# COVID-19 and Public Interest in Ophthalmic Services and Conditions

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## ABSTRACT

**OBJECTIVE:** To assess the impact of the COVID-19 pandemic and associated lockdowns on public interest in ophthalmology.

**METHODS:** Search interest data for ophthalmic services and conditions were collected from January 1, 2019 to June 21, 2020. Temporal statistical analysis was used to identify significant trends. Weekly data on ophthalmic services and conditions search interest obtained from Google Trends were analyzed with analysis of variance testing and the generalized linear model based on dates.

**RESULTS:** Ophthalmic services searches decreased after the first COVID-19 case in the country ($p<0.001$); ophthalmic services and conditions search interest also declined after the first COVID-19 case and lockdown orders in each state ($p<0.001$). Following the first in-state COVID-19 case, search interest in ophthalmic services fell more than for ophthalmic conditions ($p=0.0088$). Lockdown and COVID-19 had similar effects on ophthalmic services search interest ($p=0.2246$), but interest in ophthalmic conditions decreased more after lockdown than after the first in-state case ($p<0.0001$).

**CONCLUSIONS:** Most of the decrease in search interest in ophthalmic services was associated with COVID-19 rather than lockdown orders, suggesting that public interest in ophthalmic care may be more sensitive to changes in the COVID-19 pandemic than lockdown orders.


**KEYWORDS:** COVID-19, patient care, infodemiology, search interest, Google Trends

## INTRODUCTION

To reduce the transmission of coronavirus disease 2019 (COVID-19), 43 states and several territories in the United States (US) have issued or previously issued lockdown orders as of June 18, 2020.[1] Trends in patient care have been impacted by the pandemic, with many public health authorities issuing guidelines to avoid or defer elective surgeries and in-person care.[2,3]

Understanding the impact of the COVID-19 pandemic and lockdown orders on public interest in ophthalmic services would help key stakeholders in ophthalmology prepare for a possible second wave. Moreover, it would provide unique insight into overall patient behaviors, such as balancing benefits of seeking treatment for an ophthalmic condition with the risk of contracting COVID-19. To our knowledge and based on a computerized search of the PubMed database, no previous studies have assessed the effect of COVID-19 and lockdown orders on public interest in seeking ophthalmic care.

Google Trends® is a free tool provided by Google LLC that provides data for the 1.2 trillion searches they handle per year.[4] Google Trends® data have been shown to serve as a measure of conjunctivitis outbreaks and public interest in specific treatments or health services.[5,6] In this study, we examined the impact of the COVID-19 pandemic and associated lockdown orders on Internet search interest for ophthalmic services and conditions using Google Trends® data.

## METHODS

### Data source

Google Trends is a publicly available database containing frequencies of anonymized Google searches since 2004.[7] For each query in Google Trends, the user extracts a "search interest" value ranging from 0 to 100 across specific times and geographical areas. Search interest is a relative value that is calculated following the normalization and scaling of absolute search volume. Normalization allows researchers to compare the frequency of searches in different areas accounting for their different population densities, and fixed scaling helps determine changes over time. The value of 100 is assigned to the highest level of search volume within a set location and time period. For example, a search interest value of 8 means that the search intensity at that specific time was 8% of peak intensity of all Google searches in a particular location and time period.

Public interest in ophthalmic services was obtained by searching 'ophthalmologist' in Google Trends, and the following internet search terms for eye conditions were employed based on a previous study:[6] 'basal cell', 'blepharitis', 'blindness', 'blurred vision', 'blurry vision', 'cataract', 'conjunctivitis', 'contact lens', 'contact lenses', 'double vision', 'dry eye', 'dry eyes', 'eye allergies', 'eye allergy', 'eye flashes', 'eye floaters', 'eye infection', 'eye pain', 'eye twitch', 'eye twitching',

'eyeglasses', 'glasses', 'glaucoma', 'headache', 'itchy eye', 'itchy eyes', 'LASIK', 'macular degeneration', 'melanoma', 'migraine', 'pink eye', 'rosacea', 'shingles symptoms', 'sinus', 'squamous cell', 'stye', 'uveitis', and 'watery eyes'.

