

BMJ Open Global monitoring of public interest in preventive measures against COVID-19 via analysis of Google Trends: an infodemiology and infoveillance study

Tomoo Ito 

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ABSTRACT

Objectives The COVID-19 pandemic has influenced people's concerns regarding infectious diseases and their preventive measures. However, the magnitude of the impact and the difference between countries are unclear. This study aimed to assess the magnitude of the impact of COVID-19 on public interest and people's behaviours globally in preventing infectious diseases while comparing international trends and sustainability.

Design An infodemiology and infoveillance study.

Setting The study employed a web-based data collection to delineate public interest regarding COVID-19 preventive measures using Google Trends.

Primary and secondary outcome measures A relative search volume was assigned to a keyword, standardising it from 0 to 100, with 100 representing the highest share of the term searches. The search terms "coronavirus", "wash hand", "social distancing", "hand sanitizer" and "mask" were investigated across 196 different countries and regions from July 2018 to October 2021 and weekly reports of the relative search volume were obtained. Persistence of interest was assessed by comparing the first 20 weeks with the last 20 weeks of the study period.

Results Although the relative search volume of "coronavirus" increased and was sustained at a significantly higher level ($p < 0.05$) than before the pandemic declaration, globally, the trends and sustainability of the interest in preventable measures against COVID-19 varied between countries and regions.

Conclusions Sustained interest in preventive measures differed globally, with regional differences noted among Asia, Europe, Africa and the Americas. The global differences should be considered for implementing effective interventions against COVID-19. The increased interest in preventive behaviours against COVID-19 may be related to overall infectious disease prevention.

INTRODUCTION

COVID-19 was first reported in Wuhan, China, in November 2019 and was declared a public health emergency of international concern on 31 January 2020. On 11 March 2020, it was declared a pandemic by WHO.¹ As of 6 December 2021, there have been 265 194 191 confirmed cases of COVID-19, including 5 254 116 deaths.² Considering its widespread

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study used Google Trends to objectively show the trends in people's interest in COVID-19 and its preventive measures worldwide.
- ⇒ The study monitors people's interest in preventive measures over a long period of time to assess the sustainability of the interest in preventable measures.
- ⇒ The differences in internet availability and the percentage of Google users may have affected the global-level evaluation of public interest using Google Trends.

relevance, the COVID-19 pandemic may impact people's interest in infectious diseases and their lifestyles.³ Therefore, the interest in preventive measures against infectious diseases may be growing worldwide at a whole new level. However, the magnitude of the impact on people's preventive behaviour is difficult to measure objectively, and the differences in behaviours among countries are unclear. Moreover, with the prolonged pandemic, it is uncertain whether the growing interest in preventive actions against infectious diseases can be sustained.

When faced with rapidly progressing infectious disease outbreaks, such as COVID-19, the assessment of population awareness on infection prevention behaviours needs to be accomplished promptly if the findings are informative in the context of the public health response. However, such an assessment is not an easy task. For instance, population-representative household surveys generally require several months of preparation and data collection; therefore, they do not always provide timely results. Such an effort could be aided using available web search query data, which provide insight into public interests related to such behaviours.

The use of internet search data to draw conclusions on the determinants and delivery



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Bureau of International Health Cooperation, National Center for Global Health and Medicine, Shinjuku-ku, Tokyo, Japan

Correspondence to

Dr Tomoo Ito;
t-itot@it.ncgm.go.jp

of health information is known as infodemiology.^{4,5} Since the first reported use of search engine data to track the 2008 influenza epidemic,⁶ several research publications related to behavioural change and public interest in health have used the same.^{7–11} Google Trends is a web-based tool that analyses a portion of daily Google searches, generating data on geographical and temporal patterns according to specified keywords. Previous studies have demonstrated accurate prediction and forecasting of current public interests, allowing for analysis in various fields.^{12–14}

Since the pandemic declaration by WHO in 2020, some researchers have investigated the impact of COVID-19 using Google Trends. The very first studies reported that Google Trends could forecast the rise of new cases.^{15–17} Since then, studies on various COVID-19 topics have been conducted using Google Trends. Effenberger *et al*¹⁸ showed a relationship between the highest interest and the peak of newly confirmed cases. Walker *et al*¹⁹ reported a correlation between symptom search terms and confirmed case growth. Furthermore, Sousa-Pinto *et al*²⁰ reported a relationship between media coverage and COVID-19 keywords, whereas Heerfordt and Heerfordt²¹ evaluated whether COVID-19 was associated with smoking cessation behaviours. Kutlu²² reported the trends and impacts of dermatological diseases on public perceptions during the COVID-19 pandemic, Springer *et al*²³ reported the people's interest in the medical therapeutic direction and Onchonga²⁴ reported on the use of the interest in self-medication during the COVID-19 pandemic.

