ORIGINAL PAPER

Decreased public pursuit of cancer-related information during the COVID-19 pandemic in the United States

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Abstract

Background In response to the prioritization of healthcare resources towards the COVID-19 pandemic, routine cancer screening and diagnostic have been disrupted, potentially explaining the apparent COVID-era decline in cancer cases and mortality. In this study, we identified temporal trends in public interest in cancer-related health information using the now-casting tool Google Trends.

Methods We used Google Trends to query search terms related to cancer types for short-term (September 2019–September 2020) and long-term (September 2016–September 2020) trends in the US. We compared average relative search volumes (RSV) for specified time ranges to detect recent and seasonal variation.

Results General search interest declined for all cancer types beginning in March 2020, with changes in search interest for "Breast cancer," "Colorectal cancer," and "Melanoma" of -30.6%, -28.2%, and -26.7%, respectively, and compared with the mean RSV of the two previous months. In the same time range, search interest for "Telemedicine" has increased by $+907.1\%$ and has reached a 4-year peak with a sustained increased level of search interest. Absolute cancer mortality has declined and is presently at a 4-year low; however, search interest in cancer has been recuperating since July 2020.

Conclusion We observed a marked decline in searches for cancer-related health information that mirrors the reduction in new cancer diagnoses and cancer mortality during the COVID-19 pandemic. Health professions need to be prepared for the coming demand for cancer-related healthcare, foreshadowed by recovering interest in cancer-related information on Google Trends.

Keywords Infodemiology · Google trends · Health promotion · Patient education · Cancer awareness

Abbreviations

AML	Acute myeloid leukemia
CRC	Colorectal cancer
HCC	Hepatocellular carcinoma
NCHS	National Center for Health Statistics
NSCLC	Non-small cell lung cancer
PSA	Prostate-specific antigen
US	United States
RSV	Relative search volume
SCLC	Small-cell lung cancer
SVI	Search volume index

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Introduction

The ongoing coronavirus disease 2019 (COVID-19) pandemic poses several challenges for cancer care [1]. Patients with cancer are more susceptible to severe complications

of COVID-19 due to their immunosuppressed status, caused both directly by cancer and from cancer treatment [2–4]. Although many cancers require timely diagnosis and treatment, healthcare providers have had to delay or cancel important activities including screening programs, surgery, chemotherapy, and radiation therapy.

While numbers in surgeries and admissions to emergency departments decreased, a substantial increase in telemedicine has been reported [5, 6]. As a tool to minimize exposure to SARS-CoV-2 for both patients and healthcare providers, telehealth has been shown to be a feasible alternative in the management of chronic diseases such as diabetes and has recently been adopted in the guidelines of the American Society of Clinical Oncology (ASCO) for cancer patients not urgently requiring a physical exam, treatment, or diagnostics [6–9].

The beneficial role of seeking cancer-related information especially for the adherence to preventive measures including cancer screening and cancer risk factor optimization has been shown in several observational studies [10, 11]. Additionally, a clear increase in health-related and life quality in cancer survivors that actively seek cancer-related information has been previously reported [12, 13]. It is, however, less well known to what extent the ongoing COVID-19 pandemic may have influenced these potentially life-saving search behaviors. In line with the known phenomena of redirected healthcare resources in response to the ongoing pandemic, online search interests for COVID-19-related information peaked with increasing COVID-19 case numbers [14]. This might in turn suggest a diversion of typical cancer-related online search behavior. The analyses of the distribution of online public health data have sparked the formation of the rather new field termed infodemiology [15]. Infodemiology has contributed to health evaluation by assessing real-time (online) information in a range of diseases and conditions including infectious diseases and cardiovascular health [16–19]. Google Trends represents a publicly available database allowing to monitor searches on the commonly used Google search engine in near real time [19]. It has been shown to potentially complement epidemiologic trends in cancer incidences and cancer screening for the US [20, 21].

In this study, we aim to explore short-term and long-term trends in public online search interest for the most common cancer entities according to recent cancer statistics. We hypothesized a temporal decrease in search interest following the official declaration of the global COVID-19 pandemic as well as the imposed lockdown measures across numerous US states throughout March 2020. We further hypothesized a gradual recuperation of cancer-related online search volumes with lockdown measures being lifted in May–June 2020. In response to the COIVD-19 crisis management, we expected a relative and transient increase in search behavior related to telemedicine.

