

ORIGINAL ARTICLE

Medicine Science 2021;10(1):111-7

Can Google® trends predict emergency department admissions in pandemic periods?

 **Serkan Emre Eroglu**,  **Gokhan Aksel**,  **Ibrahim Altunok**,  **Serdar Ozdemir**,
 **Abdullah Algin**,  **Hatice Seyma Akca**,  **Kamil Kokulu**

University of Health Sciences, Umraniye Research and Training Hospital, Department of Emergency Medicine, Istanbul, Turkey

Received 12 August 2020; Accepted 03 September 2020
Available online 17.01.2020 with doi: 10.5455/medscience.2020.08.162

Copyright©Author(s) - Available online at www.medicinescience.org

Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.



Abstract

Currently, individual sharing and emotions can affect health behaviors and admissions to hospitals. Google Trends created from Google search can use for screening mood changes associated with people's daily lives. We aimed to investigate the association between emergency department (ED) admissions and Covid-19-associated search engine use. This cross-sectional observational study was carried out in the ED between 2018 to 2020. Since the Covid-19 disease is specific to this year, Google Trends analysis was done between December 31, 2019 and March 31, 2020. However, ED admissions data for the same period were also compared with the data of 2018 and 2019 to observe the change from previous years. The correlation between the IOTs (a kind of search data score defined by google trends) term and the number of admissions to ED were evaluated. A total of 118,765 patients admitted from December 31, 2019 to March 31, 2020. Out of these ED visits, 34,830(29.3%) were admitted by Covid-like symptoms. The average rate of patients with these symptoms in the same periods of the last 3 years was 24%. We discovered that the IOTs for the term 'corona', which has the greatest IOTs among other terms, was positively correlated with the ratio of patients with coronavirus-like symptoms to all patients ($r = 0.249$, $p < 0.001$) and negatively correlated with the ratio of patients with other symptoms to all patients ($r = -0.249$, $p < 0.001$). Contrary to the expectations, the pandemic situation, a decrease in the number of cases should make us question a patients' urgency. Because of the association between search engine using and patient admissions during the coronavirus pandemic, our study is the first study to predict emergency crowding. Due to this characteristic, our research can provide important data for forecasting health system management.

Keywords: Emergency departments, patient admission, search engine, pandemics, Covid-19, Covid-19 symptoms, coronavirus, pneumonia.

Introduction

Currently, people can easily follow global health issues via newspaper articles and advertisements, radio and television messages, and social media outlets (i.e., Twitter and Facebook) [1,2]. With the information disseminated via these channels, information can quickly reach a large population and create curiosity, excitement, anxiety and even fear. With the effect of these feelings and situations, people often need to research various issues to a greater extent and use internet search engines for this aim. This intense information mobility can also affect patients' hospital admission behaviors. In this context, in the last few months, we observe that the most important situation that has affected people is Covid-19, which originated in China in December 2019 and caused a pandemic.

This current coronavirus pandemic situation affects the whole world, is at the top of the global agenda and creates anxiety in every layer of society.

People worry and search for information about the pandemic on the internet. Mood changes may affect current admissions to hospitals. Many studies have revealed a significant number of non-urgent admissions to emergency departments (EDs) on routine working days [3,5]. If this situation continues during the pandemic, the healthcare systems struggling with the pandemic will be influenced by this group of patients, who create additional burden on healthcare workers.

The aim of this study was to investigate the association between ED admissions and Covid-19-associated search engine use and thus, the effect of mood changes in people's daily lives on their ED admissions was observed.

Materials and Methods

This study is a cross-sectional observational study that was conducted in the ED of the Training and Research Hospital in University of Health Sciences Umraniye Research and Training Hospital, (Istanbul, Turkey), which has approximately 580,000 visits annually. The study began after the Institutional Review Board approved it with number B.10.1.TKH.4.34.H.GP.0.01/75.

*Corresponding Author: Hatice Seyma Akca. University of Health Sciences, Umraniye Research and Training Hospital, Department of Emergency Medicine, Istanbul, Turkey, E-mail: haticeseymaakca@gmail.com

The months of January, February, March of 2018 - 2019 and the same months of 2020 were the time period of data collection of the study.