However, the impact of the global COVID-19 pandemic on the long-term interest in preventive measures against infectious diseases has not been studied, and whether such interest can be sustained or is only temporary. Moreover, global differences in public interest regarding COVID-19 and preventive measures have not been objectively monitored.

This study aimed to assess the magnitude of COVID-19's impact on public interest regarding preventive behaviours by focusing on the pace at which public interest increased due to the COVID-19 pandemic, the suitability of the interest and types of preventive measures preferred by different countries.

MATERIALS AND METHODS

Google Trends was used to quantify and measure changes in internet searches regarding the COVID-19 pandemic worldwide and in each country.

Google Trends' function and data collection method

Google Trends uses a fraction of searches for a specific term (also known as 'keyword' or 'search term') and then analyses the number of Google searches according to a geographical location and defined timeframe. After examining the keyword(s) or topic(s), the region and the period are entered. The region can be a country, a region or a combined dataset of all regions (global).

The popularity of a search term in a given week relative to other weeks in the mentioned time period within a geographic region is shown as the relative search volume (RSV). The most popular week has a RSV of 100, while all other weeks are reported relative to the most popular week on a scale from 0 to 99. For example, a RSV of 50 would indicate that the search term was 50% as popular as it was in the most popular week. A score of 0 indicates insufficient searches to show for this term in the week. When a sufficient number of searches cannot be confirmed for a keyword or topic in a specified country, the system display indicates that the data cannot be retrieved.

For international comparisons among countries using different languages, topic searches are useful. Topics are a group of terms that share the same concept in any language, and they are displayed below search terms. For example, when we searched the topic "London", the search provided results for topics such as the "Capital of the UK" and "Londres" (Spanish), which is "London". This study used topic searches using keywords in 196 countries, and the results of the topic searches are reported as the frequency of searches for all included keywords that refer to the same concept, regardless of the language in the specific countries. This method allowed us to understand the situation on a global level, including in countries where English is not the native language.

The data are retrieved directly from the Google Trends Explore page in .csv format. If the survey period is long, the values are displayed as weekly values.

In this study, first, the RSV of one topic in one country was obtained for a defined period on a weekly basis. This work was repeated for all the topics. Second, the same process was repeated for the 196 countries and regions. Finally, differences between countries and regions in the trends and sustainability of the topics were examined. Data for global trends (combined dataset of all regions) were obtained by changing the location setting on Google Trends to "Worldwide" for a defined period for each topic.

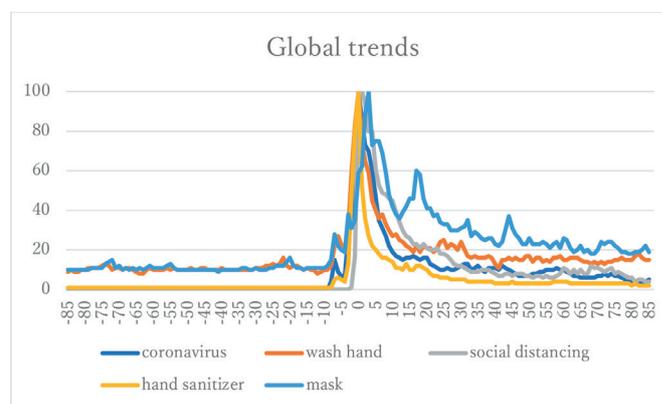


Figure 1 Relative search volume of "coronavirus", "wash hand", "social distancing", "hand sanitizer" and "mask" in the combined data for all countries and regions.

Target country, search term selection and study term

For the 196 countries and regions around the world, Google Trend's "Topics" was used to show the RSVs of "coronavirus" and typical preventive behaviours, including "wash hand" and "social distancing", and the supplies needed for prevention, such as "hand sanitizer" and "mask". These topic terms were mentioned on the Centers for Disease Control and Prevention site²⁵ as recommendations for prevention and were listed as related topics in Google Trend's coronavirus.

The specified survey period was set using the following procedures: first, the end of October 2021 was set as the study's end period, and the most recent RSV was obtained on 1 November 2021. Second, the study's starting point was set from the same interval period between the WHO pandemic declaration and the study's end period. It was 85 weeks before and 85 weeks after the week of 11 March 2020.¹ Therefore, the date range was from the week of 22 July 2018 to that of 24 October 2021, assessing the timing of raising the interest in each topic term.

For each country's topic term, the week in which RSV exceeded 50 (RSV50) after the beginning of 2020 was defined as the timing of the rise in RSV in each country. In Google Trends, RSV50 means 50% of the search activity of the peak (RSV100) was performed in particular countries and regions using the defined term.

Assessing the sustainability of people's interest

In this study, the sustainability of interest was assessed by comparing the last 20 weeks (from the week of 13 June 2021 to that of 24 October 2021) of the survey period with the first 20 weeks (from the week of 22 July 2018 to that of 2 December 2018) for each topic term. This was because all topics used in this study are terms that had been used before the COVID-19 pandemic; thus, if the RSV in the latter period, which was >1 year after the WHO pandemic declaration, was higher than the RSV in the period before the outbreak, the sustainability on public interest was presented regardless of its magnitude.

