Original Article

Changes in internet search behaviors related to smell and taste disorders during the COVID-19 outbreak in Turkey

Erdal Sakallı[1], Dastan Temirbekov[1], Mehran Mahouti[2], Mustafa Caner Kesimli[3], Deniz Kaya[3]

[1]*Department of Otorhinolaryngology, Istanbul Aydın University, Faculty of Medicine, Istanbul, Turkey*
[2]*Faculty of Engineering, Computational Bioformatics and Artifical Neural Networks, Yıldız Technical University, Istanbul, Turkey*
[3]*Department of Otorhinolaryngology, Liv Hospital Ulus, Istanbul, Turkey*

ABSTRACT

Objectives: This study aims to assess the change in internet searches terms related to smell and taste disorders (STDs) during the novel coronavirus-2019 (COVID-19) outbreak and to investigate the relationship between the changes and the daily number of COVID-19 cases and deaths reported in Turkey.

Patients and Methods: Between March 1st, 2019 and April 30th, 2020, the average number of internet searches of the most common 10 key terms related to STDs during the COVID-19 outbreak was compared to the average number of internet searches of those terms in previous months in Turkey. The daily average number of most common 10 key terms based on Google AdWords (GA) and the relative search volume (RSV) of most searched two terms ("inability to smell" and "inability to taste") related to STDs based on Google trends (GT) were compared with the change in the daily number of COVID-19 cases and deaths in Turkey.

Results: The average number of internet searches of 10 key terms between March and April 2020 increased approximately six times from both the average number of the same terms in the previous 10 months and between March and April 2019 months period ($p<0.001$). We identified a strong correlation between the daily numerical changes of key terms and the increase in the number of daily COVID-19 cases and deaths ($r=0.810$ and $r=0.783$, respectively; $p<0.001$). There was a strong correlation between the RSV surges of two terms ("inability to smell" and "inability to taste") and the increase in the daily number of cases and deaths during the outbreak in Turkey ($p<0.001$).

Conclusion: The COVID-19 in Turkey led to an increase in internet searches terms related to STDs. This increase was strongly correlated with the increase in COVID-19 cases and deaths in Turkey.

Keywords: Coronavirus, COVID-19, Google trends, smell disorders, taste disorders.

Coronaviruses are a very large family of viruses which cause mild-to-moderate symptoms in many individuals, but may cause severe respiratory failure and even death in some cases. Novel coronavirus-2019 (COVID-19) is the newest member of the coronavirus family. It was first identified in the Hubei Province of China in late 2019 and soon spread all over the world.[1] A pandemic was declared by the World Health Organization after its rapid spread worldwide in a few months.[2]

The main symptoms of COVID-19 are cough, difficulty in breathing, fever, and fatigue. In some cases, COVID-19 causes viral pneumonia,

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Correspondence: Erdal Sakallı, MD. İstanbul Aydın Üniversitesi Tıp Fakültesi Kulak Burun Boğaz Hastalıkları Kliniği, 34295 Küçükçekmece, İstanbul, Türkiye.
e-mail: erdalkbb1979@hotmail.com

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leading to severe respiratory failure in later stages of the disease and death, eventually.[1,3] In one of the first published articles, neurological findings of the disease including smell and/or taste dysfunctions (STDs) with COVID-19 were described and, later, STDs started to be investigated in patients with COVID-19.[4] Many studies conducted in the following weeks revealed that patients infected with COVID-19 had STDs with or without major symptoms.[5-7] In addition, physicians, particularly otolaryngologists, reported that patient complaints about STDs increased with the prevalence of COVID-19. Therefore, along with upper respiratory tract infections that increase seasonally in March and April, there has been a significant increase in STDs.[8] However, it is unclear whether the increase in reports of STDs occurs seasonally or whether it is due to the COVID-19 outbreak.

