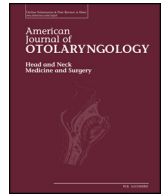




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Otolaryngology-related Google Search trends during the COVID-19 pandemic

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ABSTRACT

Objective: To assess trends of Google Search queries for symptoms and complaints encountered commonly in otolaryngology practices during the coronavirus disease 2019 (COVID-19) pandemic when in-person care has been limited.

Materials and methods: In this cross-sectional study, data on Google Search queries in the United States for 30 otolaryngology-related terms were obtained from Google Trends. The means of relative search volume from the COVID-19 period (March 29, 2020 through May 16, 2020) were compared to similar periods from 2016 to 2019 using a *t*-test of two independent samples.

Results: In total, 16.6% of search terms had significant increases in relative search volume during the COVID-19 period, with the largest percentage increase for “can’t smell” (124.4%, $p = .006$), followed by “allergies” (30.3%, $p = .03$), “voice pain” (26.1%, $p = .008$), and “ears ringing” (19.0%, $p < .001$). Of all search terms, 26.7% had significant decreases in relative search volume, including the largest percentage decrease for “laryngitis” (59.8%, $p < .001$), followed by “thyroid nodule” (54.4%, $p < .001$), “thyroid cancer” (45.6%, $p < .001$), and “ENT” (34.9%, $p < .001$).

Conclusion: This study demonstrates that Google search activity for many otolaryngology-related terms during the COVID-19 pandemic has increased or decreased significantly as compared to previous years. With reduced access to in-office otolaryngology care in the United States during the COVID-19 pandemic, these are important considerations for otolaryngology practices to meet the needs of patients who lack access to care.

1. Introduction

The World Health Organization declared the coronavirus disease 2019 (COVID-19) a global pandemic on March 11, 2020 [1]. In the United States (U.S.), federal guidelines for “social distancing” followed shortly thereafter, and by March 30, 30 states had officially announced “stay-at-home” orders, and 12 additional states issued similar orders during the following week [[2,3]]. Outpatient medical visits, including those in otolaryngology practices, have been reduced drastically secondary to these measures in an effort to protect patients and providers, as well as preserve personal protective equipment [4]. Changes in regulations have prompted providers to offer more telehealth

opportunities, and some otolaryngology practices have increased utilization of this method of care delivery [[4–6]]. For patients unable to access in-person or telehealth care, it is plausible that they might increasingly utilize internet search engines such as Google Search (Google Inc., Mountain View, California) to obtain information about symptoms, diagnoses, or treatments. During this unprecedented situation, it is important to understand the alternative ways in which patients are obtaining medical information in order to develop strategies within the otolaryngology community for meeting their needs. Google Trends (GT) is a free and publicly available tool that provides information on geospatial and temporal patterns in search volumes for user-specified terms [7]. GT has contributed to the emerging field of “infodemiology”,

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showing utility in assessing outbreaks of influenza-like illness or providing unique insights into human behavior [[8–10]]. This tool also has been utilized to examine relationships of otolaryngology-related search terms with environmental factors [11,12]. This study aims to assess trends within the U.S. for Google Search queries of symptoms and complaints encountered commonly in otolaryngology practices comparing the time of COVID-19 pandemic with similar time periods in previous years.

