferon gamma (IFN-γ), chemoattractive proteins from monocyte chemoattractant protein-1 (MCP-1) and interferon-inducible protein 10 (IP-10). These cytokines are indicative of a reaction more focused on the recruitment of monocytes and T-lymphocytes. In addition, a study demonstrated a possible correlation between anosmia and IL-6 levels. IL-6 induces the expression of several acute-phase proteins, among them C-reactive protein, serum amyloid A, α1-antiquimotripsin, haptoglobin, fibrinogen and complement components.

Therefore, patients with higher levels of IL-6 may be associated with more intense cases of olfactory disorders. The high production of cytokines can provoke olfactory neurons death. The olfactory epithelial neurons replacement by basal stem cells requires a longer recovery time, thus explaining persistent anosmia cases.

Loss of smell may be due to olfactory bulb inflammation triggered by virus infection. SARS-CoV has the ability to infect the central nervous system through the synapses, using the olfactory nerve afferents to reach the olfactory bulb, raising the possibility of SARS-CoV-2 utilizing this infection path as well.[9]

Alcohol threshold test (ATT)

This test is a modification of Davidson's alcohol sniff test. In which, Ethyl alcohol was diluted in saline solutions with five different concentrations (10%, 25%, 50%, 70% and 96%). It was prepared by using 100 ml saline bags following the dilutions included in Table 1-1.[10]

The ATT is rapidly administered, reliable, and uses odor material that is readily available in the medical environment. It provides a measure of cranial nerve I function in situations where no other functional measure is feasible.

The alcohol was chosen as the stimulus for the ATT for several reasons. It is readily available in hospitals and clinics. Alcohols are ideally suited for functional testing of smell because only at high concentrations do they exert trigeminal impact. Odor thresholds for alcohol are 2 or more orders of magnitude lower than trigeminal thresholds for the same stimuli. Thus, in the ATT procedure, where the concentration of the stimulus at the nose will be related to the distance of the alcohol pad from the nose, normosmic and hyposmic subjects will detect the alcohol on the basis of its odor well before it has trigeminal impact. Because anosmics cannot detect the odor of alcohol, they must rely on trigeminal reactivity to detect the presence of alcohol and will do so only when it is extremely close to the nose.

Because it is meant to be a rapid screening instrument, the protocol for the ATT has been developed for bilateral testing. It can be readily adapted for unilateral testing of patients whose clinical history suggests unilateral deficits simply by occluding one nostril while testing the other.[11]

For each patient, they prepared five different gauzes soaked with 3–5 ml of the solution (according to the gauze size). It was presented to the patient in a solid surface. Participants were instructed to smell the gauze as many times as they needed, hold it at 3 cm of their nose and try to identify the one with the lowest concentration. This distance is estimated to be localized at the labiomental fold to avoid trigeminal irritation. Participants were instructed to smell the gauze in no particular order. The weakest concentration of alcohol a participant could detect was recorded as a threshold score (TS) of 1, 2, 3, 4 and 5 for the 10%, 25%, 50%, 70% and 96% alcohol concentrations, respectively. It was not a forced choice answer. If the participant was not able to detect 96% alcohol, a TS of 6 was recorded. Patients with severe olfactory loss (anosmia) found to have threshold scores of 4, 5 or 6.

The alcohol threshold test as a useful tool for SARS-CoV-2 screening. It is a simple, quick and low-cost method to assess olfactory loss. It can be easily performed without any training and in almost any environment.

People with suspected SARS-CoV-2 (exposure or mild symptoms) can be easily checked with the alcohol threshold test. If the results are pathological, they should undergo further SARS-CoV-2 testing.[10]

Table 1-1: Alcohol threshold test preparation values.[10]

	10%	25%	50%	70%	96%
Alcohol 70%					
Alcohol (ml)	14.3	35.7	71.4	100	Not applicable
Saline (ml)	85.7	64.3	28.6	0	Not applicable
Alcohol 96%					
Alcohol (ml)	10.4	26.0	52.1	72.9	100
Saline (ml)	89.6	74.0	47.9	37.1	0

Reference values to prepare 100 ml alcohol dilutions
Upper table: dilutions using 70% alcohol/Lower table: dilutions using 96% alcohol.