The majority of internet users use Google's search engine to search for key terms. For this purpose, Google AdWords (GA) keyword planner and Google Trends (GT) were used in this study. These applications share the number of worldwide searches, as well as graphs of increases and decreases in searches during specified periods for any concept, object, country or person and from specified cities or countries. These applications have been reliable guides for scientific studies and used to obtain data for scientific studies.[9,10]

In the present study, we aimed to assess the changes in internet searches for key terms related to STDs in Turkey during the COVID-19 pandemic using GA and GT and to investigate the relationship between the search changes and the daily number of COVID-19 cases and deaths in Turkey.

PATIENTS AND METHODS

As this study does not constitute human participants research, an ethical approval was waived in accordance with the Institutional Review Board of Istanbul Aydın University, Turkey. The GA (http://adwords.google.com./keywordplanner) shows the number of searches containing key terms from any location and within any date range. The GT (https://trends.google.com/trends/) gives the relative search volume (RSV) of the results of the search terms from any location and within any date range in the form of value indices between 1 and 100. The period (which can be narrowed down by day, month, or year) with the most searches for a specific key term is assigned a value of 100, and the period with the least searches is assigned a value of 1. Using this scale, the RSV of the search terms is obtained.

Using the GA application, all key terms used in internet searches related to STDs in Turkey between the dates of March 1st, 2019 and April 30th, 2020 were determined, and of these, the 10 most common key terms ("I cannot taste and smell", "inability to smell", "loss of smell", "loss of taste", "no smell", "inability to smell and taste", "I cannot smell", "my nose is open but I cannot smell", "inability to taste and smell", "inability to taste") were selected for our study. Monthly data for internet searches containing these 10 key terms between March 1st, 2019 and April 30th, 2020 were obtained. Then, the average number of searches containing any of the 10 search terms conducted between March and April 2020 were compared to the average number of searches containing the same terms conducted in the previous 10 months and in the period of March and April 2019.

Search results for the common 10 key terms from March 18th, 2020 (the date of the first reported death due to COVID-19 in Turkey) to April 30th, 2020 were included to investigate the relationship between the internet search and the declared numbers of infected cases and number of deaths by the Republic of Turkey, Ministry of Health.[11] Using GT, it was determined that the terms used in searches related to smell and taste had the highest number of searches were "inability to smell" and "inability to taste". Based on these data, the relationship between the changes in the average number of searches containing 10 internet search terms related to STDs obtained from GA and the daily RSV surges of both terms ("inability to smell" and "inability to taste") obtained from GT, as well as the increase in COVID-19 cases and deaths related to COVID-19 in Turkey was analyzed.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp.,

Table 1. Comparison of internet search numbers of key terms related to STD in 2019 and 2020 years

Internet search key terms	Search number in 2019								Search number in 2020				Percentage of increase in the average of March - April 2020 compared to the average number of previous 10 months (%)
	May	June	July	August	September	October	November	December	January	February	March	April	
I can not taste and smell	50	110	20	30	20	40	20	90	140	110	1,000	590	1,262
Inability to smell	1,000	480	720	880	720	480	720	880	880	1,300	1,600	5,400	434
Loss of smell	480	480	90	110	170	140	320	390	260	210	2,900	880	713
Loss of taste	30	20	20	40	20	40	70	50	50	40	390	880	1,671
No smell	50	40	40	30	30	50	50	50	50	70	390	590	1,065
Inability to smell and taste	90	140	150	100	30	100	180	150	240	360	1,390	2,600	1,295
I can not smell	390	260	260	140	170	590	260	260	590	260	1,900	1,600	550
My nose is open, but I can not smell	480	320	390	320	260	320	320	480	720	480	1,900	1,900	465
Inability to taste and smell	210	110	140	50	110	110	50	50	90	320	480	1,600	839
Inability to taste	390	320	260	260	170	320	320	390	390	590	880	1,900	408
Total number	3,170	2,280	2,090	1,960	1,700	2,190	2,310	2,790	3,410	3,740	12,830	17,940	600

STD: Smell and/or taste dysfunction.

Armonk, NY, USA). Descriptive data were expressed for all categorized keywords to determine differences in the number of search volume within the months, and one-way analysis of variance (ANOVA) was used. The Pearson correlation coefficient was used for search terms with the highest pattern of similarity with the daily number of COVID-19 cases and deaths reports. A *p* value of <0.05 was considered statistically significant.

