

ORIGINAL ARTICLE

Interest in dentistry in early months of the COVID-19 global pandemic: A Google Trends approach

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Abstract

Background: In early the COVID-19 pandemic, routine dental treatments have been delayed due to the risk of disease transmission. This delay may lead public to search for information on the Internet for a solution.

Objectives: This study aims to evaluate the public interest in dentistry in the early months of the COVID-19 global pandemic in the selected countries.

Methods: The daily numbers of new COVID-19 cases were recorded for China, South Korea, Italy, Germany, Russia, Ukraine and Turkey. For these countries, Internet search interest of the keyword 'dentistry', 'coronavirus', 'COVID-19', 'SARS-CoV-2' and 'pandemic' in the early months of the COVID-19 pandemic was evaluated by using Google Trends data.

Results: In most countries included the public Internet search interest in 'dentistry+coronavirus+COVID-19+SARS-CoV-2+pandemic' peaked prior to the peak of new COVID-19 cases. While a statistically significant positive correlation was observed between the number of new cases and Google Trends data in China, South Korea, Italy and Germany, a statistically significant negative correlation was observed in Turkey.

Conclusion: The peak public interest in dentistry has been prior to the peak of COVID-19 new cases in most countries. The use of Internet data can provide useful information about pandemics and many other diseases.

KEYWORDS

dental health, Internet, pandemic, research, quantitative

INTRODUCTION

At the end of December 2019, a new pneumonia disease with an unknown cause was reported in the city of Wuhan in Hubei, China (Hui et al., 2020). Later, the causing factor of this new and serious pneumonia was described as a novel *coronavirus* (nCoV) (He et al., 2020). The disease has been named severe acute respiratory syndrome *coronavirus* 2 (SARS-CoV-2), and *coronavirus* disease 2019 (COVID-19) in short, by World Health Organization (WHO) (He et al., 2020; Lu et al., 2020). COVID-19 is

transmitted from person to person, mainly through the respiratory tract, droplets, respiratory secretions and direct contact. The symptoms are usually a high fever, cough and weakness (Li, Chen, et al., 2020; Li, Guan, et al., 2020). However, the infected patients may be asymptomatic and can contaminate a number of individuals (Rothe et al., 2020).

Dentists are in close contact with their patients during dental procedures. In dental clinics, saliva and blood spreads to the environment because high-speed rotary instruments are used for treatment (Kohn et al., 2003). The

droplets and aerosols include viruses, bacteria or various pathogenic microorganisms (Kampf et al., 2020; Kohn et al., 2003). Many reports have shown that COVID-19 has been spread by droplets and aerosols from infected patients in dental clinics (Peng et al., 2020; Rothe et al., 2020). Therefore, dental practice had to be delayed during the COVID-19 pandemic period (da Cruz Perez et al., 2020). In other words, the pandemic made it difficult for patients in need of dental treatment to reach dental clinics (Meng et al., 2020). It has been shown that the number of emergency patients who consulted their dental clinic at the beginning of the COVID-19 pandemic decreased by 38% (Guo et al., 2020).

Today, the Internet use has rapidly increased worldwide. People can consult the Internet on various subjects. Lately, it has been reported that eight out of 10 Internet users utilized the Internet for accessing health care knowledge (Hegarty et al., 2017). The widespread use of the Internet gives insight into people's interest in health (Wilson & Brownstein, 2009). It is precisely here that the term 'infodemiology' is proposed. By Eysenbach (2009), infodemiology is defined as 'the science of distribution and determinants of information in an electronic medium, specifically the Internet, or in a population, with the aim to inform public health and public policy'. In other words, infodemiology argues that there is a relationship between public health and information and communication patterns in the electronic environment. Prediction and monitoring of previous outbreaks have been made using infodemiology methods (Eysenbach, 2003; Farhadloo et al., 2018). The most widely used Internet resources are Google, Twitter and Facebook in infodemiology studies (Mavragani, 2020a; Mavragani et al., 2018).

