Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Original article

Self-reported and clinically identified loss of smell and taste among persons tested for COVID-19 in Chennai, southern India, July-August 2020: A cross sectional study

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ABSTRACT

Background: Early detection of symptoms of loss of smell and taste lately added for Coronavirus disease 2019 (COVID-19) has the potential for improving pandemic response. In the Indian context, we compared proportion experiencing new loss of smell or taste among COVID-19 positive and negative individuals in Chennai city, Southern India.

Methods: We did an analytical cross-sectional study among individuals aged 18–80 years undergoing testing at COVID-19 sample collection centres. We ascertained loss of smell and taste using standardised self-reporting and clinical examination procedures. We administered Sino Nasal Outcome (SNOT 22) questionnaire for comprehensive understanding of these symptoms. We compared proportion having symptoms between COVID-19 positive and negative persons. We compared the two assessment methods to compute diagnostic validity indicators.

Results: Of the 277 participants, 169 (61%) were men and mean age of 40.7 years [SD = 13.3]. Fifty eight (21%) had COVID-19 and 12 (36%) of them were asymptomatic. Predominantly reported symptoms were fever (30%), headache (18%) and cough (18%). Self-reported or clinically identified new loss of smell or taste was higher among COVID-19 positive (n = 13; 22%) than negative persons (n = 23; 11%) [p = 0.02]. Sensitivity was higher for self-reported or clinically identified loss of smell (17.2%) than that of loss of taste (6.9%). Negative predictive value for loss of smell or taste, self-reported or clinically identified was 81%. Likelihood ratio of positive test was 2.13.

Conclusion: Loss of smell or taste are predominantly reported by COVID-19 confirmed individuals. Objective and subjective assessments of smell and taste may be required to identify those requiring COVID-19 testing.

1. Introduction

As of October 2020, there have been over 40 million confirmed cases of Coronavirus disease 2019 (COVID-19), including around 1.1 million deaths worldwide.[1] India suffers one of the highest burden of cases with over 8 million cases recorded up to October 2020.[2] While still in pursuit of a vaccine and drug, the strategies employed to combat the pandemic are to test, treat and isolate, alongside community-based preventive measures emphasising social distancing, and hand hygiene among others. India's testing strategies have undergone revisions to suit the demands of the evolving pandemic and the country is currently testing for COVID-19 at the rate of around 19,000 tests per one million population.[3,4] The current testing strategy advises testing those with symptoms of influenza-like-illness or severe acute respiratory illness and asymptomatic people with a history of direct, and high-risk contact with a confirmed case.[5]

A considerable proportion of the COVID-19 cases can be asymptomatic.[6] Globally, the commonly reported symptoms among patients

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with COVID-19 include fever, cough, fatigue, sputum production, shortness of breath, myalgia, sore throat, headache, and others.[7–10] Other gastrointestinal[11] and dermatological symptoms[12] have also been reported.

The United States Centre for Disease Control and Prevention (CDC) listed six new symptoms that were reported among patients with COVID-19 including new loss of taste (anosmia) or smell (ageusia), chills, and muscle ache.[13,14] In a subsequent addition to this list of symptoms, nausea or vomiting, runny nose, and diarrhea were also included.[10] Anosmia, with or without ageusia, has been reported commonly to manifest either early in the disease process or in patients with mild or no constitutional symptoms.[15–21] The prevalence of loss of smell widely ranged from 10% to over 80% in European countries. Odour threshold detection was more affected by COVID-19 compared to odour identification.[22] The proportion reporting taste disorders ranged up to 60%. The guidelines for diagnosis recommend chemosensory assessment by subjective assessment and psychophsical assessment testing for one or a combination of odour threshold, discrimination, and identification. Management of anosmia includes safety counselling, olfactory training and adjuvant medication.[23]