Statistical analysis

The Mann-Whitney U test was used to compare the RSV during the first 20 weeks at the beginning of the study (from the week of 22 July 2018 to that of 2 December 2018), with the RSV during the last 20 weeks at the end of the study (from the week of 13 June 2021 to that of 24 October 2021) for each topic term. All statistical analyses were performed using IBM SPSS Statistics for Windows, V.25 (IBM, Armonk, New York, USA). $P < 0.05$ was considered statistically significant.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

Global trends (combined dataset of all regions)

The search terms "coronavirus", "wash hand", "social distancing", "hand sanitizer" and "mask" reached RSV50 by the week of the WHO pandemic declaration (11 March 2020) in global trends (combined dataset of all regions). Subsequently, "coronavirus", "wash hand" and "hand sanitizer" RSVs peaked (RSV100) in the week of the WHO pandemic declaration. This was followed by the RSV of "social distancing" a week later (the week of 15 March 2020) and that of "mask" 3 weeks later (the week of 5 April 2020) (figure 1). In Global Trends, the RSVs of "coronavirus", "wash hand", "social distancing", "hand sanitizer" and "mask" were significantly higher ($p < 0.05$) in the last 20 weeks of the study period (from the week of 13 June 2021 to the week of 24 October 2021) than in the first 20 weeks before the pandemic declaration (from the week of 22 July 2018 to that of 2 December 2018).

Search word "coronavirus" trend

The "coronavirus" RSVs were obtained in 196 countries and territories. All of the target countries and regions had enough searches to show RSVs. In late January 2020, only eight countries (4.1%) in and mainly around China reached RSV50 (Bhutan, China, Laos, Macao, Mongolia, The Philippines, Thailand and Vietnam). However, in the week of the pandemic declaration (the week of 8 March 2020), the number of countries that reached RSV50 rose sharply, especially in the Americas and Europe, and by late March, 96.4% of all the countries and regions, including African countries, reached RSV50. Japan, which was the only G7 country that did not initially have a $RSV \geq 50$, had a $RSV \geq 50$ at this time. In early April, the RSV reached 50 in all targeted regions (table 1, figure 2).

Search word "wash hand" trend

In total, 192 countries and territories had "wash hand" RSVs, and 4 countries (Central Africa, Commonwealth of Dominica, Eritrea and Turks and Caicos Islands) did not have enough searches to show RSVs. Six countries (3.1%) reached RSV50 in late January 2020 and included mostly Asian countries around China: Brunei, Cambodia, Singapore, South Korea, Taiwan and Vietnam. Moreover, Antigua and Barbuda, Bhutan, Cyprus and Syria were also above RSV50, but this was a temporary increase as it dropped to zero in the following week of late January 2020.

In the week after the pandemic was declared (the week of 8 March 2020), 107 countries (54.6%), mainly in North America, Europe and Asia, had $RSVs \geq 50$, and by late March, 160 countries (81.6%), including most countries in South America, had $RSVs \geq 50$. Japan, which was the only G7 country that did not have a $RSV \geq 50$ in the week of 8 March 2020, had a $RSV \geq 50$ at this time. Conversely, even in early April, the RSV did not exceed 50 in 21 countries (10.7%), including 9 countries on the African continent (Algeria, Botswana, Burundi, Cameroon, Mozambique, Democratic Republic of the

Table 1 Number of countries with a RSV ≥ 50

	Week of 26 January 2020	Week of 23 February 2020	Week of 8 March 2020	Week of 22 March 2020	Week of 5 April 2020
RSV "coronavirus"					
Number of countries with RSV >50 , n (%)	8 (4.1%)	18 (9.2%)	118 (60.2%)	189 (96.4%)	196 (100%)
Number of countries without valid data, n (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
RSV "wash hand"					
Number of countries with RSV ≥ 50 , n (%)	10 (5.1%)	37 (18.9%)	107 (54.6%)	160 (81.6%)	171 (87.2%)
Number of countries without valid data, n (%)	4 (2.0%)	4 (2.0%)	4 (2.0%)	4 (2.0%)	4 (2.0%)
RSV "social distancing"					
Number of countries with RSV ≥ 50 , n (%)	0 (0.0%)	0 (0.0%)	18 (9.2%)	102 (52.0%)	125 (63.8%)
Number of countries without valid data, n (%)	22 (11.2%)	22 (11.2%)	22 (11.2%)	22 (11.2%)	22 (11.2%)
RSV "hand sanitizer"					
Number of countries with RSV ≥ 50 , n (%)	8 (4.1%)	24 (12.2%)	121 (61.7%)	186 (94.9%)	187 (95.4%)
Number of countries without valid data, n (%)	3 (1.5%)	3 (1.5%)	3 (1.5%)	3 (1.5%)	3 (1.5%)
RSV "mask"					
Number of countries with RSV ≥ 50 , n (%)	27 (13.8%)	65 (33.2%)	77 (39.3%)	130 (66.3%)	154 (78.6%)
Number of countries without valid data, n (%)	1 (0.5%)	1 (0.5%)	1 (0.5%)	1 (0.5%)	1 (0.5%)
RSV, relative search volume.					