Google Trends (www.trends.google.com.tr) (Google, USA) is a service that provides users with statistical information, including in which geography, in which languages and how often a word or phrase queries are searched in Google search engine. Thus, thanks to Google Trends, how much a word is searched on Google and its popularity can be evaluated. What makes Google Trends data so useful is that it is collected in real-time, reported and it is publicly available (Arora et al., 2019). In this way, it is known how often a term is searched on Google, and the public interest is analysed. However, some limitations have been reported. Firstly, it does not include data from individuals who are not Internet users (elderly people, individuals with low sociocultural levels, etc.). Further, the results relate only to the searched words and it should be noted that only biased positive correlations may be published (Arora et al., 2019).

There are many articles in the literature using Google Trends data during the COVID-19 pandemic process (Ayyoubzadeh et al., 2020; Effenberger et al., 2020; Hu et al.,

Key Messages

- Google Trends may be useful in assessing the growth in public interest in certain health topics during pandemics.
- A case study of dental health during the pandemic, using Google Trends, showed that searching by the public may increase as access to professional dentistry services become difficult, and self-management more important.

2020; Husnayain et al., 2020; Kluger & Scrivener, 2020; Li, Chen, et al., 2020; Li, Guan, et al., 2020; Mavragani, 2020; Strzelecki, 2020a, 2020b; Walker et al., 2020), however the number of studies conducted in the field of dentistry by analysing this data is relatively few (Sycinska-Dziarnowska & Paradowska-Stankiewicz, 2020). In addition, daily the number of COVID-19 cases has not been taken into account. For the first time, this study examines the relationship between daily the number of new COVID-19 case and Google Trends data of words relating to both dentistry and the current pandemic. This study hypothesizes that due to the delay of dental treatments and the decrease in dental clinics consultancies observed, patients will turn to Internet searches to solve dental problems. As this delay is due to the COVID-19 pandemic, the Internet search for information on dentistry and the pandemic will increase day by day. This study aims to evaluate the interest in dentistry of the public in the early months of the COVID-19 global pandemic in the selected countries.

METHODS

Data collection

China, South Korea, Italy, Germany, Russia, Ukraine and Turkey, which are thought to be most affected by the pandemic relative to the early months of the pandemic, were included in the study.

Firstly, the numbers of new COVID-19 infected cases of these countries were saved daily. The numbers of COVID-19 cases were obtained from the European Center for Disease Control (ECDC) for the period from 31 December 2019 to 27 April 2020. ECDC presents that the number of COVID-19 cases recognized by the WHO (<https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide>).

These countries were divided into two groups according to the date of first case detection.

- Early Group: Countries that detected the first case before on 1 March 2020. According to this, early group countries were China, South Korea, Italy and Germany.
- Late Group: Countries that detected the first case after on 1 March 2020. According to this, late group countries were Russia, Ukraine and Turkey. In Russia, although the first case was detected on 1 February 2020, there were no other cases in February, so the first case detection date was accepted as on 1 March 2020.

Then, the data of the Internet search interest of Google search engine users related to the determined keywords were obtained by using Google Trends for these selected countries. Google Trends presents the relative search volumes (RSV) for the search terms on the Internet. RSV refers to the relative searched number according to the total searched number for a search term in the selected category, location and time frame. RSV uses a scale between 0 and 100. One hundred indicates the most relatively frequent search activity (Arora et al., 2019).

In this study, the methodology framework about Google Trends was established as follows (Mavragani & Ochoa, 2019):

- Keyword selection: In terms of the purpose of the study, the words 'dentistry', 'coronavirus', 'COVID-19', 'SARS-CoV-2' and 'pandemic' were determined as Google Trends search words. A plus sign (+) meaning 'or' was put between each search term to present the association of those plural terms (Arora et al., 2019).
- Region selection: China, South Korea, Italy, Germany, Russia, Ukraine and Turkey.
- Period selection: The time frame was daily customized for each country. According to this, the time frame from the date of the first COVID-19 case detected in a country to the date when the study was last (27 April 2020) performed was determined as the timeframe for that country.
- Search categories: Selecting a category was not required as the keyword searched is specific.