Methods

Google Trends (https://trends.google.com/) is a publicly available query tool that aggregates data on Google search engine trends, both—geographically and over time. Based on most recent epidemiological estimates on prevailing cancer types [22], we queried the most common cancer types and topographic anatomic regions, including cervical cancer, hepatocellular carcinoma, melanoma, bladder cancer, thyroid cancer, multiple myeloma, meningioma, and acute myeloid leukemia. Additionally, we grouped several search terms into a subset of cancer types associated with modifiable risk factors (including unhealthy diet, obesity, physical inactivity, and tobacco use), namely small-cell lung cancer (SCLC), non-small cell lung cancer (NSCLC), and colorectal cancer. We also grouped search terms into a subset of cancer types considered hormone sensitive including breast cancer, ovarian cancer, endometrial cancer, uterine cancer, and prostate cancer. Topographic regions included cancers of the digestive system (averaging search volume for "Esophageal cancer," "Gallbladder cancer," "Pancreatic cancer," "Hepatocellular carcinoma," and "Colorectal cancer"), respiratory system (averaging search volume for "Laryngeal cancer," "Small-cell lung carcinoma," and "Non-small cell carcinoma"), breast and genital system (averaging search volume for "Breast cancer," "Ovarian cancer," "Endometrial cancer," "Uterine cancer," "Prostate cancer," and "Cervical cancer"), urinary system (averaging search volume for "Renal cell carcinoma" and "Bladder cancer"), and head and neck region (averaging search volume for "Oropharyngeal cancer," "Oral cancer," "Nasopharyngeal cancer," "Astrocytoma," "Glioblastoma," "Thyroid cancer," and "Meningioma"). We queried all terms using search categories assigned by Google; these included "Topic," "Disease," or "Medical condition" (Supplemental Table 1). We used these search categories to encompass a broader range of search results that were queried with a similar intention; we, therefore, chose search terms Google identified as most commonly searched over the medically more common term—the search term "Small-cell carcinoma" includes searches for "small-cell lung carcinoma." Details on the decision making behind this assignment process are described by Google Trends in more detail [23]. We also used Google's "near me"-tool, a suffix used for searches in Google and affiliated websites to show customized and customer behavior-oriented search queries. Search terms queried with the addition of "near me" were considered indicative for a potential interest in medical services in the

near future and vicinity. We used this tool for the search term "Doctor near me." Additionally, we queried search terms related to telehealth including "Telehealth," "Telemedicine," and "Virtual doctor visit."

We defined two time ranges: short-term trends were defined by the time range of September 1, 2019 to September 1, 2020, long-term trends as the time range September 1, 2016 to September 1, 2020. Data included in this analysis represent search volume in the US to reduce potential variability between strategic approaches related to COVID-19 in different countries. All data for further quantitative analysis were extracted on September 21, 2020. Google reports search trends as relative search volume (RSV), i.e., all exported values are relative to the peak search volume index (SVI) of 100 in for the indicated time range and location. Thus, singular events with a sudden peak in search interest may make the SVI at all other time points appear low—this has previously been reported for events that draw significant public attention, as for example the National Breast Cancer Awareness Month [24]. Search terms were excluded from this study if we detected such sudden spikes lasting less than three consecutive weeks and recuperating to prior levels within that time range; if feasible, we excluded only a limited time range to mirror search interest for the rest of the time range specified above. Of note, the included data from Google Trends solely represent search terms queried through Google and affiliated websites but does not include other search engines. This study utilized publicly available data without personal identifiers and was, thus, exempt from institutional review board approval.

Results

Decrease in online search interest at the beginning of 2020

For all cancer types included in our analysis, online search interest via Google and affiliated search websites results declined sharply since March 2020. Search interest changed for the terms "Cervical cancer" (−30.0%), "Hepatocellular carcinoma" (−21.8%), "Melanoma" (−26.7%), "Thyroid cancer" (−33.9%), and "Meningioma" (−38.0%), when comparing the mean RSV of March–April 2020 with the mean RSV of the previous two months. We noted a rebound phenomenon that varied across cancer types. For example, search interest increased moderately for "Cervical cancer" (+8.9%) and "Hepatocellular carcinoma" (+2.8%) and stronger for "Melanoma" (+26.6%) and "Meningioma" (+15.2%), when comparing the mean RSV of May–June 2020 with the mean RSV of the two preceding months (Fig. 1a, b; Supplemental Table 2).