2. Methods

2.1. Google Trends data

GT determines the proportion of each search term among an anonymized sample of all search requests performed using Google Search [13]. Repeated searches by the same individual over a short period of time are eliminated. To account for geographical differences in total search volumes, GT normalizes each data point by dividing by the total searches within the time range and region. Relative Search Volume (RSV) is presented on a scale from 0 to 100 based on a term's proportion to all other searches, with the query's peak for the time range and geographic region set at 100 and all other data points divided by that peak value. For example, a value of 100 is the peak popularity for the term, while a value of 50 means that the term is half as popular. Table 1 includes the 30 search terms selected by the authors. These included a range of otolaryngology-related symptoms and complaints in technical and non-technical terminology as well as variations on a term to capture search activity more broadly. Internet search activity data were obtained and downloaded from the GT website (<https://trends.google.com/>). Each term search was performed with the following parameters: “United States” region; “1/1/2016 through 5/16/2020” time range; “All categories” for category; “Web search” type of search. Our aim was to investigate search volume coinciding with “stay-at-home” orders issued by the majority of states in the U.S. by March 30, 2020 [3]. Therefore, we compared the COVID-19 period (March 29, 2020 to May 16, 2020) to similar periods from the previous 4 years (2016–2019). The GT search data are reported in weekly intervals, thus the start dates for each of the 7-week periods under investigation were: March 27, 2016 to May 14, 2016; March 26, 2017 to May 13, 2017; April 1, 2018 to May 19, 2018; March 31, 2019 to May 18, 2019; and March 29, 2020 to May 16, 2020. Because this study does not constitute human participants research, it was exempt from review based on criteria established by the Institutional Review Board of Drexel University.

2.2. Statistical analysis

RSV data from the periods in 2016–2019 were pooled, the means calculated, and the RSV means from the corresponding COVID-19 timeframe in 2020 were calculated. Comparison of the RSV means between these time periods was performed using a *t*-test of two independent samples assuming unequal variances with two-sided *p*-value < .05 considered statistically significant. All computations were conducted in Microsoft Excel 2017 (Microsoft Corporation, Redmond,

Washington).

3. Results

Comparisons of the means of RSV and percentage change for respective search terms are described in Table 2. Of the 5 (16.6%) search terms with statistically significant increases in RSV during the COVID-19 period, the largest percentage increase was for “can't smell” (124.4%, $\mu_1-\mu_2 = 24.8$ [95% CI 14.0 to 35.6]; *p* = .006). This was followed by “allergies” (30.3%, $\mu_1-\mu_2 = 17.3$ [95% CI 6.0 to 28.6]; *p* = .03), “voice pain” (26.1%, $\mu_1-\mu_2 = 10.6$ [95% CI 4.5 to 16.7]; *p* = .008), “ears ringing” (19.0%, $\mu_1-\mu_2 = 13.4$ [95% CI 9.1 to 17.8]; *p* < .001) and “ear pain” (14.5%, $\mu_1-\mu_2 = 10.3$ [95% CI 5.1 to 15.4]; *p* = .004). The weekly RSV of two terms with the greatest percentage increase during the time range investigated is illustrated in Fig. 1. Statistically significant decreases in RSV also were found for 8 (26.7%) search terms, with the largest percentage decrease for “laryngitis” (59.8%, $\mu_1-\mu_2 = -33.6$ [95% CI -38.3 to -28.8]; *p* < .001). This was followed by “thyroid nodule” (54.4%, $\mu_1-\mu_2 = -41.1$ [95% CI -48.4 to -33.8]; *p* < .001), “thyroid cancer” (45.6%, $\mu_1-\mu_2 = -32.4$ [95% CI -36.6 to -28.1]; *p* < .001), and “ENT” (34.9%, $\mu_1-\mu_2 = -29.4$ [95% CI -34.7 to -24.2]; *p* < .001) and “big tonsils” (32.1%, $\mu_1-\mu_2 = -15.3$ [95% CI -26.0 to -4.6]; *p* < .02). The weekly RSV of two terms with the greatest percentage decrease during the time range investigated is illustrated in Fig. 2.

Three pairs of non-technical and technical terms were examined: “ears ringing” and “tinnitus”, “hoarseness” and “dysphonia”, and “trouble swallowing” and “dysphagia”. “Ears ringing” demonstrated a significant 19.0% increase in RSV ($\mu_1-\mu_2 = 13.4$ [95% CI 9.1 to 17.8]; *p* < .001) while “tinnitus” showed a nonsignificant decrease of 1.4% ($\mu_1-\mu_2 = -1.0$ [95% CI -5.4 to 3.4]; *p* = .67). In contrast, the non-technical term “hoarseness” had a non-significant 1.0% decrease in RSV ($\mu_1-\mu_2 = -0.7$ [95% CI -10.0 to 8.6]; *p* = .89) while “dysphonia” decreased significantly by 20.1% ($\mu_1-\mu_2 = -4.8$ [95% CI -7.9 to -1.7]; *p* = .006). Finally, RSV for “trouble swallowing” increased 4.3% without statistical significance ($\mu_1-\mu_2 = 2.8$ [95% CI -6.6 to 12.1]; *p* = .60), while “dysphagia” decreased significantly by 8.5% ($\mu_1-\mu_2 = -6.5$ [95% CI -11.1 to -1.8]; *p* = .02).