Normalized Google Trends results were saved as.csv for visualization and further data analysis.

Statistical analysis

SPSS version 23 (IBM Corp.) was used for data entry and analysis. Correlation analysis was conducted between the daily number of COVID-19 cases and the daily RSV of 'dentistry+coronavirus+COVID-19+SARS-CoV-

2+pandemic'. A Kolmogorov–Smirnov test was used in the assessment of the data for normal distribution. A Pearson correlation analysis was used when the data were normally distributed, and a Spearman correlation analysis was used when the data were not normally distributed. Statistical significance level was accepted as $p < 0.05$.

RESULTS

Date of first case, new cases peak and the Google Trends RSV peak for the searched terms by countries

Table 1 shows the date of the first detected COVID-19 case, new cases peak and Google Trends RSV peak and the number of days between these dates for each country. The COVID-19 case was first identified at the end of December 2019 in China. The shortest time between the first detected case and Google Trends RSV peak was in Turkey (4 days) and the longest in South Korea (82 days).

Distribution of Google Trends RSV for the terms 'dentistry + coronavirus + covid-19 + sars-cov-2 + pandemic' by countries

In the early months of the COVID-19 pandemic, the public interest was related to the terms occurred at different times for each country. Figure 1 shows the distribution of new cases, deaths and Google Trends RSV data according to date, in the early group countries. Figure 2 shows the distribution of new cases, deaths and Google Trends RSV data according to date, in the late group countries. Google Trends RSV at the date of first confirmed case had more than 20% in only two of the late group countries (Italy and Germany). Google Trends RSV at the date of the first confirmed case had more than 10% in all early group countries. After the first COVID-19 case was detected in the country, Internet searches related to the determined terms increased in that country. It was found that the date of the Google Trends RSV peak was before the date when the new case peak was detected in all countries except South Korea. It was observed that Google Trends RSV for each country had an increasing trend on 11 March 2020.

Correlation between the new cases and the google trends RSV

A statistically significant correlation was found between the number of new cases and the Google Trends

TABLE 1 For each country, the date of the first case, the new case peak and Google Trends RSV peak for the searched terms and the number of days between these dates

Country	The dates	The date of RSV peak	The number of days between these dates		
Early group	China	The first case	31.12.2019	24.01.2020	24
		The new cases peak	13.02.2020		-20
	South Korea	The first case	20.01.2020	05.04.2020	82
		The new cases peak	29.02.2020		35
	Italy	The first case	31.01.2020	23.02.2020	23
		The new cases peak	22.03.2020		-28
Germany	The first case	28.01.2020	13.03.2020	45	
	The new cases peak	28.03.2020		-15	
Late group	Russia	The first case	03.03.2020	28.03.2020	25
		The new cases peak	27.04.2020		-29
	Ukraine	The first case	04.03.2020	29.03.2020	15
		The new cases peak	16.04.2020		-17
	Turkey	The first case	12.03.2020	16.03.2020	4
		The new cases peak	12.04.2020		-27

RSV for the searched terms in many countries (Table 2). Pearson correlation analysis was used because the data has been shown to have a normal distribution in Italy, Germany, Russia, Ukraine and Turkey according to the Kolmogorov–Smirnov test. Spearman correlation analysis was used because the data is not normally distributed in China and South Korea. A significant positive correlation between Google Trends RSV and the number of new COVID-19 cases was observed in China, South Korea, Italy and Germany. A significant negative correlation between Google Trends RSV and the number of new COVID-19 case was observed in Turkey.