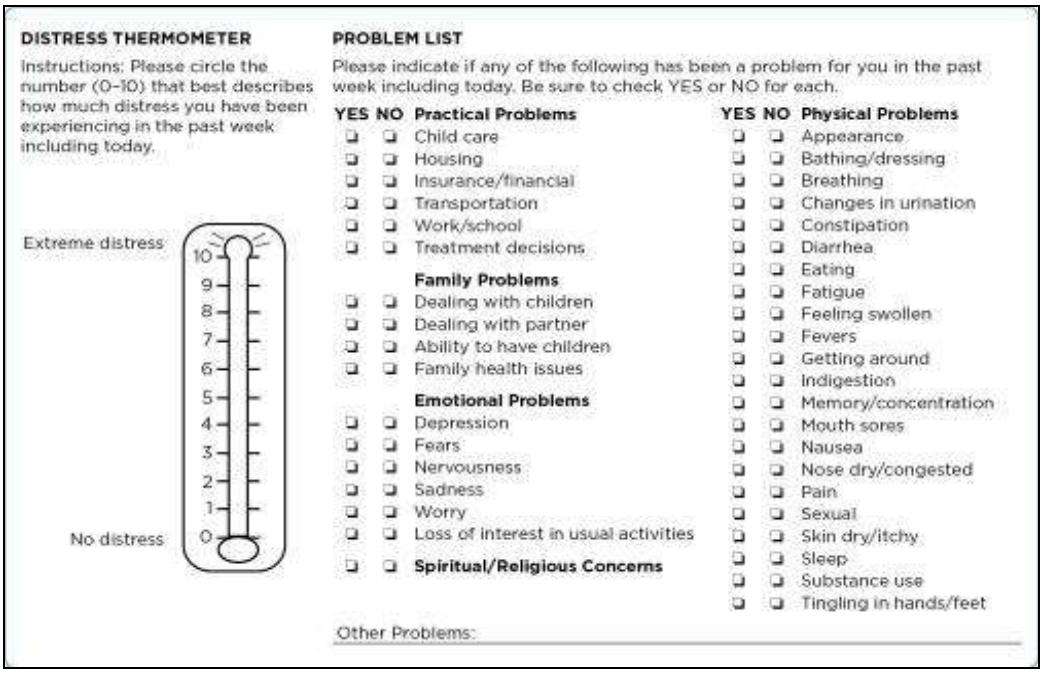
Distress Thermometer Score

The Distress Thermometer (DT) was developed as a simple tool to effectively screen for symptoms of psychological distress. The instrument is a self-reported

tool using a 0-to-10 rating scale. Additionally, the patient is prompted to identify sources of distress using a Problem List. The DT has demonstrated adequate reliability and has been translated into numerous languages. The tool is easy to administer and empowers the clinician to facilitate appropriate psychosocial support and referrals.[12]

Distress was rated as mild (DT scores of 4 and 5), moderate (DT scores of 6 and 7), and severe (DT scores ≥8).[13]

Table 1-2: Distress thermometer score.



Aim of the study

To create a specific scoring system to predict the prognosis of anosmia in COVID-19 patients.

PATIENTS AND METHOD

Study setting

This study has been conducted at Otolaryngology Outpatient Clinic at Al- Yarmouk Teaching Hospital between October 2020 and October 2021.

Study design

A prospective, cross sectional, descriptive study.

Patient selection

After taking an oral consent, 135 patients who fulfilled the inclusion criteria have enrolled in this study, however 35 patients have lost follow up and excluded from the study.

Study criteria

Inclusion criteria

1-Anosmia due to previous covid 19 infection (confirmed by previous positive PCR).
2-Both gender
3-Age >15 years
4-ATT 4-6 (threshold score ranging from 4-6)

Exclusion criteria

1-Patient has other forms of olfactory dysfunction due to COVID-19 infection.
2-Pre-existing smell problem
3-Patient has nasal pathology (such as polyposis, severe septal deviation…etc.)

Patient assessment

History

A detailed history has been taken, starting from the onset of anosmia, duration, history of associated nasal symptoms, social history, past medical and past surgical history, general symptoms of covid 19 infection, any history of previous nasal surgery, previous head trauma, history of receiving previous treatment, ending with psychological disturbances due to anosmia (the psychological distress had been assessed using the Distress Thermometer score).

Examination

A general examination and comprehensive nasal examination has been done for each patient, anterior rhinoscopy using a head light and killian's nasal speculum,

Nasal patency test, and nasal endoscopic examination using zero degree Hopkin's Rod scope 2.7 mm for full assessment of the nasal cavity and post nasal space. (examination done using full protection measures).

Olfactory assessment

Using alcohol threshold test (ATT),[8]

The weakest concentration of alcohol a patient could detect was recorded as a threshold score of 1,2,3,4,5 for 10%, 25%, 50%, 70 % and 96 % alcohol concentration respectively.

It was not a forced choice answer, if the patient was not able to detect 96% alcohol, a threshold score of 6 was recorded.

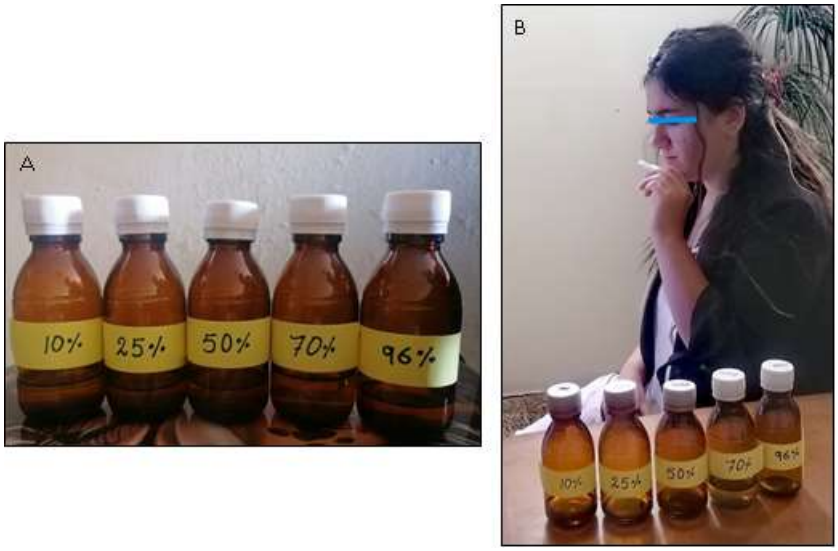


Figure 2-1: A) Alcohol threshold test ranging from 10% to 96% B) Alcohol threshold test on a patient Follow up.