The dates for the first confirmed COVID-19 case and lockdown orders in each state were recorded from state government websites and records. The date of the first COVID-19 case in the US was recorded from federal government records.[8]

Data for each state were collected weekly. There were 25 weeks of data for each state, with the time frame categorized into three phases: Phase 1 (from January 1, 2020 to January 20, 2020, the date of the first confirmed COVID-19 case in the US), Phase 2 (from January 21, 2020 to the date of the first confirmed COVID-19 case in each state), and Phase 3 (following that date until June 20, 2020).

To examine the impacts of lockdown orders, the time frame was categorized into four phases: Phase 1 and Phase 2 as defined previously, a revised Phase 3 (from the date of the first confirmed COVID-19 case in each state to the date of each state lockdown order), and Phase 4 (beyond that date to June 20, 2020).

### Statistical analysis

The primary outcomes were search interest in ophthalmic services and conditions. The mean and standard deviation of the outcomes were calculated for each phase. To examine the impact of ophthalmic services and conditions search volumes, one-way analysis of variance (ANOVA) test was conducted. Significance level of <0.05 was used for all hypothesis testing.

A multivariate generalized linear model with repeated measures compared the changes in ophthalmic services and conditions search interest across the four phases, using Phase 1 as a reference and controlling for state fixed effects. The temporal relationship between the two search interests for each state was modeled using repeated measures correlation. We used the same method to examine the impacts of COVID-19 and lockdown on the two search interests, using Phase 4 as the reference.

Statistical analyses were performed using SAS/STAT® software (version 9.4, SAS Institute Inc., Cary, US) and R (version 3.4.3, R Core Team, Vienna, Austria).[9]

## RESULTS

A comparison of trends in ophthalmic services and conditions searches for all states is shown in **Table 1**. Internet searches for ophthalmic services decreased significantly after the first COVID-19 case in the country; ophthalmic services and conditions search interest decreased after the first COVID-19 case in each state.

Search interest under the lockdown order was also significantly lower compared with the first phase (**Table 2**). Search interest in ophthalmic services decreased significantly more than search interest in ophthalmic conditions after the first in-state COVID-19 case (p=0.0088) but not significantly after the first case in the US or after lockdown.

Additionally, there was no significant difference between the association of COVID-19 and lockdown with search interest in ophthalmic services but search interest in

**Table 1.** Search interest in ophthalmology based on the COVID-19 timeline

| Mean search interest | Phase 1[a], estimate (95% CI) | Phase 2[b], estimate (95% CI) | Phase 3[c], estimate (95% CI) | p-value |
|---|---|---|---|---|
| 'Ophthalmologist' searches, mean (SD) | 6.17 (2.30) | 5.63 (2.75) | 4.32 (2.12) | <0.0001 |
| Ophthalmology-related searches, mean (SD) | 10.29 (2.01) | 10.41 (2.07) | 9.75 (1.93) | <0.0001 |

CI, confidence interval; COVID-19, coronavirus disease 2019; SD, standard deviation.
[a]Time before the first COVID-19 case in the US
[b]Time between the first domestic case and the first in-state case
[c]Time after the first in-state case
[d]All fifty states and Washington, District of Columbia.

**Table 2.** Change in search interest in ophthalmology associated with occurrence of COVID-19 and state lockdown orders

| Change in search interest from previous phase | Phase 1[a], estimate (95% CI) | Phase 2[b], estimate (95% CI) | Phase 3[c], estimate (95% CI) | Phase 4[d], estimate (95% CI) |
|---|---|---|---|---|
| 'Ophthalmologist' searches | 1 [reference] | -0.59 (-1.09 – -0.10)* | **-1.76 (-2.29 – -1.24)*** | -1.99 (-2.48 – -1.50)* |
| Ophthalmology-related searches | 1 [reference] | 0.06 (-0.27–0.38) | **-0.44 (-0.92 – 0.03)** | -1.22 (-1.57 – -0.88)* |
| Difference of change in volume for each search interest during each phase | - | 0.1645 | 0.0088 | 0.0819 |