DISCUSSION

In the epidemiology of information, the behaviour of the public in the field of health can be estimated by looking at Internet searches. To date, studies investigating the behaviour and surveillance of the public have been carried out using the infodemiology method in many subjects, such as epidemics caused by Severe Respiratory Syndrome (SARS) and *Zika virus* (Eysenbach, 2003; Farhadloo et al., 2018). In this study, Google Trends RSV data of some countries in the early months of the COVID-19 pandemic were evaluated with the infodemiology method. An association was found between Google Trends RSV data for specific search terms and the number of new COVID-19 cases.

In the study conducted by Zeraatkar and Ahmadi (2018), Google Trends was reported to be the most widely used data source to access the information requested by

the public; as a general principle, this may not be the case with pandemics. Google Trends provides varied, real-time and valuable information on people's health information search behaviour (Arora et al., 2019). It was used to determine the public Internet search behaviour in diseases such as SARS, *Zika virus*, *H1N1* influenza, flu, bird flu and swine flu (Bentley & Ormerod, 2009; Cook et al., 2011; Eysenbach, 2003; Morsy et al., 2018). Google Trends data is useful because it reflects the Internet behaviour of the public in accessing health care information during infectious diseases. Thus, we used Google Trends data for this study in this pandemic process.

Worldwide, the COVID-19 cases started at the end of December 2019 in China. Later, the pandemic spread to the other countries, and the public interest in the pandemic began to increase around 31 December 2019 in other countries. In addition, this is the date when the first *coronavirus* case was accepted by WHO (2020). This situation may be associated with the start of public interest in this issue. According to the results of this study, the greatest interest in the terms was first shown by the Chinese people. This finding is in accordance with the previous studies (Effenberger et al., 2020; Hu et al., 2020), and may be associated with the fact that the outbreak affected the Chinese people first.

The previous studies have found that an increase in public interest had on 11 March 2020 (Effenberger et al., 2020; Hu et al., 2020). According to this study, consistent with previous studies, the increase in public interest was observed at the relevant date. The public interest has increased since the *coronavirus* was declared a global