All the patients have been followed up monthly after the first visit for 6 months, in each visit olfactory assessment using alcohol threshold test was done, to see if there is any improvement in the patient condition.

They were divided in to three groups according to their prognosis;

1. Patients with persistent anosmia; those whose ATT result remain the same during the whole follow up period.
2. Partially improved; those whose their ATT result have improved by more than one degree but not totally cured.
3. Cured; those whose smell function return to normal and their ATT results are completely normal.

Questionnaire
Name
Age
Gender
Occupation
Education
Phone number
Date of presentation
Socioeconomic status
high middle low

History
Onset of anosmia: sudden gradual
Duration of anosmia: is there any other nasal symptoms: yes no, what are they: associated gustatory symptoms: yes no smoking hx: positive negative medical hx does the patient receive any treatment for his anosmia: yes no -if the answer is yes, what are they;
Is there any improvement over time?

Yes no changed into other type
The effect of anosmia on patient life: (using The Distress Thermometer score) -devastating moderate mild.
How much was your oxygen saturation during your active covid 19 infection.
Were your symptoms: severe moderate mild

Nasal examination findings
Alcohol threshold test

1	2	3	4	5	6
(10%)	(25%)	(50%)	(70%)	(96%)	no one

Follow up
1st month
ATT result

2nd month
ATT result

3rd month
ATT result

4th month
ATT result

5th month
ATT result

6th month
ATT result

Statistical analysis
Analysis of data was carried out using the available statistical package of SPSS-27 (Statistical Packages for Social Sciences- version 27). Data were presented in

simple measures of frequency, percentage, mean, standard deviation, and range (minimum-maximum values).

The significance of difference of different percentages (qualitative data) were tested using Pearson Chi-square test (χ^2-test) with application of Yate's correction or Fisher Exact test whenever applicable. Statistical significance was considered whenever the P value was equal or less than 0.05.

RESULTS

1 – Age distribution

The age range of the patients included in the current study is (18-62) years, with a mean age 36.5 +-11.9 (table 3.1).

2-Gender distribution

The number of females in this study was 62 patients, while the males number was 38. (table 3.1).

3-Smoking

The smoker patients in the current study were 21 patients from the total of 100 patients (table 3.1).

4-Socioeconomic status level

This has been divided in to three levels taking into account their occupation, income and level of education, their distribution in the current study is shown in table (3.1).

5-Associated comorbidities

The associated comorbidities were either diabetes or hypertention or a combination of both of them, the distribution is as seen in table (3.1).

Table 3-1: Distribution of patients according to age, gender, smoking, socioeconomic status level, associated comorbidities.

		No	%
Age (years)	18---19	5	5.0
	20---29	25	25.0
	30---39	32	32.0
	40---49	21	21.0
	50---59	12	12.0
	60---62	5	5.0
Age (years), Groups	<30years	30	30.0
	30---39	32	32.0
	40---49	21	21.0
	=>50years	17	17.0
	Mean±SD (Range)	36.5±11.9 (18-62)	
Gender	Male	38	38.0
	Female	62	62.0
Smoking	Smoking	21	21.0
	Not	79	79.0
Socioeconomic status level	Low SES	27	27.0
	Middle SES	56	56.0
	High SES	17	17.0
Associated comorbidities	Yes	18	18.0
	No	82	82.0
Hypertension	Hypertensive	16	16.0
	Not	84	84.0
Diabetes	Diabetic	6	6.0
	Not	94	94.0

6-Duration of anosmia

The duration of anosmia ranges from 1 month to 1 year, with a mean of 4.3 ±2.9 month, as shown in table (3.2). and in figure (3.2).

7- Onset of anosmia

98% of patients have a sudden onset of anosmia, as shown in table (3.2).

8- The severity of anosmia

These measured using alcohol threshold test (ATT), while all the patients included in the current study were anosmic, so their ATT results were ranging between 4 and 6, as shown in table (3.2) and figure (3.1).

9-Associated nasal symptoms

98% of the patients included in the current study have no associated nasal symptoms, as shown in table (3.2).

Table 3-2: Distribution of duration of anosmia, onset, severity and other nasal symptoms.