Our study was conducted by using two sets of independent data: the number of ED admissions obtained from hospital information management system and Google Trends data obtained from <https://trends.google.com/>. Because of the Covid-19 disease is specific to this year, Google Trends analysis was only done between December 31, 2019 and March 31, 2020. In addition to this, ED admissions data for the same period were also compared with the data of 2018 and 2019 to observe the change from previous years. So, the sample size was 119,422 patients for 2018, 128,317 patients for 2019, and 118,765 patients for 2020. Then, the number of ED admissions and Google Trends search term data were analyzed using a time-series analysis. Non-traumatic patients over the age of 18 and trauma patients of all ages were included in the study. Despite their visit to the ED, patient files that belonged to patients that were discharged without examination were not included in the analysis.

Study Center Description

According to the statistics of 2019, the population of Istanbul was 15,519,267. The hospital where our study is conducted is located in University of Health Sciences Umraniye Research and Training Hospital, district; its population was 710,280. When the population of the 5 districts surrounding this district is included, the total population of the regions under the responsibility of our hospital was 2,616,700 [6]. Because of the surrounding population density is high, our ED is considered to be one of the most crowded emergency services in Turkey. In addition to this, ED overcrowding is an issue not only in University of Health Sciences Umraniye Research and Training Hospital, Istanbul but also all EDs in Turkey [7]. The Ministry of Health reported that the number of ED admissions in Turkey were more than five times the Istanbul population in the first 10 months of 2017 ($n = 76,834,439; 25.97\%$) [8].

In the triage system used in our ED, patients are categorized by a triage nurse firstly and then grouped as green, yellow or red. While the green code states the lowest level of urgency, red code states the highest. Then, all of the patients grouped are taken care in specialized ED areas such as green area for green code, red code for red area, yellow code for yellow area. In addition to this, trauma area is structured for noncritical green code trauma patients and injection room is also structured for the prescribed IV/IM administrations.

Data Pre-processing

Patient admission and epidemiological data, which includes the emergency patient's digital records, were obtained from the hospital information management system, whereas Google Trends data were obtained from <https://trends.google.com/>.

The patients were divided into two groups: the first group (Covid-19-like symptoms) consisted of patients who present with symptoms that could be associated either with Covid-19 or other flu-like infections (symptoms of upper and lower respiratory tract infection), while the second group (other symptoms) consisted of

other patients. In our search, we chose Covid-19-related English/Turkish terms that are used frequently by the World Health Organization (WHO), Health Ministry and the public. The terms "coronavirus", "covid", "COVID19", "SARS-Cov-2", "corona", "korona" and "Koronavirüs" were searched (Figure 1). First, these words were searched in separated groups because the Google Trends application does not allow word combinations and more than 5 calls at once. Second, comparative analyses were performed according to one term (term "corona"), which had the highest IOTs.

Google Trends

Google Trends is a search trends feature that shows how frequently a given search term is entered into Google's search engine relative to the site's total search volume over a given period of time. Google Trends was created from Google search and other sites affiliated with Google [9]. The popularity of a search term is represented as a number defined as an IOTs. The peak popularity of a search term is defined by 100 points. An IOTs of 50 points means that the searched term has half the popularity. A score of 0 means that the data for this term is insufficient [10].

Statistical Analysis

Statistical analysis was performed using SPSS v25.0 for Mac OS X (Chicago, IL, USA). Patient data were obtained from the hospital information management system. The normality of the data distribution was determined by the Shapiro-Wilk test. The categorical values of the patients were expressed as a number and a percentage and continued values were presented as a mean standard deviation (SD) or median values and an inter-quartile range (IQR) of 25%–75% according to the distribution of variables. Because the variables were not normally distributed, Spearman's correlation was performed to calculate the correlation of Covid-19-related IOTs ("corona") with the number of emergency admissions.

P value ≤ 0.05 were admitted statistically significant.

Results

A total of 366,504 patients admitted to ED over the 3-month period (from the last day of December to the last day of March) for 2018, 2019 and 2020 were enrolled. The median age was 39 years (IQR, 26 to 54), and 48.9 percent were men. While 118,765 patient encounters occurred from December 31, 2019 to March 31, 2020, out of these ED visits, 34,830 (29.3%) were admitted by Covid-like symptoms. The average number of patients with these symptoms in the same periods of the last 3 years was 88,127 (24%) [Table 1].