RESULTS

Between March 1st, 2020 and April 30th, 2020, the average number of internet searches for the 10 most common key terms related to STDs was approximately six times higher than the average number of searches conducted in the previous 10 months (p<0.001) (Table 1, Figure 1). In addition, the average number of internet searches for the 10 most common key terms related to STDs between March 1st, 2020 and April 30th, 2020 was approximately six times higher than the average number of those conducted between March 1st, 2019 and April 30th, 2019 (p<0.001) (Figure 2). There was a strong correlation between the change of internet searches containing the 10 most common key terms related to STDs and the change in the reported daily numbers of COVID-19 infections and deaths related to COVID-19 between March 18th, 2020 and April 30th, 2020 in Turkey (r=0.810 and r=0.783, respectively; p<0.001) (Figure 3).

The RSV surge for the term "inability to smell" that occurred between March 18th, 2020 and April 30th, 2020 was found to be strongly correlated with the increase number of COVID-19 cases and deaths due to COVID-19 between the same period (r=0.910 and r=0.854, respectively; p<0.001). The RSV surge for the term "inability to smell" that occurred in the period of March 18th, 2020 and April 30th, 2020 began to increase on March 21st, 2020, and the highest value was reached on April 12th, 2020.

The RSV surge for the term "inability to taste" that occurred between March 18th, 2020 and April 30th, 2020 was strongly associated with the increase in the number of COVID-19 infections and deaths in the same period (r=0.821 and r=0.801, respectively; p<0.001). The RSV surge for the term "inability to taste" that occurred between March 18th, 2020 and April 30th, 2020 began to increase on March 21th, 2020, and reached its highest value on April 12th, 2020.

DISCUSSION

The present study showed that there was a strong correlation between the daily number of cases of COVID-19 and deaths due to COVID-19 during the COVID-19 outbreak period in Turkey and the internet searches related to STDs. Although our study did not prove that the exact cause of the recent changes in STD complaints was COVID-19, it showed that there was an increase in internet searches at the announcement of the onset of the pandemic in

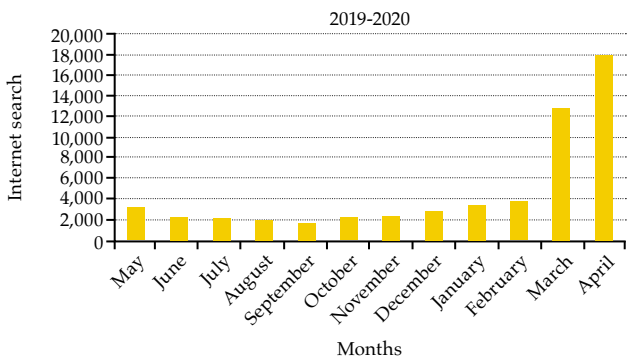

Figure 1. *The graphics of internet search numbers of key terms related to smell and/or taste dysfunction from May 2019 to April 2020.*

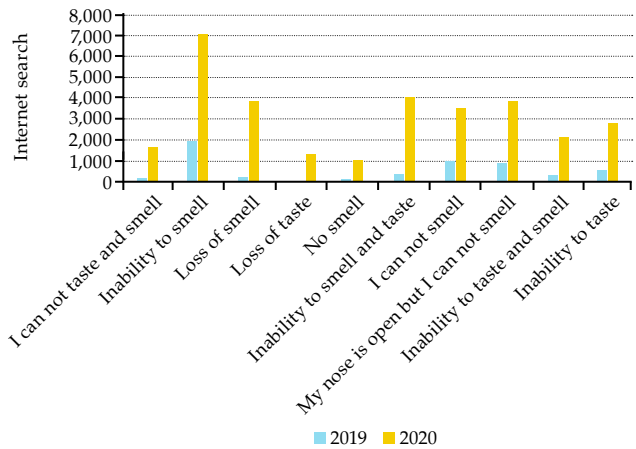

Figure 2. *Comparison the average internet search numbers of key terms related to smell and/or taste dysfunction between March and April 2019 and March and April 2020*