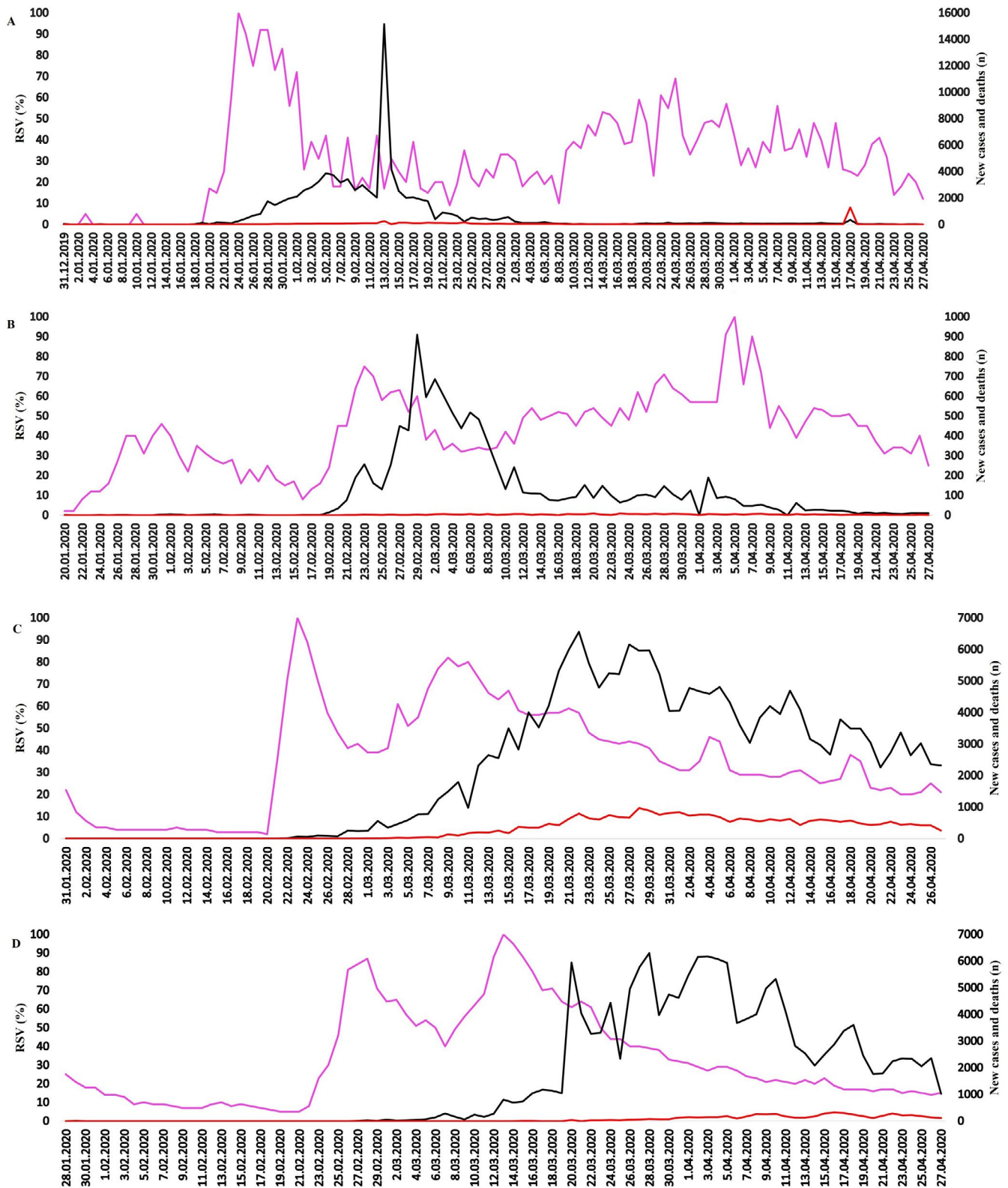


FIGURE 1 Distribution of new cases, deaths and Google Trends RSV for the searched terms according to the date, in the early group countries (A: China, B: South Korea, C: Germany, D: Italy; pink line: Google Trends RSV, black line: daily new case number and red line: daily death number; RSV, relative search volume)

pandemic on this date by WHO. The previous study found that when the threat of the *H1N1* epidemic increased, the use of the Internet increased due to anxiety and the

need for protection and the use of the Internet decreased when the perceived risk decreased (Chew & Eysenbach, 2010). In other words, the Internet use of the public in