Google Trends analysis was shown that the topic word that yielded the greatest IOTs was "corona", which was searched using the "search term" option [figure 1]. Thus, we used this term for statistical analysis in our study.

According to our study, while Over the 3-month period for 2020, the median number of patient encounters was 1,368.5 patients per day (IQR: 1272.0 – 1481.75), The median IOTs for the same period of the patient encounters was 9 (IQR: 2 – 24).

Google Trends analysis was shown that the highest IOTs of 100 was obtained on March 11, 2020: on this day, the first Covid-19

case in Turkey was reported. A second peak was observed on March 16, 2020 (IOTs = 86/100), which coincides with the day after the first death was reported in Turkey. Our study clearly demonstrated that ED admissions decreased, especially in contrast to the increase in Covid-19-associated search starting from March 11, 2020. Accordingly, the IOTs for the term “corona”, which has the greatest IOTs among other terms, was positively correlated with the ratio of patients with coronavirus-like symptoms to all patients ($r = 0.249$, $p < 0.001$) and negatively correlated with the

ratio of patients with other symptoms to all patients ($r = -0.249$, $p < 0.001$). The association between patients' behaviors of ED admissions and Google Trends IOTs during the first 3 months of the Covid-19 pandemic is shown in figure 2.

According to our study, when patient admissions according to the triage code were evaluated, most of the patients were assigned a green triage code for all three years [figure 3].

Table 1. The demographic and clinical characteristics & emergency department admission areas of patients by years

		2018	2019	2020	Total
Age (median)		39.0 (27.0 – 55.0)	39.0 (26.0 – 55.0)	38.0 (26.0 – 53.0)	39.0 (26.0 – 54.0)
Gender (n(%))	Male	58575 (49.0)	61706 (48.1)	58836 (49.5)	179117 (48.9)
	Female	60847 (51.1)	66611 (51.9)	59929 (50.5)	187387 (51.1)
Emergency Department Admission Area (n(%))	Green Area	64417 (53.9)	71496 (55.7)	71732 (60.4)	207645 (56.7)
	Trauma Area	23249 (19.5)	23107 (18.0)	18672 (15.7)	65028 (17.7)
	Injection Room	15441 (12.9)	16706 (13.0)	16034 (13.5)	48181 (13.1)
	Yellow Area	11062 (9.3)	11487 (9.0)	7769 (6.5)	30318 (8.3)
	Red Area	5253 (4.4)	5521 (4.3)	4558 (3.8)	15332 (4.2)
	Total	119422	128317	118765	366504
The Most Common Reasons of Admission	Acute upper respiratory infections	20140	27891	31615	79646
	Prescribed treatment	15441	16706	16034	48181
	Soft tissue disorders	12059	14032	10084	36175
	Falls	8744	8382	6019	23145
	Digestive system and abdomen	7684	7785	6745	22214
	Circulatory and respiratory systems	3981	4281	5422	13684
	Exposure to inanimate mechanical forces	5108	4375	3524	13007
	Non-infective enteritis and colitis	2297	3333	3243	8873
	Dorsopathies	2403	1778	2218	6399
	Other diseases of urinary system	1995	1952	1493	5440
	Exposure to animate mechanical forces	1880	1622	1771	5273
	Hypertensive urgency	1428	1627	1352	4407
	Acute lower respiratory infections	1492	846	878	3216
	Other	34770	33707	28367	96844
Outcome (n(%))	Discharged	117206 (98.1)	125429 (97.7)	115551 (97.3)	358186 (97.7)
	Hospitalized to clinic	1755 (1.5)	2453 (1.9)	2577 (2.2)	6785 (1.9)
	Referred to another center	347 (0.3)	198 (0.2)	304 (0.3)	849 (0.2)
	Hospitalized to ICU*	49 (0.0)	185 (0.1)	225 (0.2)	459 (0.1)
	Died within ER**	65 (0.1)	52 (0.0)	108 (0.1)	225 (0.1)
Patients with Covid-like symptoms (n(%))	Other symptoms	96681 (81.0)	97761 (76.2)	83935 (70.7)	278377 (76.0)
	Covid-like symptoms	22741 (19.0)	30556 (23.8)	34830 (29.3)	88127 (24.0)
Total (n(%))		119422 (32.6)	128317 (35.0)	118765 (32.4)	366504 (100.0)