Search interest among subgroups of cancer depending on risk factor profiles

Based on the underlying risk factor profiles, cancers that are largely attributable to modifiable risk factors (colorectal cancer and lung cancer) and sex-specific cancers (breast, ovarian, endometrial, uterine, and prostate cancer) are depicted separately (Figs. 2, 3) [25]. These cancer types exhibit more options for primary and secondary prevention and may, thus, depend even more on in-person clinical visits to either avoid (further) progression or enhance overall outcome. Lifestyle and dietary changes are also crucial in some of these types. For cancer entities related to modifiable risk factors, we observed a similar trend as in Fig. 1. Search interest decreased for "Small-cell lung carcinoma" (−30.7%), "Non-small cell lung cancer" (−22.1%) and "Colorectal cancer" (−28.2%), when comparing the RSV means of January–February 2020 to March–April 2020. Search interest has since partly recuperated with changes of −0.7%, +7.3%, and +10.0%, respectively, comparing May–June 2020 with the preceding 2 months (Fig. 2a, Supplemental Table 3).

For sex-specific cancers, search interest decreased since March 2020 reaching its minimum at the end of March 2020. Similar to modifiable risk-related cancers, search interest has been recuperating since April 2020 (Fig. 3a, Supplemental Table 4).

Interestingly, for "Breast cancer," a strong peak in October 2019 was observed that was consistently to be detected in the defined long-term timeframe from September 1, 2016 to September 1, 2020, potentially reflecting a seasonal pattern (Fig. 3b). This finding largely corresponds with the National Breast Cancer Awareness Month every October. Also, but less strikingly, a similar pattern could be detected for "Ovarian cancer" in September, and "Endometrial cancer" in November of each year (Fig. 3b). Additionally, we identified seasonal peaks for "Non-small cell lung cancer" in February and for "Colorectal cancer" in February/March annually (Fig. 2b).

In order to even out the observed seasonal peaks in search volumes for individual cancer entities, the respective entities were subsumed according to the affected organ system or region. As shown in Supplemental Fig. 1A, search volumes clearly dropped in March 2020 and showed a rising trend in May–June with a subsequent recuperation. Moreover, we confirm that the decline in search interest as seen in March 2020 was unprecedented in the 4-year time scale (Supplemental Fig. 1B).

Face-to-face and remote patient–doctor interaction

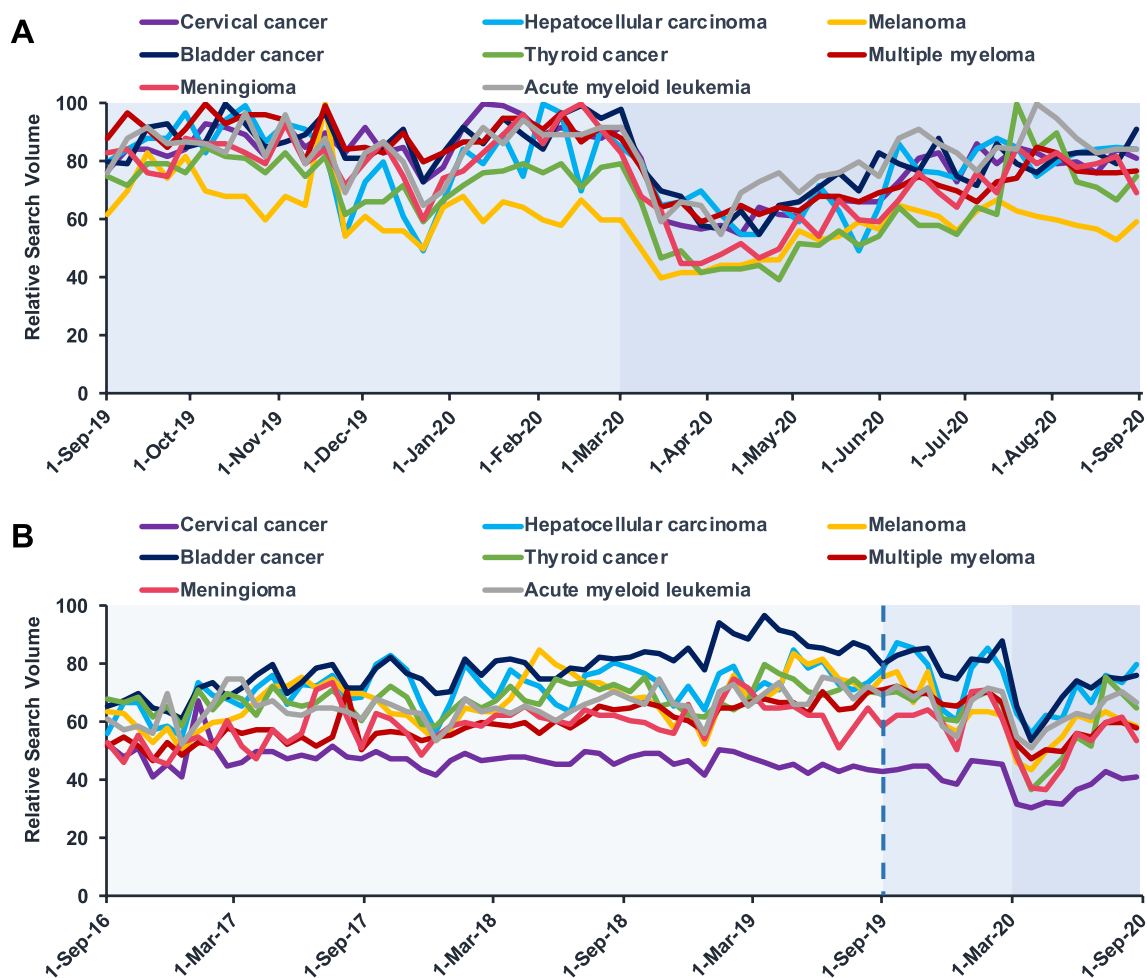Online search volumes for "Telehealth," "Telemedicine," and "Virtual doctor visit" changed