None of the listed symptoms are specific to COVID-19. Even seemingly specific symptoms like loss of smell and taste are common with other neurotropic viral infections. Struyf et al. in their Cochrane review highlighted the low sensitivity and specificity of any one of the earlier listed symptoms of COVID-19 and the need for data on potentially more specific symptoms such as loss of sense of smell.[24] Menni et al. have reported that loss of smell and taste is a potential predictor of COVID-19 in addition to other, more established, symptoms.[25] However, olfactory and gustatory dysfunction do not seem to hold prognostic value at the time of initial diagnosis.[26]

It is essential to understand the proportion of patients in India who present with these newly listed symptoms, some of which are not otherwise routinely enquired or documented. This will enable us to identify cases that would have earlier been missed and follow up with timely isolation, and effective management.

In this context, we aimed to (1) describe the symptom profile of persons who underwent testing for COVID-19 in selected sample collection centres in Chennai, Southern India (2) compare the proportion reporting the new loss of smell or taste between those who tested COVID-19 positive and COVID-19 negative. Additionally, we estimated diagnostic validity indicators of loss of sense of smell and taste towards screening for COVID-19.

2. Materials and methods

2.1. Study setting

Chennai, the fourth largest city in India, is situated in the southern state of Tamil Nadu and home to a population of over 7 million. The city had been reporting an average of 1200 COVID-19 cases per day and ranks third among the country's cities in terms of the COVID-19 case burden. Nasopharyngeal swabs are collected from all persons who require testing for COVID-19 at sample collection centres are transported to designated laboratories. Persons testing positive for COVID-19 are screened for the severity of disease at screening centres and based on the severity of the disease, recommended home isolation, admission to COVID care centres or dedicated COVID hospitals.

2.2. Study design

We conducted an analytical cross-sectional study.

2.3. Study population

Adults aged between 18 and 80 years belonging to any gender, who visited COVID-19 testing centres in Chennai city in Southern India.

2.4. Sample size

We had to recruit 55 COVID-19 positives and 165 COVID-19 negative individuals. Our assumptions were prevalence of self-reported loss of smell or taste of 25% among COVID-19 positive [based on case series (unpublished) of self-reported loss of smell or taste through telephonic interviews of COVID-19 individuals] and 5% among COVID-19 negative persons, alpha error of 5%, 1:3 allocation ratio, and non-response of 20%. We enrolled all eligible study participants consecutively from two COVID-19 sample collection centres until desired sample size was achieved.

2.5. Data collection

The data were collected from all eligible and consenting participants. The data were colleted in two parts. A face-to-face data collection of minimal identification details and clinical examination were conducted at the sample collection centre for COVID -19. This was followed by telephonic interviews on the same day.

After enquiring about history of new onset loss of smell and taste in the past 14 days, participants were clinically evaluated for loss of smell and taste using standardised tests in the testing booths set up with all necessary COVID-19 infection control measures including personal protection equipment, social distancing, and proper disinfection of testing material. We completed the clinical examination for loss of smell and taste ahead of sample collection for COVID-19 testing at the centres. The standardisation procedures used for the preparation of solutions and testing were based on De Jong's 'The Neurologic Examination' [Box 1].[27] For standardising the solutions to be used for smell and taste testing, serially increasing concentrations of the solutions were tested on ten apparently healthy participants. A concentration higher than the concentration at which the smell or taste was perceived by all volunteers was chosen for the study participants.

Following this, trained interviewers telephonically contacted the participants to collect data on a structured questionnaire (developed using Open Data Kit (ODK) application). In order to limit reporting biases, the data was collected on the same day of the specimen collection, and prior to the declaration of COVID-19 test results. The interviewers collected data on demographic details, symptoms and other co-morbidities, and administered Sino-Nasal Outcome (SNOT 22) questionnaire for comprehensive understanding of their symptoms. The nasal and oropharyngeal samples were collected and tested by RT-PCR for COVID-19 at the Government accredited laboratories. The results of this testing was obtained from the laboratory to update the participant COVID-19 status.