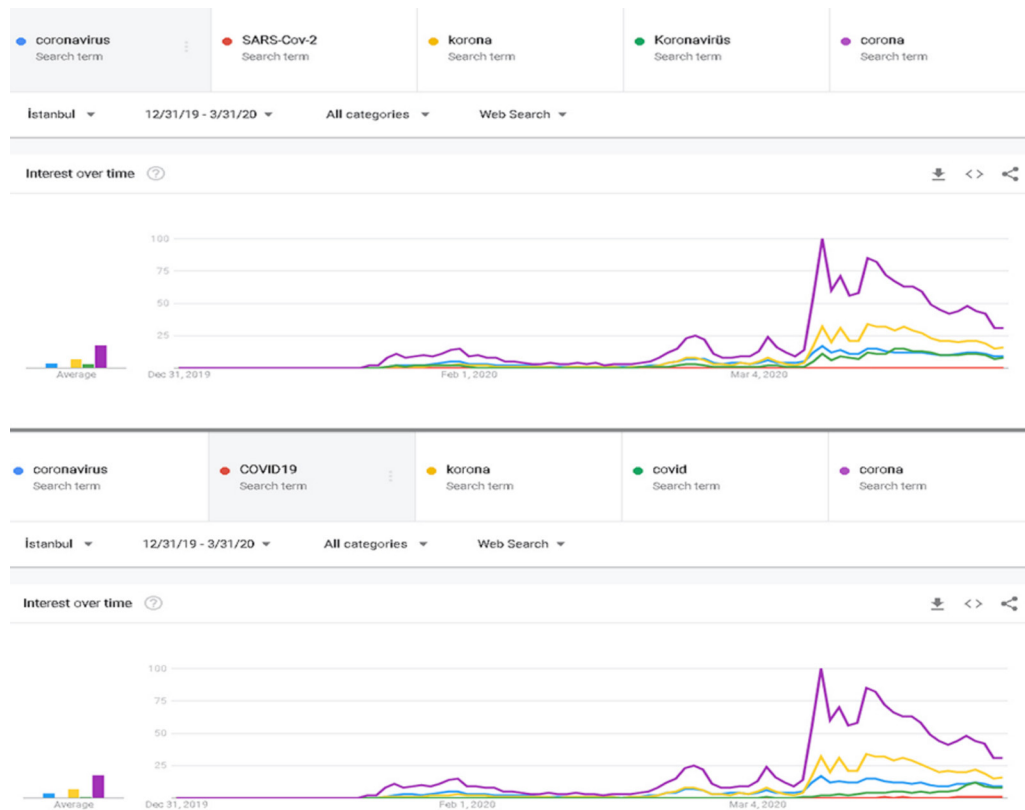


Figure 1. The terms searched in Google Trends

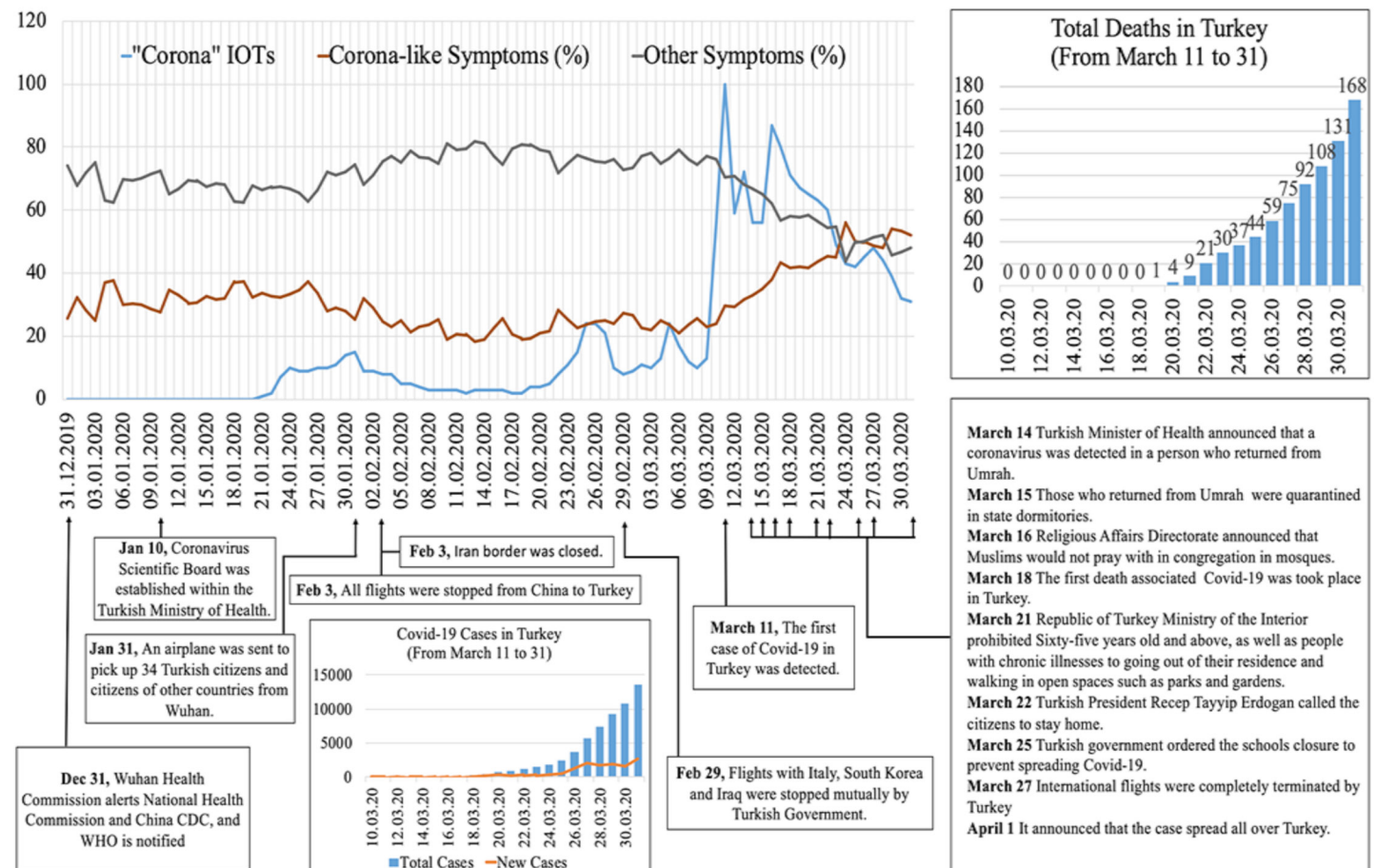


Figure 2. The association between patients' behavior of emergency department admissions and Google Trends-IOTs during the first months of the Covid-19 Pandemic