Fig. 1 US online search interest in a set of common cancer types. Google Trends relative search volume during the time periods **a** September 1, 2019 to September 1, 2020 presented as weekly data and **b** September 1, 2016 to September 1, 2020 presented as tri-weekly data for the search terms "Cervical cancer" (purple), "Hepatocellular carcinoma" (light blue), "Melanoma" (yellow), "Bladder cancer" (dark blue), "Thyroid cancer" (green), "Multiple myeloma" (dark red), "Meningioma" (pink), and "Acute myeloid leukemia" (gray). Shaded area: World Health Organization (WHO) on March 11, 2020 has declared the COVID-19 outbreak a global pandemic. Dashed line in lower panel implicates start of upper panel to visualize transient trends amidst COVID-19 pandemic versus long-term seasonal trends. (Search query: 09/20/2020). (Color figure online)

by + 1047.1%, + 907.1%, and + 421.9%, respectively, when comparing the mean RSV of September 2019–February 2020 with the mean RSV of March 2020. In the same time range, interest for the search term "Doctor near me" declined by − 23.3% (Fig. 4a, Supplemental Table 5). However, in mid-April, these trends reversed; search volumes for "Doctor near me" increased in the following three months after March 2020 (+ 13.3%) and were at a four-year high by July 1, 2020 (Fig. 4b). Conversely, search interest in telehealth-related terms has plummeted since April, but search volume remains still substantially higher than before March 1, 2020.