Figure 2 Distribution trend of countries with “coronavirus”, “wash hand”, “social distancing”, “hand sanitizer” and “mask” with relative search volume (RSV) ≥ 50 after the COVID-19 pandemic.

Congo, Seychelles, Sudan and Vanuatu) and countries in other areas (table 1, figure 2).

Search word “social distancing” trend

The “social distancing” RSVs were obtained in 174 countries and territories. There were 22 regions and countries that did not have enough searches to show RSVs.

Only 18 countries (9.2%) had a RSV ≥ 50 , even when the pandemic was declared (the week of 8 March 2020). In late March, 102 countries (52.0%), mainly in the Americas, Europe and Asia, had a RSV ≥ 50 . In early April, 125 countries (63.8%) had a RSV ≥ 50 , but 49 countries (25.0%) in various regions, including 2 G7 countries (France, Italy) in Europe (n=7), Asia and Oceania (n=10), The Americas (n=16) and Africa (n=16) did not have a RSV ≥ 50 (table 1, figure 2). The highest number of countries did not reach a RSV ≥ 50 with respect to the search term “social distancing” (n=49) by early April compared with that noted for other study terms, such as “coronavirus” (n=0), “wash hand” (n=21), “hand sanitizer” (n=7) and “mask” (n=41).

Search word “hand sanitizer” trend

In 193 countries and territories, “hand sanitizer” RSVs were available, and in the 3 countries (Central Africa, Eritrea and Liechtenstein), there were not enough searches to show RSVs.

In late January 2020, 8 countries (4.1%), mainly those around China (Cambodia, China, Macao, Maldives, Singapore, South Korea, Taiwan and Vietnam), had RSVs ≥ 50 , and in the week of the pandemic declaration, the number of countries with a RSV ≥ 50 increased to 121 (61.7%). Subsequently, the number of countries with a RSV ≥ 50 gradually increased to 187 (95.4%) in early April (table 1, figure 2). The countries with RSVs < 50 by early April (Burundi, Commonwealth of Dominica, Liberia, New Caledonia, Suriname, Tajikistan, Turkmenistan) had reached a RSV of 50 at various later times.

Search word “mask” trend

Valid “mask” RSVs were obtained for 195 countries and regions, and only 1 country (Eritrea) did not have enough searches to display a RSV. In late January 2020, 27 countries (13.8%) had a RSV ≥ 50 . They consisted mainly of countries around China (Cambodia, China, Japan, Lao PDR, Macao, Malaysia, Mongolia, Myanmar, The Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam) and some countries in other areas. In late March, there were 130 countries with a RSV ≥ 50 ; in contrast, the USA and some European countries still did not have a RSV ≥ 50 . Then, in early April, 154 countries (78.6%) had a RSV ≥ 50 . Forty-one countries, including many major European countries (Belgium, Finland, France, Germany, Ireland, Switzerland and the UK), African countries, countries on the South American continent, Australia and New Zealand had not reached RSV ≥ 50 by early April but had reached RSV of 50 at various later times (table 1, figure 2).

Comparison of RSV ≥ 65 weeks after the declaration of the pandemic and before the COVID-19 pandemic

In 191 countries, the RSV of “coronavirus” was significantly higher ($p < 0.05$) in the last 20 weeks of this study term than in its first 20 weeks before the pandemic declaration. There were five countries (Central Africa, Djibouti, Eritrea, Liberia and Samoa) with no significant difference.

In 24 countries (12.2%), the RSV of “wash hand” was significantly higher ($p < 0.05$) in the last 20 weeks of this study term than in its first 20 weeks before the pandemic declaration. The majority of these countries were from Asia and Oceania (Australia, Bangladesh, India, Indonesia, Japan, Malaysia, The Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam); followed by those of the Americas (Brazil, Chile, Colombia, Ecuador, Nicaragua, the USA and Venezuela); Europe (the Netherlands and the UK) and Africa (Kenya and South Africa).

The RSV for “social distancing” was significantly higher ($p < 0.05$) in 41 countries (20.9%) in the last 20 weeks than in the first 20 weeks of this study before the pandemic declaration. It was widely distributed among 14 Asian and Oceania countries (Australia, Bangladesh, Fiji, India, Indonesia, Japan, Malaysia, New Zealand, The Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam); 3 Middle Eastern countries (Pakistan, Saudi Arabia and the UAE); 7 European countries (France, Germany, Ireland, Italy, Spain, Turkey and the UK); 14 American countries (Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Dominican Republic, Ecuador, Mexico, Panama, Paraguay, Peru, the USA and Venezuela) and 3 African countries (South Africa, South Sudan and Zimbabwe).