2.6. Data analysis

Socio-demographic characteristics and symptom profile were summarized as frequencies and percentages. Loss of smell/taste, self-reported or clinically identified, were statistically compared between COVID-19 positive and negative participants using Fisher's exact test. We computed positive predictive value (PPV), negative predictive value (NPV) and likelihood ratio of a positive test (LRpos) to describe the diagnostic properties of the two methods of ascertaining loss of smell and taste, namely self-reporting and clinical examination. We used Epi-Info (Version 7.2) for analysis.

2.7. Human participant protection

The study was approved by the Institutional Human Ethics Committee of the ICMR-National Institute of Epidemiology, Chennai. We obtained the verbal informed consent from all the participants before conducting the study.

Box 1
Standardisation of testing kits and procedures for testing of sense of smell and taste

Serially increasing concentrations of the solutions to be used for smell and taste testing were prepared at the laboratory. The solutions were presented to a group of 10 apparently healthy volunteers. They were required to indicate the concentration at which they perceived the particular smell or taste. A supra-threshold concentration i.e., a concentration higher than the highest concentration at which the smell or taste was perceived by all volunteers was chosen for the study participants. The concentration used in the study were as follows:

Substance	Concentration
For gustation	
Sugar	32 g/100 ml
Lemon concentrate	20ml/100 ml
Salt	2.5 g/100 ml
For olfaction	
Coffee	6 g/100 ml
Asafoetida	2.5 g/100 ml
Eucalyptus oil	5 ml concentrate undiluted

The order of odour presented to the participants was Asafoetida, followed by Coffee and Eucalyptus oil in both the nostrils, one after the other. Drinking water was used as control solution. Cotton buds dipped in the respective solutions were kept close to the opening of the nostril and the participant was asked to identify the odour. Separate buds were used for all the patients and disposed appropriately after single use. Nearly 10–15 seconds time was given for desensitization between different odours.

We used salt, sugar and lemon extract solutions to identify the bitter, sweet and sour tastes, respectively. The solutions were prepared freshly on the morning of each day and kept for 3 hours before preparing again. Drinking water was used as control solution. We used single-use lolly sticks to dip into the solutions and apply on the participant's tongue for 10–15 seconds, before asking them to identify the correct taste. Drinking water was given before and after each solution to rinse the mouth.

The data collectors followed the Ministry of Health and Family Welfare, India guidelines for donning and doffing complete personal protective equipment.

3. Results

3.1. Profile of study participants

Of the total 277 persons studied, 169 (61%) were men, 247 (93%) could read and write, and 20 (8%) reported income below the poverty line. The mean (SD) age of the study participants was 40·7 (13·3) years (Tables 1 and 2). Overall, 139 (50%) persons tested reported no symptoms at all. 58 (21%) persons tested positive for COVID-19. Among 58 who tested positive for COVID-19, 36 (64%) had reported at least one symptom. Fever (30%) was the most common symptom reported by them, while cough (14%) was the most common symptom reported by those who tested COVID-19 negative (Fig. 1). The SNOT 22 score [Median; Interquartile range (IQR)] was not different between the two groups [18 (18–20) vs. 19; (18–21)].

3.2. Frequency of loss of smell/taste

Overall, 21 (7·6%) (95% CI: 5.1 to 12.1) persons self-reported loss of smell or taste. Clinical examination identified 18 (6·5%) (95% CI: 4.3 to 11.0) with loss of smell or taste. It was found that in total, 36 (13%) (95% CI: 9.9 to18.7) persons had loss of smell or taste by self-reporting

Table 1
Baseline characteristics of persons tested for COVID -19, Chennai, Tamil Nadu.