Discussion

Concordant with emerging warnings on delayed diagnostic and therapeutic procedures of patients with cancer, we report a decline in online search volumes for cancer-related information. The online search for cancer-related information is often the first approach for individuals to contextualize potential symptoms or concerns that do not require immediate emergency care. There are several potential explanations for this decrease. First, patients with non-specific symptoms may be reluctant to seek medical
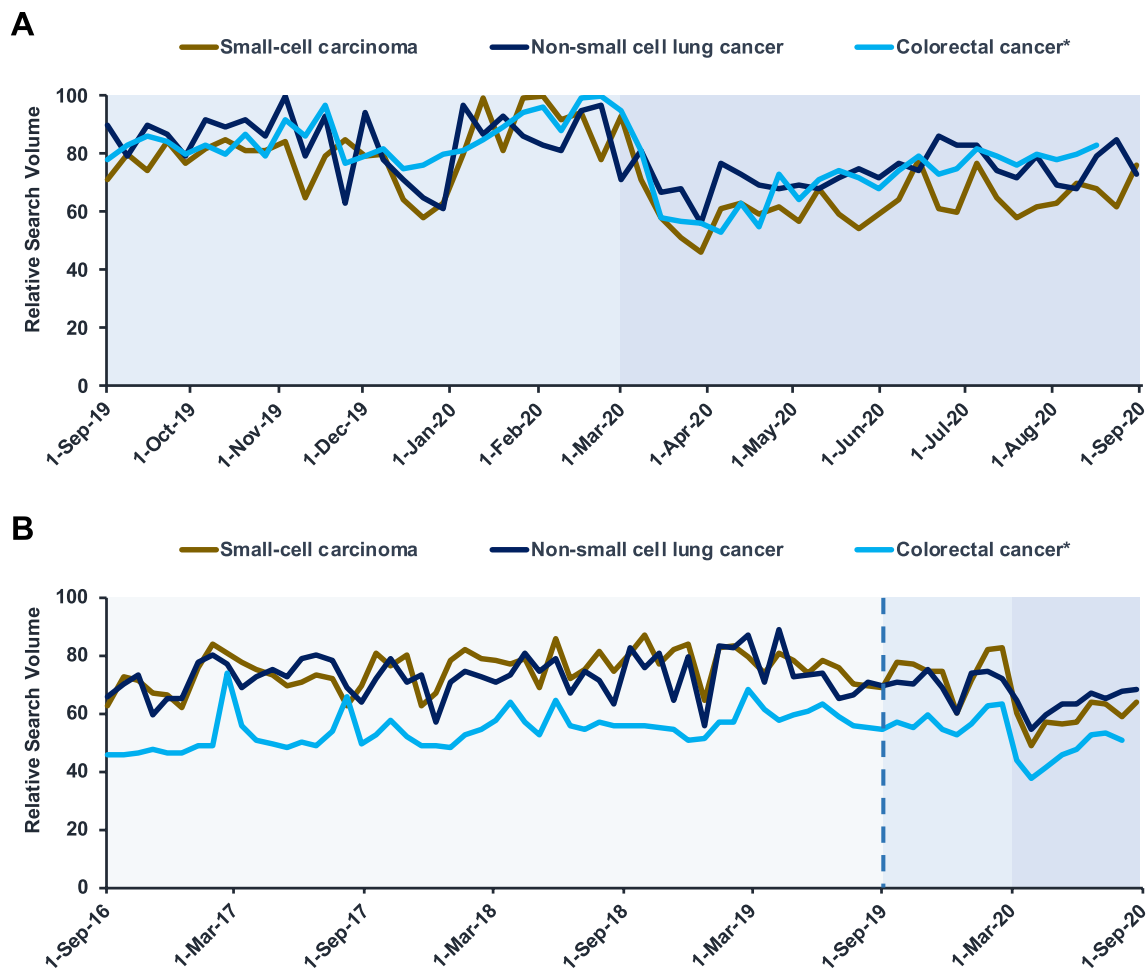
Fig. 2 US online search interest in terms related to cancer types attributable to modifiable risk factors. Google Trends relative search volume during the time periods **a** September 1, 2019 to September 1, 2020 presented as weekly data and **b** September 1, 2016 to September 1, 2020 presented as tri-weekly data for the search terms "Small-cell carcinoma" (brown), "Non-small cell lung cancer" (dark blue), and "Colorectal cancer" (light blue); the Google search term "Small-cell carcinoma" includes searches for "small-cell lung cancer." *For the search term "Colorectal cancer," we excluded the dates from August 23, 2020 onwards due to a spike in search interest possibly following the death of Chadwick Boseman from CRC; see Supplemental Fig. 2. Shaded area: World Health Organization (WHO) on March 11, 2020 has declared the COVID-19 outbreak a global pandemic. Dashed line in lower panel implicates start of upper panel to visualize transient trends amidst COVID-19 pandemic versus long-term seasonal trends. (Search query: 09/20/2020). (Color figure online)

help for fear of acquiring SARS-CoV-2 in a healthcare setting. Second, hospitals and healthcare providers have postponed diagnostic procedures potentially leading to a decreased pursuit of non-COVID-19-related information online. Third, established screening programs for breast, colon and cervical cancer have been paused in order to alleviate the impact of the pandemic on the healthcare system.

Contrary to the recently stagnating mortality rates in many cancer types [22], the widespread postponement of diagnosis and treatment may ultimately result in an increase in cancer mortality rates. Public de-prioritization of cancer care as reflected by decreased public online search interest could lead to future fatal consequences of cancer and may impose a future economic burden on the healthcare system

[26]. However, as we observed recurrent annual increases for months considered as specific cancer awareness months, public interest in cancer-related terms is likely to be mirrored by online search volumes. For instance, besides the National Breast Cancer Awareness Month March, recurrent short-term increases were also noted for ovarian and colorectal cancer that corresponded with the respective awareness months. These findings further illustrate that online search behavior might represent an additional tool for public health communication strategies in cancer care.