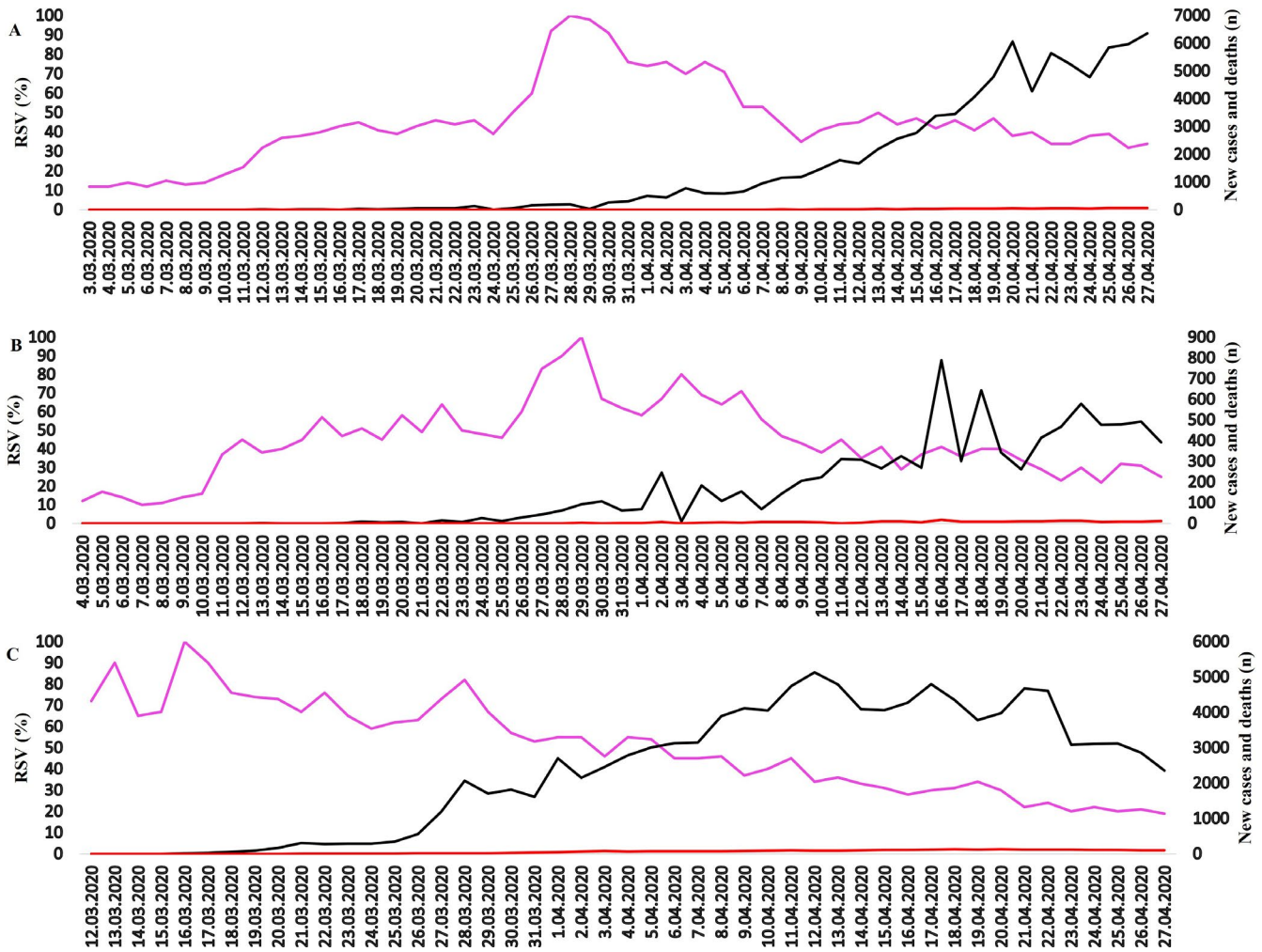


FIGURE 2 Distribution of new cases, deaths and Google Trends RSV for the searched terms according to the date, in the late group countries (A: Russia, B: Ukraine, C: Turkey; pink line: Google Trends RSV, black line: daily new case number and red line: daily death number; RSV, relative search volume)

TABLE 2 Correlation between new case and Google Trends RSV for the searched terms

Country		r	p-value
Early group	China	0.330s	<0.000**
	South Korea	0.585s	<0.000**
	Italy	0.244p	0.022*
	Germany	0.289p	0.005**
Late group	Russia	-0.113p	0.406
	Ukraine	-0.215p	0.115
	Turkey	-0.821p	<0.000**

Note: r: correlation coefficient, p*: significant at the 0.05 level, p**: significant at the 0.01 level.

the pandemics is directed towards these pandemics. Therefore, Google Trends data provides valuable information on global pandemics.