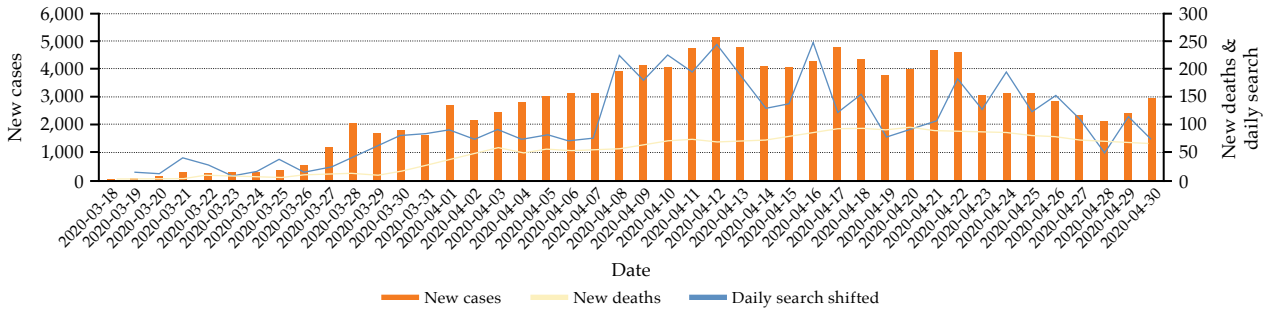

Figure 3. Comparison of COVID-19 ''New cases'' and ''New deaths'' with 'daily average number of internet search of key terms related to smell and/or taste dysfunction in Turkey

Turkey. The increase in the information gained from research on the internet may have caused STD complaints due to COVID-19 virus.

Over 80% of patients infected with COVID-19 survive this disease with mild symptoms and do not need hospitalization.[1] For the screening, healthcare providers ask about symptoms such as cough, fever, difficulty in breathing, and fatigue.[1,3] However, in recent weeks, the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) has proposed that STDs may be a symptom of COVID-19 and that it should be included in the criteria for COVID-19 screening.[12] During the same period, Prof. Claire Hopkins, MD from the British Rhinological Society (BRS) stated that there was a strong evidence that COVID-19 has caused smell dysfunction in South Korea, China and Italy, and those with smell dysfunction did not have major symptoms, such as fever or cough.[13] With these findings, STDs in COVID-19 have gained increasing importance.

Some known causes of STDs are viral upper respiratory tract infections (30 to 45%), nasal and sinus diseases (7 to 56%), head injuries (8 to 20%), drugs or toxic substances (2 to 6%), and congenital disorders (0 to 4%).[14] In addition, in 2007, Suzuki et al.[15] detected rhinovirus, coronavirus, Epstein-Barr virus, and parainfluenza virus in samples taken from the nasal secretions of patients who described smell dysfunction after viral upper respiratory infection. In their study, they found that respiratory viruses damaged the olfactory neuroepithelium and caused olfactory impairment. Similarly, many studies showed that various degrees of changes in the olfactory neuroepithelium after viral upper respiratory tract infections caused STDs.[16,17]

Although an exact pathophysiological mechanism of STDs caused by COVID-19 has not been elucidated yet, the number of studies reporting that COVID-19 causes STDs has been increasing in the COVID-19 pandemic. One of the first published articles on the neurological symptoms of COVID-19 was written by Mao et al.[4] In their study, about 6% of the patients had olfactory disorder, while 36.4% reported neurological symptoms. The authors also found that olfactory disorder might be the first symptom to appear before complicated neurological symptoms and that COVID-19 virus could spread to the brain after the olfactory region involvemet.