In 74 countries (37.8%), “hand sanitizer” had a significantly higher RSV ($p < 0.05$) in the last 20 weeks of this study term than in the first 20 weeks before the pandemic declaration. The countries with statistical significance were widely distributed among 20 Asian and Oceania countries (Australia, Bangladesh, Brunei, Cambodia, China, India, Indonesia, Japan, Kazakhstan, Malaysia, Myanmar, Nepal, New Zealand, Pakistan, The Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Thailand and Vietnam); 8 Middle Eastern countries (Iran, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia and the UAE); 17 European countries (Belgium, Denmark, Finland, France, Georgia, Germany, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Russia, Spain, Turkey, Ukraine and the UK); 17 American countries (Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Mexico, Paraguay, Peru, Puerto Rico, Trinidad and Tobago, the USA, Uruguay and Venezuela) and 12 African countries (Algeria, Botswana, Ethiopia, Kenya, Libya, Mauritius, Morocco, Nigeria, South Africa, Tunisia, Uganda and Zimbabwe).

In 98 countries (50.0%), the RSV of “mask” was significantly higher ($p < 0.05$) in the last 20 weeks of this study term than in its first 20 weeks before the pandemic declaration. This was a higher percentage than for any other

prevention-related word. Those with significant differences in RSV included 34 European (Albania, Austria, Belarus, Belgium, Bulgaria, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Isle of Man, Ireland, Jersey, Kosovo, Latvia, Lithuania, Luxembourg, Malta, Moldova, the Netherlands, Poland, Portugal, Romania, Russia, Slovenia, Spain, Switzerland, Turkey, Ukraine and the UK); 16 American (Argentina, Bahamas, Barbados, Brazil, Canada, Cuba, Dominican Republic, Guam, Jamaica, Mexico, Panama, Sint Maarten, Saint Helena, Trinidad and Tobago, the USA and Venezuela); 19 Asian and Oceania (Australia, Bangladesh, Bhutan, Brunei, Cambodia, Fiji, India, Indonesia, Japan, Kazakhstan, Macao, Malaysia, Nepal, New Zealand, The Philippines, Singapore, Sri Lanka, Taiwan and Uzbekistan); 12 Middle Eastern (Afghanistan, Bahrain, Iran, Iraq, Israel, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, the UAE and Yemen) and 17 African countries (Democratic Republic of the Congo, Egypt, Ethiopia, Ghana, Kenya, Mauritius, Morocco, Nigeria, Reunion, Rwanda, Senegal, Somalia, South Africa, Sudan, Uganda, Zambia and Zimbabwe) (figure 3).

DISCUSSION

The COVID-19 pandemic has had a significant impact on global public awareness and behaviour, including an increased interest in the prevention of infectious diseases. However, the magnitude of the impact and the differences among countries are unclear. To our knowledge, this is the first study to use Google Trends to objectively show the trends in people's interest in COVID-19 and its preventive measures in countries and regions worldwide. As globalisation progresses, it is necessary to consider countermeasures against globally transmitted infectious diseases, such as COVID-19, from a global perspective. Therefore, understanding the trends in people's interest in preventive measures is important to consider global countermeasures. We noted some interesting observations in the present situation of the global interest in COVID-19 and preventable measures.

First, the global interest in coronaviruses among people with COVID-19 has increased to an unprecedented level after WHO declared a pandemic in March 2020¹; interest in "coronavirus" has been maintained to a certain extent even now, more than a year and a half after the outbreak. We also noted an increase in interest in preventable measures globally. However, the timings of the increase differed by country and region. Even though most countries also 'reacted' to prevention measures at the time of the WHO pandemic declaration, some countries increased interest in preventable measures much earlier than others. Geographical and political factors may have influenced the timing of the increase. For example, the countries around China, such as Vietnam, increased their public interest much before the WHO's pandemic declaration, when Chinese travellers were banned from the country at a very early phase.²⁶ Contrastingly, in Japan,

the interest in "coronavirus" and preventable measures peaked much later than in other high-income countries after the WHO pandemic declaration. This occurred when the Japanese government first declared a state of emergency on 7 April 2020.

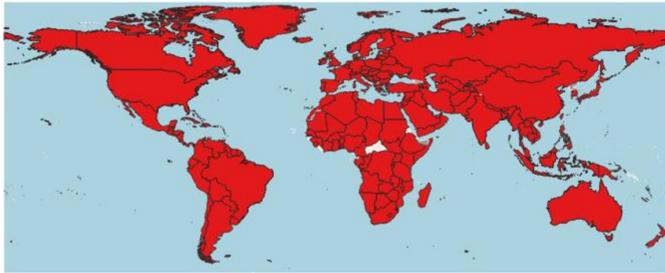
The 'increase' in awareness and how to sustain the interest in measures for preventing infectious diseases were focused on. In most countries and regions, I found that people's interest in COVID-19 and preventive measures increased, but the persistence of interest in these preventable measures was not necessarily maintained; there was also a difference in the sustainability level of interest by country and region. Furthermore, with these differences in each country's characteristics, there are also differences in sustainability between the search words "wash hand", "social distancing", "hand sanitizer" and "mask".