It was shown that highest public interest in COVID-19 was on average 11.5 days before the day when new cases were the highest (Effenberger et al., 2020). In this study, the date with peak levels of Google Trends RSV was before the date with the highest number of newly detected cases. This time interval varied between 15 and 29 days. Hu et al. suggested two new concepts to describe these days. One of these was response time and the other was the duration of public attention (Hu et al., 2020). It has been stated that response time refers to the time between the day when WHO received the report and the first day when Google Trends RSV started to occur. The duration of public attention is the time between the day when Google Trends RSV started to occur and the day it reached the apex. Hu et al. have reported that both the response time and the duration of public attention differ for each country (Hu et al., 2020). This situation varies between countries depending on the protection policies followed by the countries against the pandemic,

the measures taken, the power of the health system and the concerns and anxiety of the public. This suggests that although the first searches started on the Internet in a global pandemic, the peak of Internet searches depends on the presence of cases affected by the pandemic in that country.

In the early months of the COVID-19 pandemic, studies using Google Trends RSV data has shown that there is a correlation between the public interest in the search word 'coronavirus' and the number of new COVID-19 cases (Effenberger et al., 2020; Mavragani, 2020b; Schnoell et al., 2021). Although the correlation was mostly positive in many previous studies, there were also studies in which it was found negative (Effenberger et al., 2020; Mavragani, 2020b; Schnoell et al., 2021). In this study, in line with previous studies, mostly a positive correlation was observed between Google Trends RSV of the searched words and the number of COVID-19 cases. For the positive correlation between the case numbers and Google Trends RSV, it can be thought that the public is worried about the pandemic, while for the negative correlation, it can be thought that the public accepts the pandemic.

Coronavirus, transmitted from person to person through respiration, droplets and aerosols, has led to the delay of routine dental treatments (Peng et al., 2020). While this delay reduces the risk of cross-infection in dental clinics, it may increase the self-solution seeking of patients. This solution can be easiest with Internet and social media tools because the amount of publicly accessible medical information regarding the COVID-19 pandemic is increasing day by day (Jo et al., 2020). Oliveira and Zanatta (2020) have reported a study in which they analysed the Twitter messages of the Brazilian public during the COVID-19 outbreak. As a result of the study, it was reported that the volume of tweets about the need for dental treatment increased. Toothache and urgency were the most popular topics, and this situation reflected anxiety and distress in the public. In addition, Sycinska-Dziarnowska and Paradowska-Stankiewicz have analysed Google Trends RSV data for the first eight months of the COVID-19 pandemic (Sycinska-Dziarnowska & Paradowska-Stankiewicz, 2020). The authors, who found an increase in the search for the word 'toothache' as a result of the study, argue that many patients postpone their visit to the dentist and turn to an Internet search. In this study, positive correlation between the number of COVID-19 cases and Google Trends RSV was found for many countries. This situation suggests that patients used the Internet in the early months of the current pandemic for a solution to postponed dental treatments.

There are some limitations of this study. The first limitation is that as the pandemic continues, data changes every day. These correlations were obtained with baseline

data, and results may change over time. The second limitation is that choosing a search term can affect the results of the study; for example, individuals can search with different words such as 'high fever' or 'pneumonia'. Therefore, we used up-to-date terms to get the most accurate data. Although studies with Google Trends are increasing, there is no validated procedure in this regard. The third limitation is that not all countries in the study may use Google as an Internet search resource. For example, China generally uses Baidu, and if these data were used, perhaps different results would have been produced. However, we used the data of a single Internet search volume to avoid confusion in this study. In addition, in such a study, we wanted to examine the data of China, which is the starting centre of the COVID-19 pandemic. One last limitation is that studies using Internet data can never be said to reach the entire population because Google Trends data is only searched by users accessing the Internet. In addition, these data may not reflect the exact opinions of these users.

CONCLUSION

In the study, it was found that the public interest in dentistry has been prior to the peak of COVID-19 new cases in most countries included. A significant positive correlation between the number of new COVID-19 case and the Google Trends RSV was observed in most countries, in the early months of the COVID-19 pandemic.

The use of Internet data can provide real-time useful information about the pandemics and many other diseases for the management of health information. More research should be performed on pandemics, rare diseases or other health care by using Internet data such as Google Trends, social media.

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CONFLICTS OF INTERESTS

None.

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