		No	%
Duration of anosmia	One	13	13.0
	Two	19	19.0
	Three	18	18.0
	Four	14	14.0
	Five	12	12.0
	Six & more	24	24.0
	Mean±SD (Range)	4.3±2.9 (1-12)	
Onset	Sudden	98	98.0
	Gradual	2	2.0
Severity of anosmia from 4-6 ATT	4	60	60.0
	5	36	36.0
	6	4	4.0
Associated nasal symptoms (Rhinorrhea)	Rhinorrhea	2	2.0
	No	98	98.0

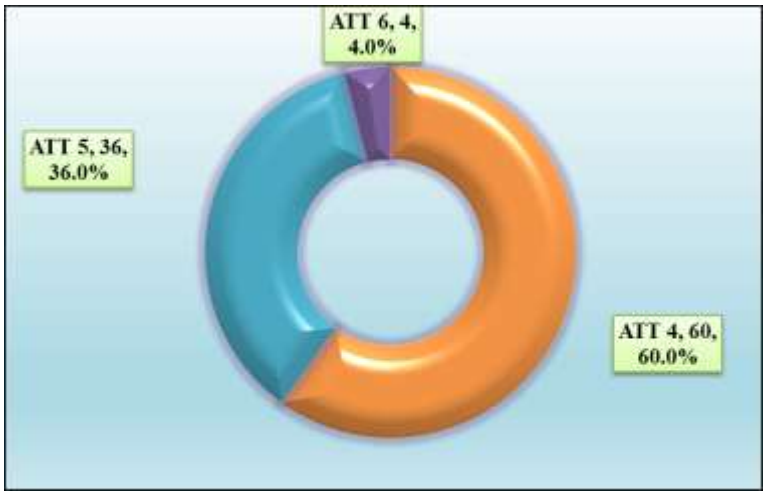


Figure 3-1: Severity anosmia from 4-6-ATT.

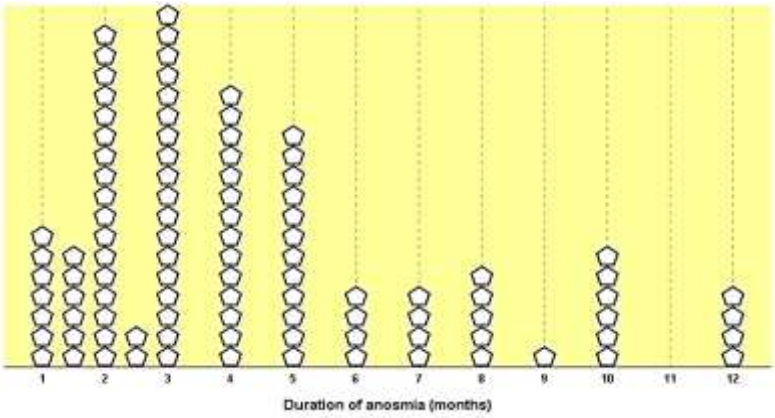


Figure 3-2: Duration anosmia.

10- Severity of COVID 19 infection

The severity of COVID 19 infection in the patients of the current study is shown in table (3.3).

Table 3-3: Distribution of the severity of COVID-19.

Severity of COVID-19	**Mild**	**81**	**81.0**
	Moderate	15	15.0
	Severe	4	4.0

11-Associated psychological distress due to anosmia
This can be mild, moderate or devastating according to the patient's description of the impact of anosmia on their life (using Distress Thermometer score). As shown in table (3.4) and figure (3.3).

12- Associated gustatory dysfunction
All the patients have aguesia, as shown in table (3.4).

13-Prognosis of anosmia
This shown in table (3.4) and figure (3.4).

Table 3-4: Distribution of psychological distress, aguesia and prognosis of anosmia.

		No	%
Psychological distress due to anosmia	Mild	37	37.0
	Moderate	52	52.0
	Devastating	11	11.0
Associated gustatory dysfunction (Aguesia)	Aguesia	100	100
	No	-	-
Prognosis of anosmia	Persistent	67	67.0
	Improved	13	13.0
	Cured	20	20.0