The sustainability of people's interest in masks was confirmed in a wide range of countries and regions than other search terms. At the beginning of the outbreak, interest in masks spread mainly in Asian countries relatively quickly, where a mask culture was already present. A report showed the regional difference in wearing masks by region at an early stage of the COVID-19 pandemic.²⁷ This might be attributed to geographic and cultural differences that could have enhanced self-protecting habits.²⁸ However, notably, the sustainability of the other word 'impact' of 'mask' was confirmed in many countries that are not necessarily familiar with the practice of wearing masks during winter, such as many Western countries.²⁹ This implies that familiarity with masks may spread in countries without a mask-wearing culture. Although the effectiveness of facemask use in community settings for COVID-19 prevention has been controversial,^{30–32} the COVID-19 pandemic introduced a 'new culture' to these countries and regions.

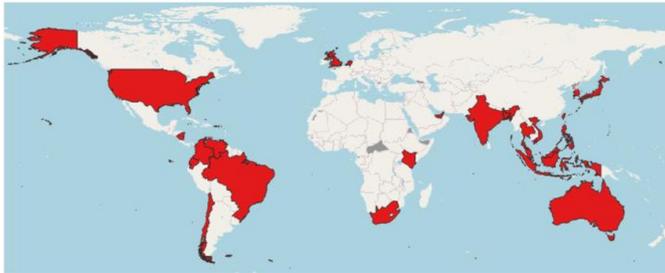
Contrastingly, countries that could sustain interest in the search term "wash hand" were relatively limited. Notably, the impact of COVID-19 was confirmed in relatively few European countries with low sustainable interest for the term "wash hand", where the cumulative number of confirmed cases was high.² The impact was concentrated in Southeast and East Asian countries, where the number of confirmed cases and death rates were relatively low.² This suggests that for the countries that did not sustain the interest of "wash hand", including many European countries, interventions to maintain public interest may be necessary in cases of repeated outbreaks. As governments consider effective ways to control infections, they need to consider that they may not be able to sustain the population's interest in preventive actions against infection.

Countries in East and Southeast Asia maintained an interest in "wash hand" and in other preventive measures such as "social distancing" and "hand sanitizer". Thus, in these regions, the COVID-19 pandemic greatly impacted the public mind's interest and awareness of prevention measures against infectious diseases. Since prevention

(A) Countries with significant difference of “coronavirus” RSV in the first 20 weeks and the last 20 weeks



(B) Countries with significant difference of “wash hand” RSV in the first 20 weeks and the last 20 weeks



(C) Countries with significant difference of “social distancing” RSV in the first 20 weeks and the last 20 weeks



(D) Countries with significant difference of “hand sanitizer” RSV in the first 20 weeks and the last 20 weeks



(E) Countries with significant difference of “mask” RSV in the first 20 weeks and the last 20 weeks



Figure 3 Distribution of countries with statistically significant relative search volume (RSV) of “coronavirus”, “wash hand”, “social distancing”, “hand sanitizer” and “mask” in the last 20 weeks compared with that before the COVID-19 pandemic. Area coloured red: countries with statistical significance in the last 20 weeks versus before the COVID-19 pandemic. Area coloured grey: countries without valid data.

methods are common to many infectious diseases, the increased awareness of people regarding the prevention measures due to the COVID-19 pandemic can be expected to be reflected in future COVID-19 trends

and in the decrease in other infectious diseases. Some previous studies in East Asia reported that the number of seasonal influenza cases in the 2019–2020 season was lower after COVID-19 transmission than in previous

years and suggested the positive effects of prevention measures against COVID-19 on seasonal influenza.^{33–35} The National Institute of Infectious Diseases in Japan also reported that in 2020 and 2021, mycoplasma pneumonia infection, respiratory syncytial virus infection and group A streptococcal pharyngitis decreased, whereas infectious gastroenteritis significantly decreased and reached its lowest level in a decade.³⁶ These infections can be effectively prevented by washing hands, social distancing, using hand sanitizers and wearing masks, as discussed in this study. In combination with these trends and the results from this study, it is suggested that the increasing interest in preventive actions in East Asian countries may be associated with the decrease in other infectious diseases.