4. Discussion

During the COVID-19 pandemic when “stay-at-home” orders and “social distancing” guidelines drastically affected everyday life as well as otolaryngology practices in the U.S., we present evidence that internet search activity for many otolaryngology-related terms has changed significantly.

Of the 5 search terms with significant increases in RSV, “can't smell” demonstrated the greatest increase. A likely contributing factor to this increase was the inclusion of olfactory dysfunction as a possible symptom of COVID-19. By mid-March 2020, the American Academy of Otolaryngology-Head and Neck Surgery recommended including this symptom when screening for possible COVID-19 [14]. Meta-analysis later indicated a 52% prevalence of olfactory dysfunction among

Table 1
All search terms investigated with Google Trends.

Ear-related	Voice-related	Mouth and swallowing-related	Neck-related	Nose and sinus-related	Other
Ear infection	Hoarseness	Trouble swallowing	Neck lump	Nosebleed	Allergies
Ear pain	Dysphonia	Dysphagia	Thyroid cancer	Can't smell	Otolaryngology
Ears ringing	Difficulty speaking	Tonsillitis	Thyroid nodule	Sinusitis	ENT
Tinnitus	Laryngitis	Big tonsils		Sinus pressure	
Hearing loss	Throat pain			Sinus congestion	
Dizziness	Voice pain			Sinus pain	
Facial paralysis					
Bell's palsy					

Table 2
Relative search volume during the COVID-19 period vs previous years^a.

Search term	RSV, 2020, mean (SD)	RSV, 2016–19, mean (SD)	Percent change	Difference in means	95% CI	p value
Ear-related						
Ear infection	59.7 (6.0)	60.9 (5.7)	-2.0	-1.2	[-6.1, 3.7]	.66
Ear pain	81.1 (5.8)	70.9 (7.6)	14.5	10.3	[5.1, 15.4]	^b .004
Ears ringing	84.1 (3.9)	70.7 (8.7)	19.0	13.4	[9.1, 17.8]	^b < .001
Tinnitus	70.4 (2.9)	71.4 (10.5)	-1.4	-1.0	[-5.4, 3.4]	.67
Hearing loss	68.1 (2.7)	84.5 (6.1)	-19.4	-16.4	[-19.4, 13.3]	^b < .001
Dizziness	84.3 (3.4)	81.2 (5.3)	3.8	3.1	[-0.1, 6.3]	.10
Facial paralysis	50.9 (10.3)	57.1 (14.0)	-10.9	-6.2	[-15.4, 3.0]	.27
Bell's palsy	11.6 (1.3)	12.8 (1.5)	-9.7	-1.3	[-2.4, -0.1]	.06
Voice-related						
Hoarseness	71.9 (11.0)	72.6 (12.3)	-1.0	-0.7	[-10.0, 8.6]	.89
Dysphonia	19.0 (1.4)	23.8 (7.9)	-20.1	-4.8	[-7.9, -1.7]	^b .006
Difficulty speaking	63.1 (3.7)	61.2 (15.7)	3.2	2.0	[-4.5, 8.4]	.56
Laryngitis	22.6 (5.4)	56.1 (6.9)	-59.8	-33.6	[-38.3, -28.8]	^b < .001
Throat pain	62.3 (12.4)	52.5 (5.9)	18.6	9.8	[0.3, 19.2]	.10
Voice pain	51.3 (6.8)	40.7 (9.1)	26.1	10.6	[4.5, 16.7]	^b .008
Mouth and swallowing-related						
Trouble swallowing	66.9 (10.8)	64.1 (13.2)	4.3	2.8	[-6.6, 12.1]	.60
Dysphagia	69.7 (3.9)	76.2 (9.8)	-8.5	-6.5	[-11.1, -1.8]	^b .02
Tonsillitis	65.1 (9.0)	72.7 (5.5)	-10.4	-7.6	[-14.6, -0.6]	.09
Big tonsils	32.4 (11.1)	47.8 (18.5)	-32.1	-15.3	[-26.0, -4.6]	^b .02
Neck-related						
Neck lump	75.6 (5.8)	78.5 (7.1)	-3.7	-2.9	[-7.9, 2.1]	.31
Thyroid cancer	38.6 (4.5)	70.9 (7.0)	-45.6	-32.4	[-36.6, -28.1]	^b < .001
Thyroid nodule	34.4 (9.0)	75.5 (8.2)	-54.4	-41.1	[-48.4, -33.8]	^b < .001
Nose and sinus-related						
Nosebleed	70.6 (6.3)	67.7 (7.1)	4.2	2.9	[-2.5, 8.2]	.35
Can't smell	44.7 (14.5)	19.9 (3.4)	124.4	24.8	[14.0, 35.6]	^b .006
Sinusitis	59.4 (8.1)	65.7 (5.7)	-9.5	-6.3	[-12.6, 0.1]	.11
Sinus pressure	55.3 (8.1)	57.6 (6.6)	-4.0	-2.3	[-8.8, 4.2]	.53
Sinus congestion	45.4 (11.6)	49.4 (5.9)	-8.0	-4.0	[-12.9, 4.9]	.44
Sinus pain	52.4 (6.6)	58.3 (7.6)	-10.1	-5.9	[-11.5, -0.2]	.08
Other						
Allergies	74.4 (14.5)	57.1 (9.4)	30.3	17.3	[6.0, 28.6]	^b .03
Otolaryngology	53.9 (7.4)	52.7 (9.6)	2.2	1.1	[-5.4, 7.7]	.75
ENT	55.0 (6.3)	84.4 (6.7)	-34.9	-29.4	[-34.7, -24.2]	^b < .001