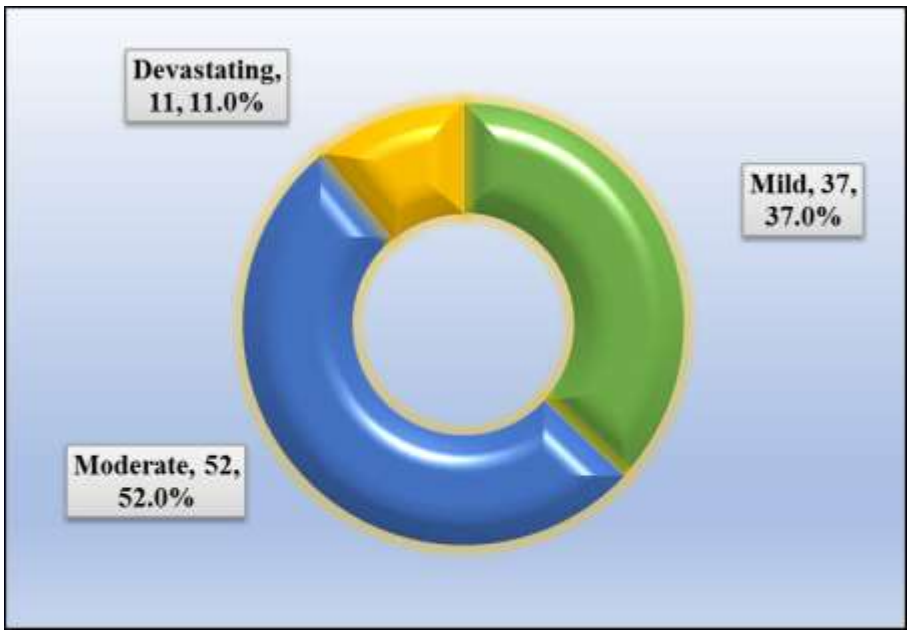


Figure 3-3: Distribution of Psychological distress due to anosmia.

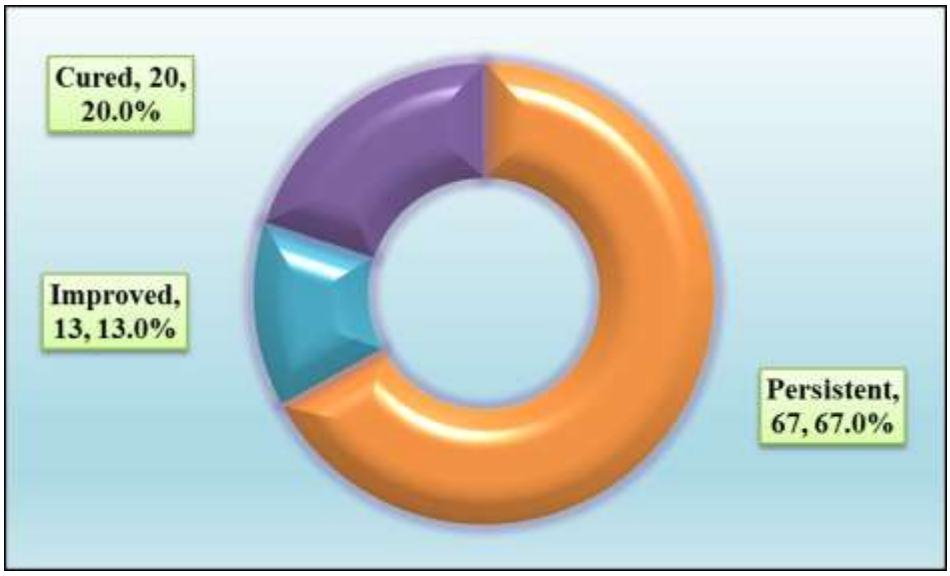


Figure 3-4: Distribution of the Prognosis of anosmia.

The severity of anosmia in relation to other variables

In the two tables included below, we can see the relation between the severty of ansmia as measured by ATT and different variables. (table 3.5 and 3.6).

Table 3-5: The severity of anosmia in relation to other variables.

		Severity of anosmia from 4-6 ATT						P value
		4		5		6		
		No	%	No	%	No	%	
Age (years)	<30years	21	70.0	9	30.0	-	-	0.110
	30---39	22	68.8	10	31.3	-	-	
	40---49	9	42.9	8	38.1	4	19.0	
	=>50years	8	47.1	9	52.9	-	-	
Gender	Male	18	47.4	17	44.7	3	7.9	0.044*
	Female	42	67.7	19	30.6	1	1.6	
Smoking	Smoking	7	33.3	12	57.1	2	9.5	0.005*
	Not	53	67.1	24	30.4	2	2.5	
Socioeconomic status level	Low SES	12	44.4	14	51.9	1	3.7	0.004*
	Middle SES	32	57.1	21	37.5	3	5.4	
	High SES	16	94.1	1	5.9	-	-	
Associated comorbidities	Yes	5	27.8	12	66.7	1	5.6	0.002*
	No	55	67.1	24	29.3	3	3.7	
Hypertension	Hypertensive	5	31.3	10	62.5	1	6.3	0.010*
	Not	55	65.5	26	31.0	3	3.6	
Diabetes	Diabetic	1	16.7	5	83.3	-	-	0.025*
	Not	59	62.8	31	33.0	4	4.3	
*Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level.								

Table 3-6: The severity of anosmia in relation to other variables.

		Severity of anosmia from 4-6 ATT						P value
		4		5		6		
		No	%	No	%	No	%	
Duration of anosmia	One	13	100	-	-	-	-	0.001*
	Two	16	84.2	3	15.8	-	-	
	Three	10	55.6	7	38.9	1	5.6	
	Four	7	50.0	7	50.0	-	-	
	Five	5	41.7	5	41.7	2	16.7	
	Six & more	9	37.5	14	58.3	1	4.2	
Onset	Sudden	59	60.2	35	35.7	4	4.1	0.771
	Gradual	1	50.0	1	50.0	-	-	
Associated nasal symptoms (Rhinorrhea)	Rhinorrhea	1	50.0	1	50.0	-	-	0.771
	No	59	60.2	35	35.7	4	4.1	
Severity of COVID-19	Mild	42	51.9	35	43.2	4	4.9	0.003*
	Moderate	14	93.3	1	6.7	-	-	
	Severe	4	100	-	-	-	-	
Psychological distress due to anosmia	Mild	22	59.5	15	40.5	-	-	0.650
	Moderate	30	57.7	18	34.6	4	7.7	
	Devastating	8	72.7	3	27.3	-	-	
Prognosis	Persistent	27	40.3	36	53.7	4	6.0	0.0001*
	Improved	13	100	-	-	-	-	
	Cured	20	100	-	-	-	-	
***Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level.**								