The other main finding of the difference between the regions is the slower pace of development of interest in countries on the African continent as well as the limited areas where the persistence of interest had been observed, especially in terms that were related to behaviour change, such as “wash hand” and “social distancing”. When interpreting data about African countries, it is necessary to consider their relatively low level of internet availability.³⁷ However, considering that the trend of increased and sustained interest in “coronavirus” was confirmed even in African countries at the same level as other regions, the general interest in preventive measures in the African continent can be considered relatively lower. Thus, the data can be used as a reference for understanding the present situation in Africa. Some studies also mentioned the issues of attitude toward knowledge and healthy practices, including COVID-19 preventive practices in African countries.^{38–40} The low-level interest in preventive measures in African countries needs to be considered in future strategies for expanding preventive measures against infectious diseases at the global level. As the pandemic is still unfolding, there is a strong need to continually implement health promotion measures to better prevent the pandemic and improve related-health behaviours in African populations and countries with low impact of public interest on preventable measures.

The COVID-19 pandemic caused damage and impacted people’s lives worldwide. The study results showed that people’s interest in preventable measures against infectious diseases increased in most countries. This unprecedented opportunity should be maximised by policymakers, and appropriate policies should be implemented to maintain the increased interest in preventable measures, which will lead to future infectious disease control.

This study had some limitations. First, differences in the levels of internet availability may have affected the results. Second, the percentage of Google users may have affected the global-level evaluation of public interest using Google Trends. A typical example is the extreme low share of Google as a web search engine in China, given that they may have used other search engines and hence did not use Google.⁴¹ Therefore, Google Trends is not a suitable tool for understanding trends in countries

such as China; the results of these countries should be interpreted based on this prior knowledge. Although it is necessary to consider these differences to interpret the results globally, the sustainability of the search term “coronavirus” was uniform in almost all countries because of the consistent volume of internet searches from almost all countries and regions throughout the study period. This suggests that the global spread of the tools used in this study was sufficient to grasp global trends.

Conclusion

The COVID-19 pandemic may have impacted the global public interest in prevention measures against infectious diseases. However, there are differences in interest related to preventable measures and sustainability of that interest between countries and regions. The increased interest in preventive behaviours against COVID-19 may be related to overall infectious disease prevention. These global differences should be considered when implementing effective interventions against infectious diseases at the global level.

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ORCID iD

Tomoo Ito <http://orcid.org/0000-0001-7495-7225>

REFERENCES

- 1 World Health Organization. WHO, director. *General's opening remarks at the media briefing on COVID-19*. Available: <http://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020> [Accessed 01 Nov 2021].
- 2 World Health Organization. WHO coronavirus disease (COVID-19) Dashboard [Internet]. Available: <https://covid19.who.int> [Accessed 01 Nov 2021].