^a Time periods analyzed include the COVID-19 period (March 29, 2020 to May 16, 2020) and similar periods from previous years (March 27, 2016 to May 14, 2016; March 26, 2017 to May 13, 2017; April 1, 2018 to May 19, 2018; and March 31, 2019 to May 18, 2019).

^b Two-sided p-value < .05, statistically significant. RSV, relative search volume. SD, standard deviation. CI, confidence interval.

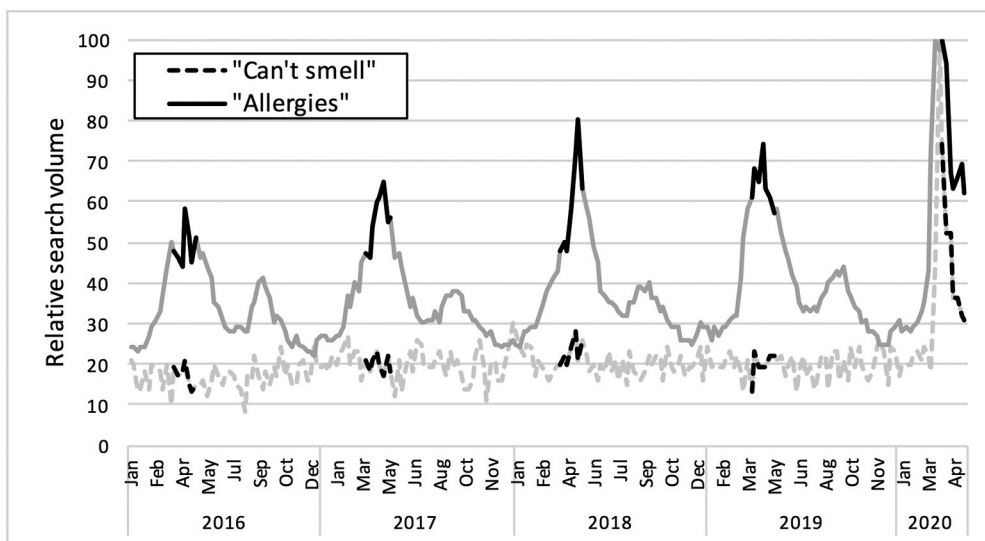


Fig. 1. Weekly Google Search results for “Can't smell” and “Allergies”^a.