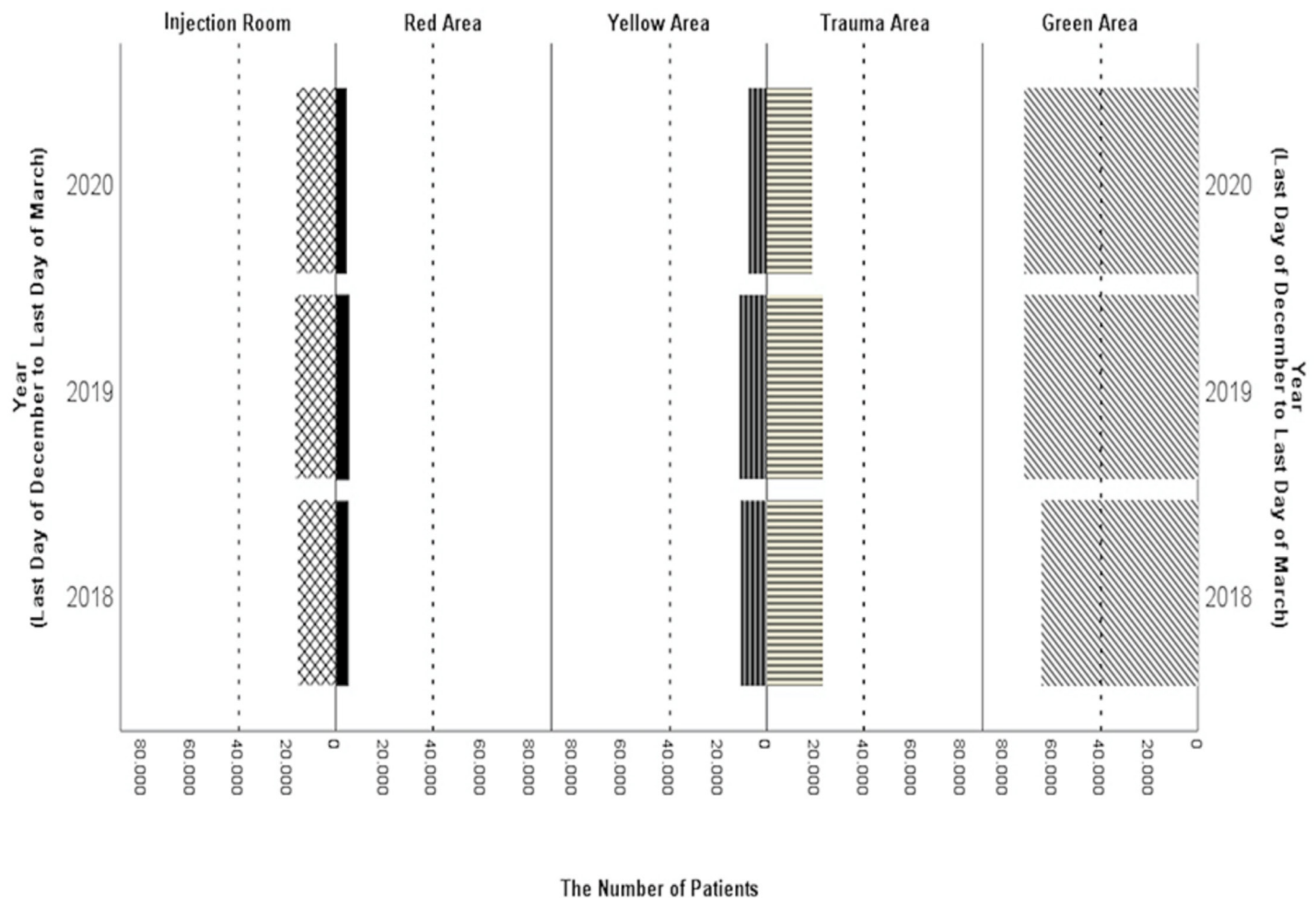


Figure 3. Emergency Department admission areas of the patients

In all, there were 53.9%, 55.7% and 60.4% patient admission who were evaluated with green triage code in 2018, 2019 and 2020, respectively.

Discussion

Coronaviruses are non-segmented, positive-sense RNA viruses that were first described in 1966 [11]. These viruses infect humans and many animal species [12]. In the past 20 years, two major outbreaks associated with coronavirus, SARS-CoV and MERS-CoV, occurred. At the end of 2019, a new type of coronavirus named SARS-COV2 caused a severe respiratory illness, Covid-19, with a global impact. Depending on the magnitude of the impact, Covid-19 term may be used more than in daily speech and practice.

In our study, the IOTs of the term “corona”, which has the greatest IOTs among other terms, was positively correlated with the ratio of patients with coronavirus-like symptoms to all patients and was negatively correlated with the ratio of patients with other symptoms to all patients. In summary, according to our study, patients do not visit the EDs due to their non-flu-like symptoms during the Covid-19 pandemic. This result may suggested that fear and anxiety directly affect the ED admissions especially the nonurgents.

With the exception of our study, no other study has investigated

the association between ED admissions and Covid-19-associated search engine use other. In a study by Alicino et al. which was published in 2015, a significant correlation between Google Trends activities and epidemiologic data during the 2014 Ebola outbreak in western Africa was identified [13]. In another study, Malik et al. discovered that syndromic indicators based on Google Flu Trends (GFT) and ED data were strongly correlated with each other and virologic data during both waves of the 2009 H1N1 pandemic in Manitoba [14].