In a multi-center study conducted by Lechien et al.,[18] out of 417 patients with mild and moderate symptoms who tested positive for COVID-19 by the laboratory method, 85.6% described smell disorder and 88.8% described taste disorder. Furthermore, 79.6% with smell disorder reported that they could not smell at all, and 78.4% of those with taste disorder reported that they could not taste at all. Interestingly, 79.7% reported only smell disorders without nasal congestion or runny nose. The authors reported that STDs might occur before, at the same time as or after the main symptoms of COVID-19 appear. In their study, 11.8% of the patients with COVID-19 experienced STDs before the main symptoms

appeared. Therefore, the authors concluded that awareness and reports of STDs were important for early diagnosis of COVID-19.

In recent years, with the increasing use of computers and smart phones, it has become faster to reach people and information. In addition, the number of medical studies conducted through the internet has been increasing rapidly, and this has become a frequently used method in the COVID-19 pandemic period, particularly, during which quarantine measures are implemented in most countries. Yan et al.[19] performed a study on the internet for patients who had influenza-like symptoms and who underwent a COVID-19 screening test. They reported that 68% of patients who tested positive for COVID-19 described smell disorder and 71% described taste disorder. Of the patients who tested negative for COVID-19, 16% described smell disorder and 17% described taste disorder. The authors concluded that COVID-19 was strongly related to STDs and that STDs were observed at least 10 times more frequently in patients who tested positive for COVID-19 than those who tested negative. Similarly, in an online study conducted by Bagheri et al.[20] in Iran in March 2020, approximately half of the participants reported symptoms of STDs that occurred within the COVID-19 pandemic period. Based on these results, the authors claimed that there was an increase in reports of STDs in March 2020 and that this increase was due to the COVID-19 outbreak.

Apart from studies conducted over the internet, internet search data were obtained using GA and GT applications, which track the behavior of internet users from a specific date and location for any term or concept. These applications have been used in the medical field and in many scientific studies. For instance, statistical data obtained from these applications are used to study diseases such as cancer, acquired immunodeficiency syndrome, or influenza and to raise awareness of such diseases.[21,22] Ginsberg et al.[22] reported that, by following the search volumes of the keywords related to influenza via GT, the influenza epidemic level in any region could be estimated with one day delay. Walker et al.[23] also used GT to include many countries in a study similar to this one and concluded that the surge in internet searches related to smell during the COVID-19 pandemic period in Italy, Spain, England, the United States of America, Germany, France, Iran, and the Netherlands were related to the number of cases of COVID-19 and deaths from COVID-19 in each country.

In our study, to obtain more accurate data, a sample search was conducted via GA for the terms that internet users might use in searches about STDs. The 10 most common search terms related to STDs were used to compare search behaviors in the months before the pandemic to search behaviors during the pandemic period. Again, among these 10 terms, the surge in internet searches containing the two most common ("inability to smell" and "inability to taste") that occurred during the COVID-19 pandemic period in Turkey was investigated. We found that the surge in internet searches for key terms related to STDs, as demonstrated by the data obtained from GT and GA, was strongly correlated with the daily number of cases of COVID-19 and deaths caused by COVID-19 in Turkey.

Many studies have demonstrated that STDs are more common after seasonal upper respiratory viral infections.[24,25] We also considered this possibility in our study and compared the data from the COVID-19 pandemic period with the same months of the previous year. We found a significant increase in internet searches related to STDs in Turkey during the pandemic period, compared to the previous year. All the data obtained in our study suggest that, during the COVID-19 outbreak in Turkey, the number of individuals experiencing a change in their sense of smell and taste increased and that they felt the need to search for information about their condition on the internet.

Nonetheless, there are some limitations to this study. First, as it is not known how many individuals in Turkey search the internet for diseases, it is not known how much of the population is represented in the data. Second, it is unclear whether those who search for an illness on the internet search have the disease they are researching or are simply investigating data they heard from media outlets, such as television and radio. Finally, it cannot be determined whether people searching for STDs on the internet were diagnosed with positive COVID-19.

In conclusion, an increase was observed in the number of internet searches related to STDs with the spread of COVID-19 in Turkey. However, it is difficult to conclude that COVID-19 caused STD symptoms in this study. Therefore, further researches through epidemiological studies investigating the frequency of STDs in patients with COVID-19 are needed.

Declaration of conflicting interests

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