Cancer patients and COVID-19

Several reports show an increased mortality for cancer patients due to COVID-19, irrespective of whether they are
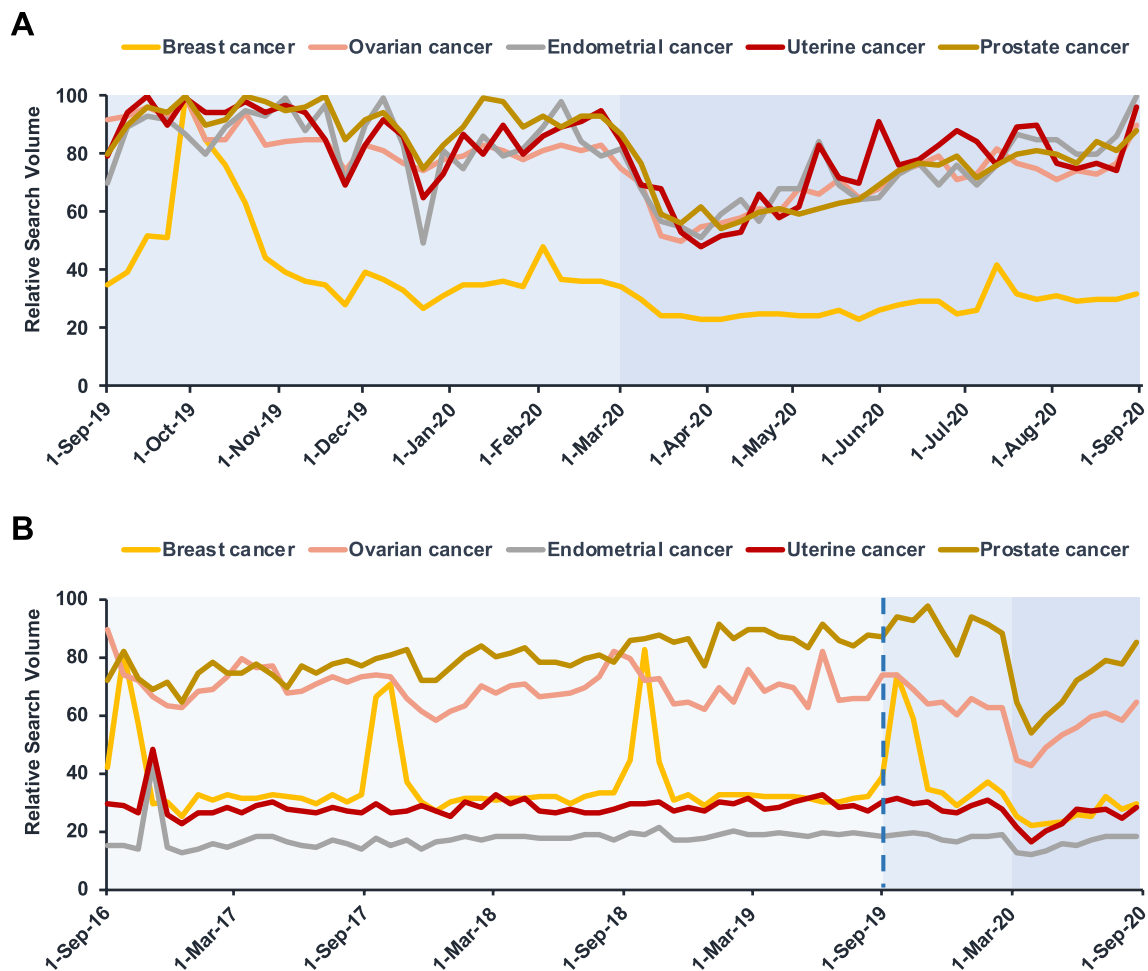
A

B

Fig. 3 US online search interest in a set of sex-specific cancer types. Google Trends relative search volume during the time periods **a** September 1, 2019 to September 1, 2020 presented as weekly data and **b** September 1, 2016 to September 1, 2020 presented as tri-weekly data for the search terms "Breast cancer" (yellow), "Ovarian cancer" (rose), "Endometrial cancer" (gray), "Uterine cancer" (dark red), and "Prostate cancer" (light brown). Shaded area: World Health Organization (WHO) on March 11, 2020 has declared the COVID-19 outbreak a global pandemic. Dashed line in lower panel implicates start of upper panel to visualize transient trends amidst COVID-19 pandemic versus long-term seasonal trends. (Search query: 09/20/2020). (Color figure online)