Characteristics		Total (N = 277)		COVID-19 Negative (N = 219)		COVID-19 Positive (N = 58)	
		n	%	n	%	n	%
Gender	Male	169	61·0	139	63·5	30	51·7
	Female	108	39·0	80	36·5	28	48·3
Read and write	Yes	247	93·2	195	93·3	52	92·9
	No	18	6·8	14	6·7	4	7·1
Occupation exposure to strong fumes[a]	Yes	9	3·4	6	2·9	3	5·4
	No	255	96·2	203	97·1	52	92·9
Income	Below Poverty Line[a]	20	7·5	15	7·2	5	8·9
	Above Poverty Line	213	80·4	172	82·3	41	73·2
	No response	32	12·1	22	10·5	10	17·9
Patient category	Symptomatic contact	16	5·8%	11	5·0%	5	8·6%
	Symptomatic Healthcare worker/Frontline workers	8	2·9%	8	3·7%	0	0·0%
	Asymptomatic family member	94	33·9%	80	36·5%	14	24·1%
	Asymptomatic healthcare worker	26	9·4%	25	11·4%	1	1·7%
	Symptomatic Influenza like Illness (ILI)	21	7·6%	12	5·5%	9	15·5%
	Pregnant woman in/near labour	1	0·4%	0	0·0%	1	1·7%
	Symptomatic among returnees and migrants	32	11·6%	23	10·5%	9	15·5%
	Persons from Hotspot/Containment zones.	79	28.5%	60	27.4%	19	32.8%

[a] A monthly household income of less than Rs. 6000 was operationally defined as below poverty line, data was missing for12 persons on occupational exposure, income and education.

Table 2
Behavioral risk factors and comorbidities among persons tested for COVID -19, Chennai, Tamil Nadu.

Characteristics	Total (N = 277)		COVID-19 Negative (N = 219)		COVID-19 Positive (N = 58)	
	n	%	n	%	n	%
Smokeless tobacco	13	4·9	12	5·7	1	1·8
Smoking	27	10·2	21	10·0	6	10·7
Alcohol	32	12·1	28	13·4	4	7·1
Hypertension	27	10·2%	17	8·1%	10	17·9%
Diabetes mellitus	30	11·3%	20	9·6%	10	17·9%
Heart diseases	6	2·3%	6	2·9%	0	0·0%
Asthma	4	1·5%	4	1·9%	0	0·0%
Chronic kidney diseases	0	0·0%	0	0·0%	0	0·0%
Liver diseases	3	1·1%	3	1·4%	0	0·0%
Neurological disorder	3	1·1%	2	1·0%	1	1·8%
Rheumatologic disorder	1	0·4%	1	0·5%	0	0·0%
ENT structural abnormalities	5	1·9%	3	1·4%	2	3·6%
Other comorbidities	15	5·7%	11	5·3%	4	7·1%

or clinical examination. Among persons with COVID-19, clinical examination identified more number of people suffering from loss of smell compared to self-reporting. On the contrary, among COVID-negative persons, self-reported loss of smell was higher than what was identified clinically (Table 3).

New loss of smell or taste was reported by or identified by clinical examination among 13 (22·4%) (95% CI: 13.2 to 31.0) participants who tested COVID-19 positive and among 23 (10·5%) (95% CI: 7.3 to 16.4) COVID-19 negative persons (p = 0·016). A person with loss of smell or taste had 2.46 (95% CI:1·16, 5·23) times higher odds for testing COVID-19 positive compared to a person who did not experience these symptoms.

There was no difference in median time (days) to testing from first symptom, among those self-reporting loss of smell and taste (4 days for both) compared to those identified to have the symptoms by clinical examination (smell = 4; taste = 5 days).

3.3. *Diagnostic validity: self-reporting vs clinical examination*

We calculated the negative predictive value of loss of smell or taste, self-reported or clinically identified to be 81% (Table 4). The probability that someone is likely to test negative for COVID-19 if they were determined to not have loss of smell or taste by self-reporting or clinical examination was over 80%.

A person is almost two times (LRpos = 2·13) more likely to report loss of smell or taste if s/he tested positive for COVID-19 as compared to someone who tested negative (Table 4). The sensitivity of self-reported or clinically identified loss of smell was 17.2% and that of loss of taste was 6.9%.