The prognosis of anosmia in relation to different variables

In the two tables included below, we will see the prognosis of anosmia according to each variable in details (table 3.7 and 3.8).

Table 3-7: The prognosis of anosmia in relation to different variables.

		Prognosis of anosmia						P value
		Persistent		Improved		Cured		
		No	%	No	%	No	%	
Age (years)	<30years	18	60.0	5	16.7	7	23.3	0.001*
	30---39	17	53.1	2	6.3	13	40.6	
	40---49	16	76.2	5	23.8	-	-	
	=>50years	16	94.1	1	5.9	-	-	
Gender	Male	26	68.4	3	7.9	9	23.7	0.435
	Female	41	66.1	10	16.1	11	17.7	
Smoking	Smoking	19	90.5	1	4.8	1	4.8	0.036*
	Not	48	60.8	12	15.2	19	24.1	
Socioeconomic status level	Low SES	26	96.3	-	-	1	3.7	0.0001*
	Middle SES	40	71.4	7	12.5	9	16.1	
	High SES	1	5.9	6	35.3	10	58.8	
Associated comorbidities	Yes	18	100	-	-	-	-	0.004*
	No	49	59.8	13	15.9	20	24.4	
Hypertension	Hypertensive	16	100	-	-	-	-	0.009*
	Not	51	60.7	13	15.5	20	23.8	
Diabetes	Diabetic	6	100	-	-	-	-	0.208
	Not	61	64.9	13	13.8	20	21.3	
***Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level.**								

Table 3-8: The prognosis of anosmia in relation to different variables.

		Prognosis of anosmia						P value
		Persistent		Improved		Cured		
		No	%	No	%	No	%	
Duration of anosmia	One	-	-	3	23.1	10	76.9	0.0001*
	Two	6	31.6	4	21.1	9	47.4	
	Three	14	77.8	3	16.7	1	5.6	
	Four	12	85.7	2	14.3	-	-	
	Five	12	100	-	-	-	-	
	Six & more	23	95.8	1	4.2	-	-	
Onset	Sudden	66	67.3	13	13.3	19	19.4	0.529
	Gradual	1	50.0	-	-	1	50.0	
Severity of anosmia from 4-6 ATT	4	27	45.0	13	21.7	20	33.3	0.0001*
	5	36	100	-	-	-	-	
	6	4	100	-	-	-	-	
Associated nasal symptoms (Rhinorrhea)	Rhinorrhea	1	50.0	-	-	1	50.0	0.529
	No	66	67.3	13	13.3	19	19.4	
Severity of COVID-19	Mild	64	79.0	8	9.9	9	11.1	0.0001*
	Moderate	2	13.3	5	33.3	8	53.3	
	Severe	1	25.0	-	-	3	75.0	
Psychological distress due to anosmia	Mild	20	54.1	6	16.2	11	29.7	0.153
	Moderate	37	71.2	7	13.5	8	15.4	
	Devastating	10	90.9	-	-	1	9.1	
***Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level.**								

DISCUSSION

Anosmia, is one of the most frequent symptom encountered in the last two years due to COVID-19 infection, each patient had a different outcome, many modalities of treatment had been used but no one seems to be effective. This study was an attempt to identify the predictors of prognosis for each patient presented to us according to specific criteria gathered in one scoring system that is easy to apply and help to draw a management plan according to the predicted prognosis.

We designed a scoring system with nine parameters, each parameter with different variables, each variable had given a scoring points according to its prognosis, in which the variable with worse prognosis (more persistent symptoms) given the highest points and accordingly.

1-according to age

In the current study the age range was (18-62) years, with mean age of 36.5±11.9, with the commonest age group was 30-39 (32 %) while persistence of symptoms

was more encountered in age group ≥50 years (94%), these results coincide with # J.R. Lechien et al. (July 2020), showed that the mean age was 36 ±10.1.[14]

D.H. Coelho et al. (September 2021), divided his study group into two age groups, the first one <40 years which were the commoner group, and the second group > 40 years in which persistence of anosmia more encountered.[15]

M. Petrocelli et al. (April 2021), showed that the mean age was 43.6±12.2, and the persistence of anosmia were more in elderly group.[16]

Raid M. Al-Ani et al. (August 2020), showed that the mean age group was 37.16 ± 8.5, and the higher age group affected was those who are > 30 years.[17]