^aTime periods analyzed are in bold, which include the COVID-19 period (March 29, 2020 to May 16, 2020) and similar periods from previous years (March 27, 2016 to May 14, 2016; March 26, 2017 to May 13, 2017; April 1, 2018 to May 19, 2018; and March 31, 2019 to May 18, 2019).

infected patients [15]. This was discussed widely in the media, which likely contributed to the 124.4% increase in Google searches for “can't smell” seen in this study [16]. The four additional search terms with significant increases in RSV were “allergies”, “voice pain”, “ears ringing”

and “ear pain”. In attempting to understand this trend, it is interesting that all of these terms are non-technical and could be associated with patients being unable to attend appointments with otolaryngologists. As a quantitative example of appointment reductions in an otolaryngology

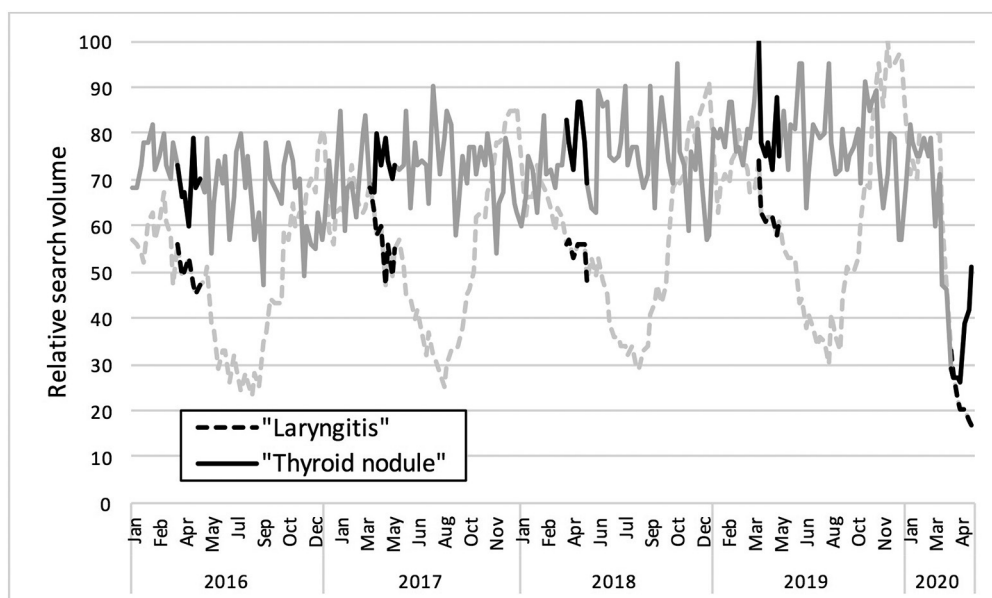


Fig. 2. Weekly Google Search results for “Laryngitis” and “Thyroid nodule”^a.

^aTime periods analyzed are in bold, which include the COVID-19 period (March 29, 2020 to May 16, 2020) and similar periods from previous years (March 27, 2016 to May 14, 2016; March 26, 2017 to May 13, 2017; April 1, 2018 to May 19, 2018; and March 31, 2019 to May 18, 2019).

practice, Kasle et al. reported a roughly 80% reduction in completed appointments from mid-March 2020 to mid-April 2020 compared with the corresponding period in 2019 [4]. Similarly, emergency departments have seen 80% reductions in the number of otolaryngology-related consultations during the COVID-19 pandemic [17]. It is possible that the increases in search queries for these four non-technical terms could be attributed partially to patients resorting to internet searches in lieu of medical consultation to obtain information about symptoms or treatment. However, this association is speculative and warrants further investigations such as correlating GT searches for “allergies” with regional pollen concentrations [18]. Nonetheless, this finding highlights the increasing use of the internet for certain non-technical symptoms during the COVID-19 period. With the marked variability in the quality of internet information on treatments for common otolaryngologic problems, this highlights the need for improvements to the web-based information available to patients [19].