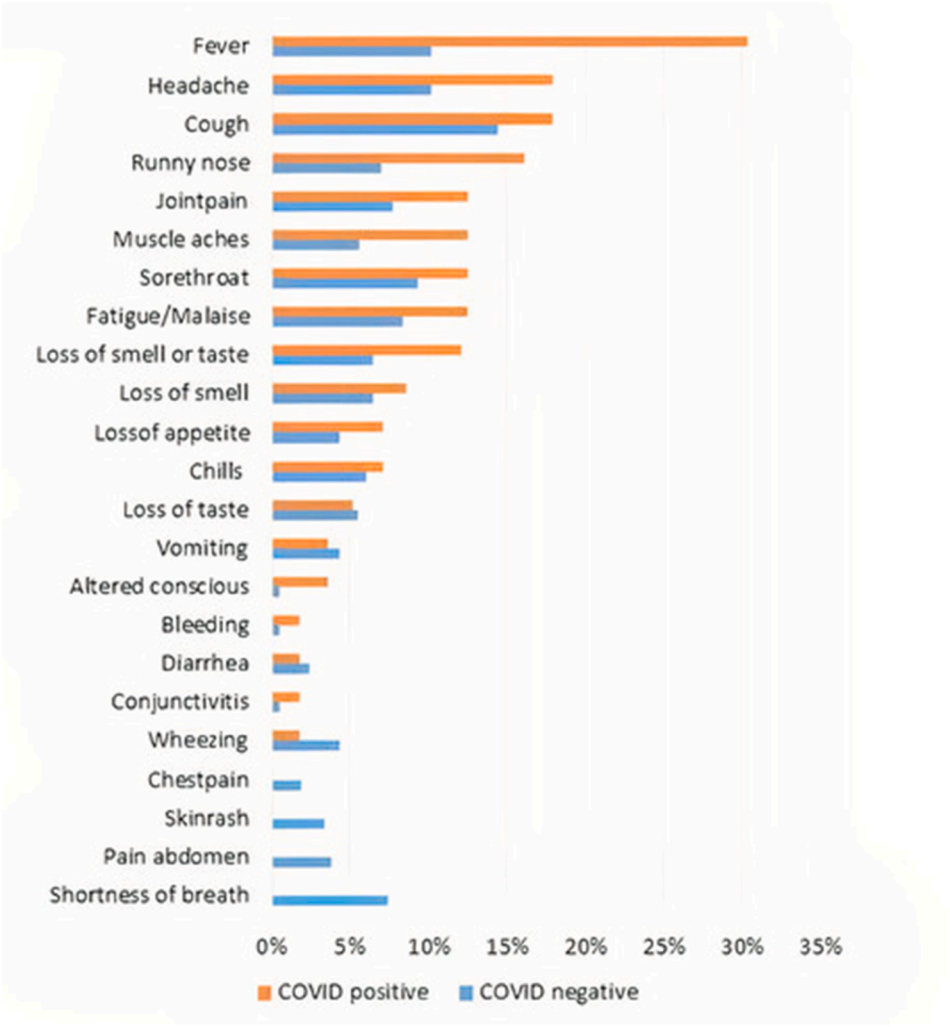

Fig. 1. Reported symptoms among COVID-19 positive and negative individuals.

Table 3
Prevalence (95% Confidence Interval) of loss of smell, loss of taste among patients tested for COVID -19, Chennai, Tamil Nadu.