receiving anticancer therapies or have active cancer diseases [27–29]. However, Mei et al. based on their experience from the Wuhan Union Hospital, identified infections acquired in an in-patient setting as one major threat to cancer patients in the beginning recent pandemic [3, 30]. According to the National Center for Health Statistics (NCHS) datasets, US cancer mortality rates are continuously declining due to treatment breakthroughs and improved risk reduction strategies [22]. Despite the seasonal variability that must be taken into account, cancer mortality fell to a four-year low in May 2020 according to our cursory analysis of the available NCHS cancer statistics. Thus, delivering cancer care to patients during this pandemic remains one of the most urgent challenges and requires a reasonable balancing of competing risks of death and morbidity from cancer versus death from COVID-19 [31]. Conversely, changes in health-seeking

behavior that is likely to have beneficial effects on cancer outcomes [10–13] as well as a transiently limited availability of essential diagnostics and care modalities in the course of the pandemic have been observed. Newly diagnosed cancer cases for six common cancer types have declined by 46.4% soon after the pandemic unfolded [32]. Recent registry-based analyses from the UK implicate that the experienced delays in cancer diagnostics and treatment, especially cancer surgery, most probably will lead to a collateral increase in avoidable cancer deaths of various cancer entities [33, 34].

Cancer types with modifiable risk factors

The decline in search interest for cancer types attributable to modifiable risk factors, which most likely could profit from preventive efforts, may imply decreased public awareness
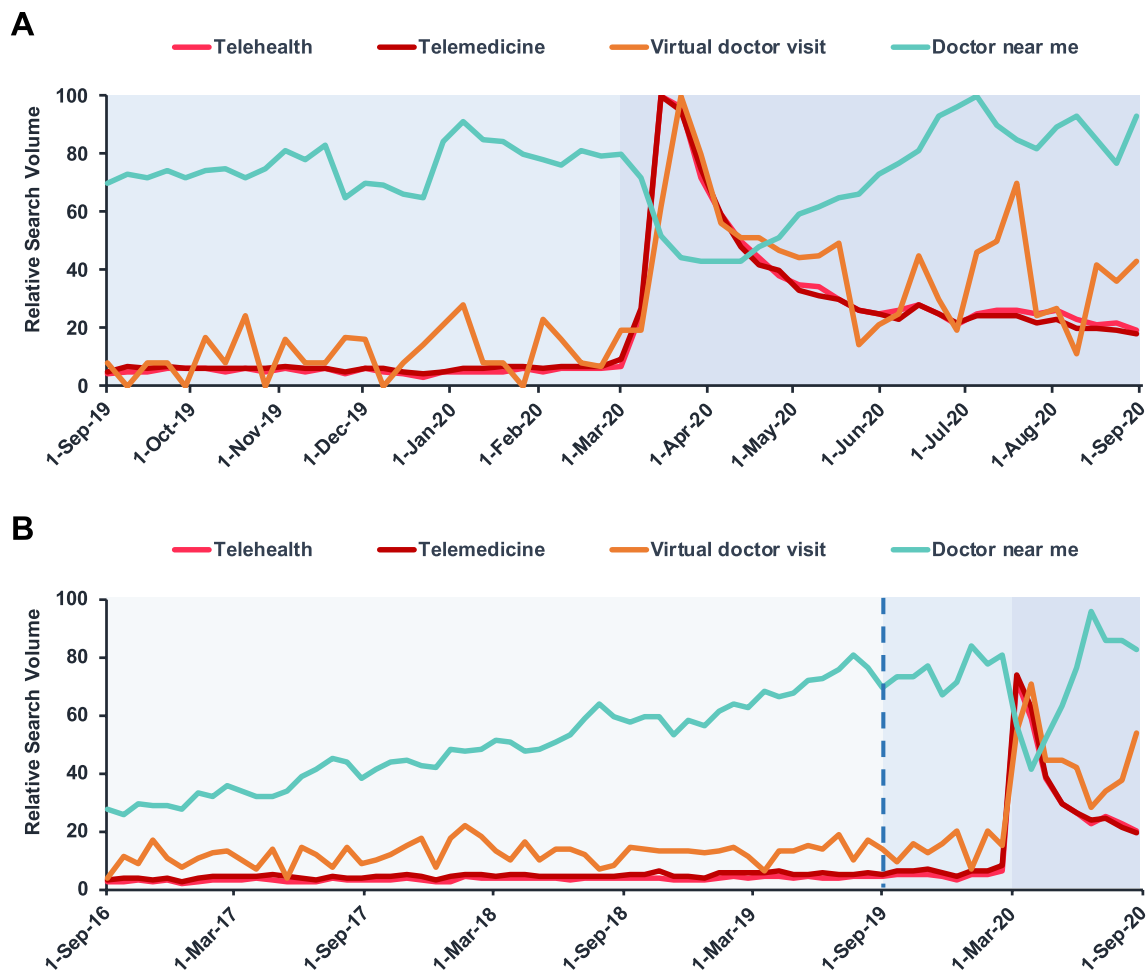
Fig. 4 US online search interest in telehealth and related terms. Google Trends relative search volume (RSV) during the time periods **a** September 1, 2019 to September 1, 2020 presented as weekly data and **b** September 1, 2016 to September 1, 2020 presented as tri-weekly data for the search terms "Telehealth" (pink), "Telemedicine" (dark red), "Virtual doctor visit" (orange), and "Doctor near me" (tur-