Some articles have addressed the use of internet search engine data to monitor infectious disease activity, outbreaks, mental health and substance abuse [13,15-19]. Our study is similar to these studies due to the use of Google Trends analysis in the methodology.

A study published in 2018 revealed that population size affected the flu spread [20]. The current pandemic situation in our country also supports this result. Most cases (approximately 60% of all confirmed Covid-19 cases in Turkey) are observed in Istanbul, which is the largest city in Turkey. In their 2012 study, Dugas et al. reported a positive correlation between flu incidents and ED overcrowding [18].

Turkey has been known as an upper-middle income country with a population of 83.2 million people [6]. According to the Turkey Electronic Communication Sector report, Turkey has 77.1 million

broadband internet subscribers [21]. Considered the largest and most developed city in the country, Istanbul is one of the cities where this technology is extensively employed. Because our study was conducted in Istanbul, future evaluations of ED admissions is important.

Covid-19 is transmitted from one person to another person by droplet transmission. Recent WHO reports have concluded that 3,759,967 confirmed patients worldwide have been exposed to SARS-CoV-2. These reports also indicated 259,474 deaths [22]. Thus, social isolation is considered the determinant of this pandemic. In the current situation, people use social media, the internet, TV, and radio. We can assume that the probability of "stay home" announcements were heard by the population more and the number of ED visits decreased due to its effect. The decrease in the number of emergency admissions during the pandemic in our study warrants further investigation of the urgency of emergency admissions during the pre-pandemic period.

Due to the Turkish Health Ministry's triage system suggestion, emergency service admissions are separated into green, yellow and red, which represent the lowest level of urgency to the highest level of urgency. In our study, 60.4% of the cases were assigned green triage in the main study period. Therefore, non-urgent cases were high in this period.

According to a study published in 2018 in Turkey, the most common complaints of non-urgent patients were musculoskeletal system pain (25.2%) and symptoms of upper respiratory tract infections (URTI) (19.7%) [4]. In another study, 6,254 (37.5%) patients admitted to the ED with a total of 23,424 admissions were diagnosed with upper respiratory tract infections [23]. In a different study conducted in the United States, it was concluded that anxiety during the pandemic period is related to google trends [24]. In this study, 31,615 (26%) patients admitted to the ED with a total of 118,765 admissions were diagnosed with upper respiratory tract infections. In previous studies, the application density was different from our study. The pandemic, which is effective all over the world, caused us to get different results from other google trends studies. Hospital admissions made due to Covid-19 symptoms during the pandemic were different from those due to other symptoms. Similar studies conducted in countries affected by the pandemic, though our study is the first study conducted in Turkey on this issue.

A study conducted in Turkey reported that approximately 22% of the ED admissions involved pregnancy tests, testing for job applications, wound dressing, and suture removal. Inappropriate ED use hinders its use for real emergency cases, decreases readiness for care, produces a negative spillover effect on the quality of emergency services, and raises overall costs [3].

Limitations

The main limitation of this study is that it was conducted in a single center in one city. Emergency department admissions made with subjective symptoms could vary according to patient psychology and social conditions. This situation could cause differences in sample size.

Conclusion

It is known that Google trends will change during the pandemic. Communication systems need to reach people with correct information and avoid panic. In emergency service admissions, patients should be aware of the risk of infection due to infection in the hospital

In our era, digitalization has reached great dimensions and has been adopted by a large population. Because of the availability of internet services, people strongly influence the volume of search engines during panic-inducing events, such as the Covid-19 pandemic. Governments and health managers should employ these interactions to guide their Emergency Health Care plans.

Nevertheless, healthcare systems should reveal the reasons for non-urgent admissions to the ED and provide solutions.

Conflict of interests

The authors declare that they have no competing interests.

Financial Disclosure

All authors declare no financial support.

Ethical approval

The study began after the Institutional Review Board approved it with number B.10.1.TKH.4.34.H.GP.0.01/75.