Parameter	Method of examination	Total (N = 277)		COVID-19 Negative (N = 219)		COVID-19 Positive (N = 58)	
		n (%)	95% CI	n (%)	95% CI	n (%)	95 %CI
Loss of smell	SR	19 (6.9%)	4.2–10.5	14 (6.4%)	3.5-10-5	5 (8.6%)	2.9–19.0
	CE	15 (5.4%)	3.1–8.8	9 (4.1%)	1.9–7.7	6 (10.3%)	3.9–21.2
	SR/CE	31 (11.2%)	8.3–16.5	21 (9.6%)	6.5–13.2	10 (17.2)	9.1–30.1
Loss of taste	SR	15 (5.4%)	3.1–8.8	12 (5.5%)	2.8–9.4	3 (5.2%)	1.1–14.4
	CE	9 (3.2%)	1.5–6.1	8 (3.7%)	1.5–7.1	1 (1.7%)	0.0–9.2
	SR/CE	24 (8.7%)	6.1–13.6	20 (9.1%)	6.1–14.8	4 (6.9%)	2.1–17.9
Loss of smell or taste	SR	21 (7.6%)	5.1–12.1	14 (6.4%)	3.8–11.2	7 (12.1%)	5.3–27.5
	CE	18 (6.5%)	4.3–11.0	11 (5.0)	2.8–9.6	7 (12.1%)	5.5–25.4
	SR/CE	36 (13.0%)	9.9–18.7	23 (10.5)	7.3–16.4	13 (22.4%)	13.2–31.0

*SR-self reported; CE- Clinical examination.

Table 4
Positive and Negative predictive values of the symptoms loss of smell and taste for COVID 19 status among patients tested for COVID -19, Chennai, Tamil Nadu.

Parameter	Method of examination[a]	NPV (%)	PPV (%)	Likelihood Ratio of a positive test
Loss of smell	SR	79·5	26·3	1·34
	CE	80·2	40.0	2·51
	SR/CE	80·5	32·3	1·79
Loss of taste	SR	79·0	20·0	0·95
	CE	78·7	11·1	0·46
	SR/CE	78·7	16·7	0·76
Loss of smell or taste	SR	80·1	33·3	1·89
	CE	80·3	38·9	2·42
	SR/CE	81·3	18·7	2·13

a SR-self reported; CE— Clinical examination; NPV- Negative predictive value; PPV- Positive predictive value

4. Discussion

We conducted an analytical cross-sectional study to ascertain loss of smell or taste through self-reporting as well as clinically examination among persons reporting for COVID-19 testing by RT-PCR at sample collection centres in Chennai city, Southern India. We identified that a significantly higher proportion of COVID-19 positive persons experienced loss of sense of smell or taste compared to those tested negative for COVID-19.

Of the 58 COVID-19 positive patients in our study, 35·7% were asymptomatic at the time of presentation for testing. This is comparable to what was reported earlier in India, where around 28% of the 40,814 COVID-19 cases were asymptomatic.[28] Systematic reviews also report the pooled proportion of asymptomatic COVID-19 infections to be around 10–20%, slightly higher in children than other age groups.[6,29,30] The difference in estimates across studies could also be due to differences across countries in testing strategies and these systematic reviews did not include any studies from India. Fever and cough were the most commonly reported symptoms among those who tested COVID-19 positive as reported in other studies.[10,31]

4.1. Loss of smell and taste

We report that almost one-fifth of the COVID-19 affected persons in our study experienced loss of smell or taste. Mullol et al. observe that the frequency of smell or taste dysfunction in COVID-19 affected persons has shown a high variability from 5% to 98%, depending on the methodology, country, and study.[32] Our estimates fall within the range estimated by Larco et al. who report that the frequency of anosmia in COVID-19 affected persons ranged between 22% and 68% and frequency of taste from 20% to 33%.[33]

However, our estimates of the prevalence of loss of smell and taste are lower than that from other systematic reviews. Samaranayake et al. in their meta-analysis including 11,054 COVID-19 patients from eight studies estimated that anosmia and dysgeusia were present in 74.9%, and 81.3% mild-to-severe cases of COVID-19 patients, respectively.[34] The pooled proportions presenting with olfactory dysfunction and gustatory dysfunction based on data from 24 studies on 8438 patients were 41·0% and 38·2%, respectively.[35] The overall prevalence of self-reported alteration of the sense of smell or taste was 31% and 67% in severe and mild-to-moderate symptomatic patients, respectively.[36]