- 3 Xiang M, Zhang Z, Kuwahara K. Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. *Prog Cardiovasc Dis* 2020;63:531–2.
- 4 Eysenbach G. Infodemiology and infoveillance: framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. *J Med Internet Res* 2009;11:e11.
- 5 Eysenbach G. Infodemiology and infoveillance tracking online health information and cyberbehavior for public health. *Am J Prev Med* 2011;40:S154–8. Supplement 2.
- 6 Pervaiz F, Pervaiz M, Abdur Rehman N, et al. FluBreaks: early epidemic detection from Google flu trends. *J Med Internet Res* 2012;14:e125.
- 7 Mavragani A, Ochoa G, Tsagarakis KP. Assessing the methods, tools, and statistical approaches in Google trends research: systematic review. *J Med Internet Res* 2018;20:e270.
- 8 Nuti SV, Wayda B, Ranasinghe I, et al. The use of Google trends in health care research: a systematic review. *PLoS One* 2014;9:e109583.
- 9 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.
- 10 Lin Y-H, Liu C-H, Chiu Y-C. Google searches for the keywords of "wash hands" predict the speed of national spread of COVID-19 outbreak among 21 countries. *Brain Behav Immun* 2020;87:30–2.
- 11 Cervellini G, Comelli I, Lippi G. Is Google trends a reliable tool for digital epidemiology? insights from different clinical settings. *J Epidemiol Glob Health* 2017;7:185–9.
- 12 Scharnow M, Vogelgesang J. Measuring the public agenda using search engine queries. *Int J Public Opin Res* 2011;23:104–13.
- 13 Choi H, Varian HAL. Predicting the present with Google trends. *Econ Rec* 2012;88:2–9.
- 14 Stein JD, Childers DM, Nan B, et al. Gauging interest of the general public in laser-assisted in situ keratomileusis eye surgery. *Cornea* 2013;32:1015–8.
- 15 Strzelecki A. The second worldwide wave of interest in coronavirus since the COVID-19 outbreaks in South Korea, Italy and Iran: a Google trends study. *Brain Behav Immun* 2020;88:950–1.
- 16 Ayyoubzadeh SM, Ayyoubzadeh SM, Zahedi H, et al. Predicting COVID-19 incidence through analysis of Google trends data in Iran: data mining and deep learning pilot study. *JMIR Public Health Surveill* 2020;6:e18828.
- 17 Ortiz-Martínez Y, García-Robledo JE, Vásquez-Castañeda DL, et al. Can Google® trends predict COVID-19 incidence and help preparedness? the situation in Colombia. *Travel Med Infect Dis* 2020;37:101703.
- 18 Effenberger M, Kronbichler A, Shin JI, et al. Association of the COVID-19 pandemic with Internet Search Volumes: A Google Trends™ Analysis. *Int J Infect Dis* 2020;95:192–7.
- 19 Walker A, Hopkins C, Surda P. Use of Google trends to investigate loss-of-smell-related searches during the COVID-19 outbreak. *Int Forum Allergy Rhinol* 2020;10:839–47.
- 20 Sousa-Pinto B, Anto A, Czarlewski W, et al. Assessment of the impact of media coverage on COVID-19-Related Google trends data: Infodemiology study. *J Med Internet Res* 2020;22:e19611.
- 21 Heerfordt C, Heerfordt IM. Has there been an increased interest in smoking cessation during the first months of the COVID-19 pandemic? A Google trends study. *Public Health* 2020;183:6–7.
- 22 Kutlu Ömer. Analysis of dermatologic conditions in turkey and Italy by using Google trends analysis in the era of the COVID-19 pandemic. *Dermatol Ther* 2020;33:e13949.
- 23 Springer S, Menzel LM, Zieger M. Google trends reveals: focus of interest in the population is on treatment options rather than theories about COVID-19 animal origin. *Brain Behav Immun* 2020;87:134–5.
- 24 Onchonga D. A Google trends study on the interest in self-medication during the 2019 novel coronavirus (COVID-19) disease pandemic. *Saudi Pharm J* 2020;28:903–4.
- 25 Yourself & others. *How to protect*. CDC Center for Disease and Prevention [Internet] <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html>
- 26 Huynh TLD. The COVID-19 containment in Vietnam: what are we doing? *J Glob Health* 2020;10:010338.
- 27 Elachola H, Ebrahim SH, Gozzer E. COVID-19: facemask use prevalence in international airports in Asia, Europe and the Americas, March 2020. *Travel Med Infect Dis* 2020;35:101637.
- 28 Siu JY-M. Qualitative study on the shifting sociocultural meanings of the facemask in Hong Kong since the severe acute respiratory syndrome (SARS) outbreak: implications for infection control in the post-SARS era. *Int J Equity Health* 2016;15:73.
- 29 Onishi N, Méheut C. Mask-wearing is a very new fashion in Paris (and a lot of other Places). *New York Times*. Available: <http://www.nytimes.com/2020/04/09/world/europe/hevirus-mask-wearing.html> [Accessed 01 Nov 2021].
- 30 World Health Organization. Advice on the use of masks in the community. during home care and in health care settings in the context of the novel coronavirus. nCoV outbreak: Interim guidance <https://apps.who.int/iris/handle/10665/330987>
- 31 Leung CC, Lam TH, Cheng KK. Mass masking in the COVID-19 epidemic: people need guidance. *Lancet* 2020;395:945.
- 32 van der Sande M, Teunis P, Sabel R. Professional and home-made face masks reduce exposure to respiratory infections among the general population. *PLoS One* 2008;3:e2618.
- 33 Itaya T, Furuse Y, Jindai K. Does COVID-19 infection impact on the trend of seasonal influenza infection? 11 countries and regions, from 2014 to 2020. *Int J Infect Dis* 2020;97:78–80.
- 34 Lee H, Lee H, Song K-H, et al. Impact of public health interventions on seasonal influenza activity during the COVID-19 outbreak in Korea. *Clin Infect Dis* 2021;73:e132–40.
- 35 Huang QS, Wood T, Jelley L, et al. Impact of the COVID-19 nonpharmaceutical interventions on influenza and other respiratory viral infections in New Zealand. *Nat Commun* 2021;12:1001.
- 36 National Institutes of infectious disease. *infectious disease weekly report Japan* [Internet] <https://www.niid.go.jp/niid/ja/10/weeklygraph.html>
- 37 Share of internet users in Africa as of December 2020, by country. Statista [Internet]. Available: <https://www.statista.com/statistics/1124283/internet-penetration-in-africa-by-country/> [Accessed 01 Nov 2021].
- 38 Odeyemi OA, Sani NA, Obadina AO, et al. Food safety knowledge, attitudes and practices among consumers in developing countries: an international survey. *Food Res Int* 2019;116:1386–90.
- 39 Habib MA, Dayyab FM, Iliyasu G, et al. Knowledge, attitude and practice survey of COVID-19 pandemic in northern Nigeria. *PLoS One* 2021;16:e0245176.
- 40 Workneh F, Wang D, Millogo O, et al. Knowledge and practice related to COVID-19 and mental health among adults in sub-Saharan Africa. *Am J Trop Med Hyg* 2021;105:351–62.
- 41 Search engine market share China. Statcounter. Available: <https://gs.statcounter.com/search-engine-market-share/all/chinahttps://www.http://nbcnews.com/technology/microsoft-blocks-censorship-skype-china-advocacy-group-2D11664965> [Accessed 01 Nov 2021].