Of the 30 terms investigated, 26.5% demonstrated significant decreases in RSV during the COVID-19 period. In assessing the possible factors contributing to these trends, it may be important to recognize the 34.4% reduction in RSV for “ENT” as the context for the decreases seen in the other terms. This decrease in “ENT” queries could reflect the reduction in referrals to otolaryngologists and the widespread cancellations of elective surgeries [20]. Previous studies have shown that patients utilize more internet search terms after receiving a diagnosis as compared to before it has been given [21]. With fewer patients accessing otolaryngologists to receive diagnoses such as thyroid cancer or dysphonia, a decreased post-diagnosis search phenomenon could explain the reductions in certain search queries. This is further supported by the findings for the three pairs of non-technical and technical terms compared in this study. The only significant RSV increase for these was the non-technical term “ears ringing”, while the only significant RSV decreases occurred with the technical terms “dysphonia” and “dysphagia.” RSV reductions for these terms, as well as “thyroid nodule”, could provide insight into patients' diagnostic needs that may have been addressed insufficiently during this period. Prompt attention to this matter may be warranted, as a portion of these diagnoses may represent underlying cancer and delays in care for head and neck cancer are associated with decreased survival [22].

Some institutions have increased telehealth utilization 100-fold during the COVID-19 period to compensate for the reduction of in-office encounters, but this degree of technological adaptation has not been seen nationally [[4,23]]. There is a substantial amount of

literature addressing the unique challenges to implementing telehealth in otolaryngology practices, and these GT findings could be incorporated into these strategies to meet patients' needs both during the COVID-19 pandemic and after it has resolved [[24–26]]. Looking beyond the ongoing pandemic, GT represents a potentially powerful source of insight into population-level searches for medical information that could guide timing of public health policies and improve understanding of regional differences in otolaryngology-related patient needs.

This report has limitations. The selected terms that were investigated represent a subjective bias toward terms that the authors suspected to be searched commonly on the internet. GT does not provide quantitative information on search terms. Therefore, the observed changes in this study cannot be quantified to determine actual numbers of searches. Data are reported from a population sample determined by GT, and thus may not represent accurately the entire population of the region under investigation. Additionally, there is inherent bias when using GT data as they are generated by a population that is literate, technologically competent, has access to the internet, and has selected Google as a search engine. The underlying motivations to perform a Google search vary widely and could include obtaining information on symptoms experienced by individuals, responding to media coverage, seeking information for academic interests, or many other motivations. These motivations cannot be discerned directly from GT data, which limits the interpretation of the information. Nevertheless, the trends suggest that patients are responding to COVID-19-related restrictions in otolaryngology care by changing their patterns of self-education through the internet.

5. Conclusion

The COVID-19 pandemic has challenged the ability of otolaryngologists to provide care to many patients in the U.S. This study demonstrates that Google search activity for many otolaryngology-related terms during this period has increased or decreased significantly as compared to previous years. These trends may suggest unmet needs of patients that otolaryngology practices should consider and attempt to address through expanded telehealth utilization. It also suggests that otolaryngologists may need to be prepared to address the information and misinformation that patients have acquired, which is likely to affect the substance of future in-person or telehealth encounters. Additional investigations are needed to better understand how patients utilize the

internet to obtain medical information, to improve the quality of available web resources, and to determine the effects of such self-education on patients' future behaviors in caring for their otolaryngologic disorders.

Author contributions

Matthew Pier: Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Writing - Reviewing & Editing; **Luke Pasick:** Conceptualization, Methodology, Writing - Original Draft, Writing - Reviewing & Editing; **Daniel Benito:** Writing - Original Draft, Writing - Reviewing & Editing; **Ghiath Alnouri:** Conceptualization, Writing - Reviewing & Editing; **Robert Sataloff:** Conceptualization, Writing - Reviewing & Editing, Supervision.

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Declaration of competing interest

None.

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