CI, confidence interval; COVID-19, coronavirus disease 2019; SD, standard deviation.
[a]Time before the first COVID-19 case in the US
[b]Time between the first COVID-19 case in the US and the first in-state case
[c]Time between the first in-state case and the state lockdown order
[d]Time following the state lockdown order
[e]Excluded states without lockdown orders prior to June 21, 2020: Arkansas, Iowa, Nebraska, North Dakota, South Dakota, Utah, and Wyoming.
*p<0.05

**Table 3.** Association of COVID-19 and state lockdown orders on search interest in ophthalmology

| Mean search interest | Phase 1[a] vs phase 4[d], mean (95% CI) | Phase 2[b] vs phase 4[d], mean (95% CI) | Phase 3[c] vs phase 4[d], mean (95% CI) |
|---|---|---|---|
| 'Ophthalmologist' searches | 1.99 (1.50 – 2.48)* | 1.39 (1.03 – 1.76)* | 0.22 (-0.14 – 0.59) |
| p-value for difference between phases | <.0001 | <.0001 | .2246 |
| Ophthalmology-related searches | 1.22 (0.88–1.57)* | 1.28 (1.06 – 1.51)* | 0.78 (0.44 – 1.11)* |
| p-value for difference between phases | .73 | .07 | <.0001 |

CI, confidence interval; COVID-19, coronavirus disease 2019; SD, standard deviation.

[a]Time before the first COVID-19 case in the US

[b]Time between the first COVID-19 case in the US and the first in-state case

[c]Time between the first in-state case and the state lockdown order

[d]Time following the state lockdown order

*p<0.05

ophthalmic conditions had a significantly greater decline after lockdown than after the first in-state COVID-19 case (p<0.0001; **Table 3**).

## DISCUSSION

The overall decrease in search interest for ophthalmic services may have occurred as many ophthalmology clinics closed or cancelled appointments and/or patient anxieties about COVID-19 overshadowed concerns about their eye conditions. Additionally, with the rise in unemployment, many patients may have lost their health insurance, precluding seeking treatment for eye conditions.[10] Interest in eye conditions relative to ophthalmic services may have decreased less drastically because people who were unable or unwilling to receive services from an ophthalmologist were attempting to learn more about their symptoms or illnesses from the internet.

The onset of the COVID-19 pandemic – rather than the lockdown orders – was associated with most of the decrease in public interest in ophthalmic services. This suggests that public interest in ophthalmic care may be more sensitive to changes in the COVID-19 pandemic than in lockdown orders. In addition, search interest in ophthalmic conditions declined significantly more than interest in ophthalmic services following the lockdown. This may reflect fewer people seeing ophthalmologists and getting their conditions diagnosed. When the danger of COVID-19 recedes, pent-up demand for ophthalmic appointments and surgeries may lead to a heavy burden on the healthcare system and substantial delays in care.[11]

This study excluded people who use search engines other than Google or do not have internet access, and Google search data for each state may not reflect the interests of their populations. The underlying sample may be more health- and technology-literate than the general population. However, 99.96% of Americans have access to high speed internet,[12] and approximately 88% of people use Google for online searches,[13] indicating that the Google user population likely reflects the general population. Moreover, there may be different reasons to start a Google search for 'ophthalmologist' or ophthalmic conditions, including personal health and scholarly interest in the profession or the conditions; still, given that significant changes to interest in the ophthalmology profession or ophthalmic conditions were unlikely over the study period, search interest should serve as an accurate measure for patient interest in ophthalmic services and conditions. Also, Google Trends only provides relative search volume, so it was not possible to examine the magnitude of search volume changes. However, search interest data were normalized based on time and geography, which was useful for capturing change in overall behaviors. In addition, our search strategy may have excluded some pertinent terms, although our approach was consistent with that reported in a previous study.[6] Finally, there was policy heterogeneity among the lockdown mandates, with implementation at different times, restrictiveness, and with different populations.[14] Our analysis adjusted for the difference in timing among lockdown mandates by assessing the period after the onset of COVID-19 and the period after implementation of the lockdown orders.

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