***According to the current study results, the patients were divided into four age groups, each group had given a different scoring points according to their prognosis, the more persistence of symptoms given the highest points, so;**
a-< 30 years --- 2 points
b- 30-39 years----1 point
c- 40-49 years-----3 points
d-=> 50year-------4 points

2-according to gender
Females (62%) affected more than males (38%), the persistence of anosmia was slightly higher in males (68.4%) than in females (66.1%), in comparison to other studies;

D.H. Coelho et al (September 2021), showed that affected females were more than males (females 80.9%, males 19.1%), but the persistence of symptoms were more in females (females 21.5%, males 17.1%).[15]

#M. Petrocelli et al. (April 2021), showed that females represented 75% of cases while males 25% only, but the persistence of anosmia were more in females (28% of females had persistent anosmia while males 22% only).[16]

M. Capelli et al. (February 2021), showed females group had slightly advantaged in functional recovery.[18]
N. N. Nguyen et al. (June 2021), also reported that females are more likely to report recovery than males.[19]

***according to the current study males had more persistence of symptoms than females, so;**
a-Females----1 point
b-Males ------2points

3- Smoking
21% of patients were smokers, in the current study smoking was associated with more persistence of anosmia (worse prognosis), that 90.5 % of smokers had persistence of anosmia. These findings are similar to:

D.H. Coelho et al. (September 2021), that showed the percentage of smoking in the affected patients were 5.8% of whom 26.1% had persistence of anosmia.[15]

T. Klopfenstein et al (April 2020), showed that 11% of affected patients were smokers.[20]

Raid M. Al-Ani et al. (August 2020), showed that 46% of patients were smokers and smoking has adverse effects on recovery.[17]

Thomas Hummel MD et al (2010), showed that smoking is negative predictor of olfactory function recovery.[21]

***according to these results**
a-non-smokers ---- 1 point
b- smokers------ 2 points
4- Socioeconomic status level
In the current study, patients of middle socioeconomic status level were the most predominant (56%), however patients of low socioeconomic status level had more persistence symptoms of olfactory dysfunction, this finding is similar to;

Marco A. Fornazieri et al. (January 2019), showed that lower socioeconomic status was independently associated with an adverse influence on olfactory test score and so on prognosis.[22]

***according to these results, the scoring points will be**
a- low socioeconomic status----3 points
b-middle socioeconomic status---2points
c-high socioeconomic status------1 point

5-Associated comorbidities
In the current study, patients with associated comorbidities including Hypertension (16%), Diabetes (6%) or both of them were associated with higher incidence of persistence of anosmia than patients with no comorbidities. in comparison to other studies.

D.H. Coelho et al. (September 2021), showed that affected patients who have diabetes were 2.5% of total number, and those with hypertension were 10.9%. and found that patients with associated comorbidities had the worse prognosis in relation to olfactory recovery.[15]

A Aravin Kumar et al. (April 2021), showed that comorbidity burden has been positively correlated with the severity of COVID-19 and mortality, and anosmia tends to affect individuals with fewer comorbidities, this could possibly be due to anosmia being the only symptom in mild to moderate COVID-19 infection.[23]
***according to these results, the scoring points will be**
a-no associated comorbidities----1 point
b- associated comorbidities-------2 points

6- Onset of anosmia
In the current study 98% had sudden onset of anosmia and only 2% had gradual onset, it was of no significance in relation to persistence of symptoms. This agrees with:
Amer M. et al. (September 2020), who found that 83% of patients had sudden onset.[24]

Walker A. et al. (July 2020), also described that most of the patients had sudden onset.[25]

7- Duration of anosmia
There are a wide range of presenting duration, but the most frequent duration of anosmia in this study was a period of more than 6 months (24%).

The persistence of symptoms was encountered in patients who presented with anosmia of > 6 months' duration (95.8% of these patients had persistence of anosmia), this agrees with.

M. petrocelli et al. (April 2021), had showed that 27% of patients still have persistent anosmia and described that it is possible to state that the spontaneous recovery margins of chemosensitive disorders especially if severe after two months from clinical onset are very poor.[16]

Andreas F.P. Temmel et al. (June 2002), showed that anosmia persistence increase as the duration of olfactory loss increased.[26]

***according to the current results, the scoring points will be**
a-< 1 month------0
b- 1-3 months---1 point
c->4 months----2 points

8- Other nasal symptoms
The only associated nasal symptom in the current study was Rhinorrhea which presented in only 2% of included patients, it had no effect on the prognosis, in comparison with other studies;
J.R. Lechien et al. (July 2020), reported Rhinorrhea in 6.3% of cases.[14]

Sayin I et al. (June 2020), reported Rhinorrhea in 17.2%.[27]

Vaira L et al. (April 2020), showed that anosmia is not accompanied by nasal obstruction or other rhinitis symptoms.[28]

9- Associated gustatory dysfunction
All the patients in the current study reported ageusia at time of presentation, other studies showed;

J. R. Lechien et al. (April 2020), reported that 88% of cases had gustatory disorders.[29]

T. Klopfenstein et al. (March 2020), showed that 85% of patients had dysgeusia.[20]

Lucrezia Spadera et al. (August 2020), reported dysgeusia in 92.2% of affected patients with anosmia.[30]