quoise). Shaded area: World Health Organization (WHO) on March 11, 2020 has declared the COVID-19 outbreak a global pandemic. Dashed line in lower panel implicates start of upper panel to visualize transient trends amidst COVID-19 pandemic versus long-term seasonal trends. (Search query: 09/20/2020). (Color figure online)

and possibly a decreased willingness to undertake aggressive prevention measures.

As shown for colorectal screening programs, delayed screening routine is likely to result in an increased proportion of advanced stage disease [35]. Thus, the continuation of widespread screening can improve patient outcomes since intervention is possible in especially early disease stages [35].

When considering the rather biological aggressiveness of certain lung malignancies [36], the decrease of online search interest is of particular concern. For example in NSCLC, survival is significantly impaired when cancer surgery is delayed for more than six months [34]. Of note, lung cancer diagnostics might, however, be more difficult due to overlapping symptoms with COVID-19 such as coughing, dyspnea, and chest pain. Eventually, lung cancer treatment requires

timely diagnostics and possibly surgery to achieve cure or symptom control. However, these patients are at a particular risk for a serious course of COVID-19 due to their cancer as well as the respective treatment [37].

The shift towards telehealth

In light of the rapid growth in telehealth, our findings on telehealth-related terms support a clear trend towards a public interest in virtual healthcare [3]. Telemedicine can partly substitute the patient–doctor interaction for the short term [7, 8]. However, it cannot replace crucial steps in the diagnostic and treatment process of cancers. For the duration of the pandemic, telehealth tools are recommended by society guidelines as summarized elsewhere [7, 9]. There are, however, limitations of this technology: systemic barriers

including funding and legal concerns, acceptance by patients and doctors, continuous training for the effective usage, and broad accessibility of technical infrastructure. As an end of the preventive measures against COVID-19 remains unlikely in the short-term future, telemedicine can contribute to providing needed care for cancer patients, potentially even with a high degree of consistency in the patient–doctor relationship [5, 38].

Preparing for an increase in cancer patients

We also showed a recent recuperation of online search interest for various cancer entities, which might indicate for an increase in demand for cancer care.

Nonetheless, the observed decrease in cancer mortality revealed by NCHS statistics might mirror the pandemic-related changes in healthcare behavior and delays in diagnostics and treatments. Thus, policy interventions are required to address the potential increase in collateral effects of COVID-19 for cancer diagnostics and treatments. As the vast online search interest in cancer-related search terms has not yet reached its pre-pandemic degree, public health messaging sensitizing, and conveying the risks of delayed cancer diagnostics, screenings and therapy versus COVID-19 could be considered. Furthermore, clear recommendations guiding clinicians in the decision making for prioritization of high-risk patients as well in the management of required procedures in cancer care are required.

Limitations

The limitations of our study are a potential overrepresentation of internet users, most likely younger individuals, actively searching for health-related terms. Second, we cannot confirm that all search activity for the respective terms exclusively reflects health-seeking behavior. The data presented complement but do not substitute for traditional epidemiological studies or analyses of actual clinical activity. Third, as Google Trends does not provide information on the individual who is seeking information, we could not identify specific subgroups with a potentially higher share in search volumes. As such, potential subgroups of interest might be the general public, cancer patients under treatment, cancer survivors, and healthcare professionals. Lastly, data from Google Trends may not represent part of the general public without access to the internet.

Conclusions

Online search interests of cancer-related screening/diagnostic information have experienced a sharp decline since the beginning of the COVID-19 pandemic in the United States.

Early evidence suggests a decline in newly diagnosed cancer cases and a decline in cancer mortality. However, we observed an increase in online search interest in recent weeks potentially translating into an increased demand for cancer care in upcoming months. Delayed diagnostic and therapeutic procedures may require mechanisms of prioritization to alleviate healthcare resources and yet, reduce an inevitable rise in cancer mortality.

Declarations

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