References

1. Zhao Y, Zhang J. Consumer health information seeking in social media: a literature review. *Health Info Libr J.* 2017;34:268-83.
2. Bastani P, Bahrami MA. COVID-19 related misinformation on social media: a qualitative study from Iran. *J Med Internet Res.* 2020.
3. Eroglu SE, Toprak SN, Urgan O, et al. Evaluation of non-urgent visits to a busy urban emergency. *Saudi Med J.* 2012;33:967-72.
4. Idil H, Kilic TY, Toker I et al. Non-urgent adult patients in the emergency department: Causes and patient characteristics. *Turk J Emerg Med.* 2018;18:71-4.
5. Di Somma S, Paladino L, Vaughan L et al. Overcrowding in emergency department: an international issue. *Intern Emerg Med.* 2015;10:171-5.
6. Address Based Population Registration System, Turkish Statistical Institute. <https://biruni.tuik.gov.tr/medas/?kn=95&locale=tr> access date. 16.02.2020.
7. Aksel G, Bildik F, Demircan A, et al. Effects of fast-track in a university emergency department through the National Emergency Department Overcrowding Study. *J Pak Med Assoc.* 2014;64:791-7.
8. Health Statistics. Turkish ministry of health. <https://dosyastane.saglik.gov.tr/Eklenti/9300,2017-ocak-ekim-donemi-poliklinik-yatis-ve-yogun-bakim-ve-acil-servis-verileri-baglaminda-her-bransta-ilk-100-hastanepdf.pdf?0> accessed date. 08.05.2020.
9. Elhussein M, Brahimi S, Alreedy A, et al. Google trends identifying seasons of religious gathering: applied to investigate the correlation between crowding and flu outbreak. *Inf process Manag.* 2020;3:102208.
10. Google Trends: What Is Google Trends? <https://www.wordstream.com/google-trends> accessed date. 01.05.2020.
11. Tyrrell DA, Bynoe ML. Cultivation of viruses from a high proportion of patients with colds. *Lancet.* 1966;1:76-7.
12. Velavan TP, Meyer CG. The COVID-19 epidemic. *Trop Med Int Health.* 2020;25:278-80.
13. Alicino C, Bragazzi NL, Faccio V, et al. Assessing Ebola related web search behaviour: Insights and implications from an analytical study of Google trends-based query volumes. *Infect Dis Poverty.* 2015;4:54.
14. Malik MT, Gumel A, Thompson LH, et al. "Google flu trends" and emergency department triage data predicted the 2009 pandemic H1N1 waves in Manitoba. *Can J Public Health.* 2011;102:294-7.
15. Ginsberg J, Mohebbi MH, Patel RS et al. Detecting influenza epidemics using search engine query data. *Nature.* 2009;457:1012-4.

16. Nuti SV, Wayda B, Ranasinghe I, et al, The use of Google trends in health care research: A systematic review. *Plos One*. 2014;9:109583.
17. Cho S, Sohn CH, Jo MW, et al. Correlation between national influenza surveillance data and google trends in South Korea. *Plos One*. 2013;8:81422.
18. Dugas AF, Hsieh YH, Levin SR, et al. Google flu trends: Correlation with emergency department influenza rates and crowding metrics. *Clin Infect Dis*. 2012;54:463–9.
19. Bragazzi NL, Barberis, I, Rosselli R, et al. How often people google for vaccination: Qualitative and quantitative insights from a systematic search of the web-based activities using Google trends. *Hum Vaccin Immunother*. 2017;13:464-9.
20. Dalziel BD, Kissler S, Gog JR et al. Urbanization and humidity shape the intensity of influenza epidemics in U.S. cities. *Science*. 2018;362:75-9.
21. Turkey Electronic Communication Sector Quarterly Market Data Report. <https://www.btk.gov.tr/uploads/pages/pazar-verileri/3-ceyrekraporu-2019.pdf> accessed date 16.02.2020.
22. World Health Organization Coronavirus disease (COVID-19) Situation Report – 109. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports> accessed date 08.05.2020.
23. Ozdemir S, Cimilli Ozturk T, et al. Evaluation of the prescriptions written for upper respiratory tract infections. *North Clin Istanbul*. 2015; 2:107-14.
24. Hoerger M, Alonzi S, Perry L M, et al. Impact of the COVID-19 pandemic on mental health: Real-time surveillance using Google Trends. *Psychological Trauma: Theory, Research, Practice, and Policy*. 2020;12:567-8.