10- Severity of anosmia according to ATT
In the current study the severity determined according to ATT points, ranging between 4- 6 points, patients with 5 points and more have more persistent anosmia (higher initial scores predicted lower improvement), this goes with;

P. Boscolo-Rizzo et al. (may 2021), reported that the severity of chemosensory dysfunction at baseline were associated with higher risk of persistence of symptoms.[31]

J. R. Lechien et al. (Nov. 2020), reported that the severity of anosmia as detected at objective olfactory testing may predict the recovery after a period of time.[32]

Thomas Hummel MD et al. (2010), showed that the prognosis of olfactory dysfunction primarily depends on residual function and higher initial scores predict poor improvement.[21]

***according to these results, the scoring points will be**
a- ATT of 4 points-----1 point
b-ATT of =>5 points---2points

11-Severity of covid 19 infection
81% had mild form of infection, and 79% of them had persistent anosmia, this goes with;

J. R. Lechien et al. (January 2021), had reported that 85% of patient with anosmia had mild infection, 4.5% had moderate infection and 6.9 % had severe infection.

He stated that anosmia was more prevalent in mild infection of COVID-19 patients compared with individuals with moderate to severe COVID-19 infection.

The main hypothesis underlying this would consist of differences in the immune response to the infection in mild and moderate –severe infection, in this hypothesis patients with mild COVID -19 could had a better local immunological response through a higher production of IgA which could limit the virus spread into the body.[33]

Y. Lee et al. (May 2020), reported that 79.6% had mild COVID-19 infection, 14.8% had moderate infection and 3.5% had severe infection.[34]

Raid M. Al-Ani et al. (2020), reported that more than half of the affected patients with anosmia had mild form of COVID-19 infection.[17]

***according to the current study results, the scoring points will be**
a-mild infection----3 points
b-moderate infection—1 point

c-severe infection----2 points

12- Psychological distress due to anosmia

52% of cases had moderate form of psychological distress, but patients with devastating distress had the worse prognosis, this goes with;

Andreas F.P. Temmel et al. (June 2002), showed that patients who reported depressed mood as a consequence of olfactory loss had higher complaint scores and higher self-rating of loss of smell.[26]

P. Kohli et al. (2016), reported that there is a reciprocal relationship between olfaction and depression, patient with primary depression have reduced objective olfactory performance when compared with healthy controls, and in patients with primary olfactory dysfunction symptoms of depression worsen with severity of olfactory dysfunction.[35]

D. L. Burgers Watson et al. (September 2021), suggests altered taste and smell with COVID-19 may lead to severe disruption to daily living that impacts on psychological wellbeing, physical health, relationship and sense of self.[36]

***according to the current study results, the scoring points will be;**
a-mild---1 point
b-moderate---2 points
c-devastating—3 points

Table 4-1: Ehab and Lubna's scoring system.

	Parameters		Points
1	age	30-39 years <30 years 40-49 years ≥50 years	**1** **2** **3** **4**
2	gender	Female male	**1** **2**
3	Duration of anosmia	<1 month 1-3 months >4 months	**0** **1** **2**
4	Severity of anosmia according to ATT	4 ≥5	**1** **2**
5	smoking	Non-smoker smoker	**1** **2**
6	Socioeconomic status level	Low Middle high	**3** **2** **1**
7	Associated comorbidities	No yes	**1** **2**
8	Severity of COVID-19	Mild Moderate severe	**3** **1** **2**
9	Psychological distress due to anosmia	Mild Moderate devastating	**1** **2** **3**

Totally ----23 points
< 10 -----good prognosis
10-17-----moderate prognosis
≥18-------poor prognosis

CONCLUSION AND RECOMMENDATIONS

Conclusion

1. Certain parameters (e.g. age, gender, smoking, duration of anosmia, etc…) found to affect the prognosis either in a positive or negative way.
2. By using of these parameters, we create a scoring system to predict the prognosis of anosmia due to COVID-19 infection.

Recommendations

1. Further studies are needed to evaluate the sensitivity and specificity of this scoring system.
2. Application of Ehab and Lubna's scoring system in the management of anosmic patient due to COVID-19 infection is recommended to predict the prognosis of anosmia in these patients and hence tailoring the treatment plan.

ACKNOWLEDGEMENT

Thanks to ALLAH for everything, meanwhile I would like to express my sincere thanks for Prof. (Naser Edan Naser) the Head of the Scientific Council of Otolaryngology Head and Neck Surgery for his support, encouragement and acceptation of this thesis for discussion.

Iam extremely thankful and pay my deep sense of gratitude to my supervisor (Prof. Ehab Taha Yaseen) for his valuable guidance, encouragement, supervision and support for the accomplishment and presentation of this study.

I am feeling oblige in taking the opportunity to thank all E.N.T. Specialists in Al-Yarmouk Teaching Hospital for their support and advice.

I can't forget to thank all my colleagues in Al-Yarmouk Teaching Hospital for their help in collecting the data.

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