We observed a significantly higher proportion of COVID-19 positive persons reporting loss of sense of smell and taste compared to those who were COVID-19 negative. Boscolo et al. followed up household contacts of COVID-19 patients for symptoms, and found a significantly lower prevalence of smell or taste impairment (1·5%) in patients who tested negative compared to those who tested positive for SARS-CoV-2 (63·0%).[37,38]

Considering the reported possibility of false-negative results with COVID-19 RT-PCR testing,[39] there is a possibility that some of our COVID negative study participants were actually COVID positive thereby giving an overestimate of the proportion of COVID negative persons experiencing the symptoms. This differential misclassification could have diluted the difference between the two study groups namely COVID positive and COVID negative persons. Thus, the actual difference in the proportion reporting these symptoms between COVID-19 positive and negative persons could be wider than what we have reported in our study.

In our study, the proportion of self-reporting loss of smell or taste was different from those detected by clinical examination. Prevalence of olfactory dysfunction is significantly greater using objective olfactory assessments compared to subjective measures.[35,40] Lechien et al. also report that of 18 (38·3%) individuals who self-reported subjective partial or total loss of smell, only three were anosmic.[41] The use of subjective measures, while operationally more feasible, may lead to underestimation of true prevalence.[42]

4.2. Diagnostic validity: self –reporting vs clinical examination

Struyf et al. reported sensitivity of 0·22 for loss of smell and 0·20 for loss of taste and a specificity of 0.95 and 0.96 respectively for the same symptoms.[24] Our estimates of specificity are comparable with these, while those of sensitivity are much lower. We report higher odds of being COVID-19 positive among those reporting loss of smell or taste compared to those who didn't. While other studies support this finding, their point estimate of the measure of association is higher. Those who reported loss of smell and taste had six-fold higher odds of being COVID-19 positive; similarly, anosmia and ageusia were associated with 10-fold higher odds of COVID-19 diagnosis.[33] In populations of patients who are currently reporting olfactory dysfunction, there was a positive predictive value of 61% for a positive COVID-19 result.[38] One reason could be the subjective nature of the symptoms reported which require a certain level of awareness and general health literacy among the population studied. The estimates available in the literature are thus far from Western countries with a higher literacy rate and a higher overall

socioeconomic status compared to our study population.

4.3. Implications of the findings

Our findings have implications for an individual, the clinicians and the public health authorities. Individuals suffering from these symptoms are required to self-isolate themselves while also seeking testing for COVID-19 and have to be prescribed an appropriate line of management thereafter. Practicing clinicians should be astute to refer persons reporting to them with these symptoms at the out-patient clinic or as in-patients for testing for COVID-19. Public health officials may incorporate these symptoms into their screening tool to identify the population requiring COVID-19 testing.

4.4. Strengths

To the best of our knowledge, this is one of the few studies from India to document the proportion of COVID-19 affected persons suffering from loss of smell and taste. Another study available is a narrative review of global literature on these symptoms.[43] We have used both subjective and objective assessment of loss of smell and taste to overcome the shortcomings of using either method alone. Further, the individuals were blinded to the status of COVID-19 at the time of examination, hence, their response to examination is not under the influence of positive test result. Therefore, our estimates may be more closer to the actual values. The solutions used for testing smell and taste were chosen to be culturally appropriate for the population being tested and can be replicated using the same standardised concentrations throughout the country.

4.5. Limitations

Our study has few limitations. The clinical examination of sense of smell and taste still entails a subjective component by relying on the participant's responses. We attempted to detect and eliminate this bias by using a control solution, and did not find any positive reporting of smell or taste with control solution. We did not measure odour threshold, which has been reported to be more affected in COVID-19 affected persons compared to odour perception and discrimination. Since we did not include hospitalised patients being tested for COVID-19, we are likely to have included only mild and moderate cases of COVID-19 in our study. Since the number of COVID-19 affected person reporting these symptoms was small, we could not comment on the duration of the symptoms or explore the association of these symptoms with other risk factors, disease severity or with the outcomes of the infection.

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Declaration of competing interest

The authors have no conflicts of interest to disclose.

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