GOOGLE TRENDS ANALYSIS OF TOOTHACHE-RELATED INFORMATION-SEEKING BEHAVIOURS DURING COVID-19 PANDEMIC IN MALAYSIA

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Abstract

Google Trends (GT) is a primary tool for studying online behaviours and exploring web search trends related to specific topics over time. During the COVID-19 outbreak in Malaysia, several Movement Control Orders (MCO) were implemented, resulting in restricted access to dental care. The public may have searched for online information to manage their dental problems and needs. This study aimed to investigate toothache-related information-seeking keywords via GT and their correlation with different phases of the MCO implementation. A retrospective study was conducted using GT to collect Relative Search Volume (RSV) of toothache-related keywords from 2020 to 2021 in Malaysia. RSV was compared between the various MCO phases which were the First MCO (March-May 2020), Conditional MCO (May-June 2020), Recovery MCO (June 2020-March 2021), MCO by states (March-May 2021), MCO3.0 (May-June 2021) and the National Recovery Plan (NRP) from June 2021 onwards. Data were analysed descriptively using Microsoft Excel and SPSS software. The mean RSV was 74.43 (SD ± 8.46), with a peak of 100 on the week of 25th July 2021. The highest recorded RSV period between May to September 2021 corresponded with MCO3.0 and the early phase of NRP. The most searched toothache-related keyword in Malaysia was "*ubat sakit gigi*", with an RSV of 100. All top related search keywords were in the Malay language. States with the highest RSV of toothache-related keywords were Kelantan, Sabah, and Terengganu. There was a positive correlation between RSV of toothache-related keywords and the different phases of MCO, $r = 0.206$ and $p = 0.036$ ($p < 0.05$). MCO implementations and seasonal interest during the COVID-19 pandemic seemed to influence the trend of Google users in Malaysia seeking information about toothaches. These findings may be used as supplementary data to support planning for oral health services and information delivery.

Keywords: COVID-19, Google Trends, Information-Seeking Behaviours, Relative Search Volume, Toothache

Introduction

Internet data has become a valuable source for research and a tool for exploring human behaviours. The use of publicly available data has given rise to a field known as infodemiology and infoveillance (information surveillance), which focuses on the science of distribution and determinants of information in the electronic medium, particularly on the internet, to inform public health and public policy (1). Many studies worldwide utilise internet data for analysis, such as Google Trends (GT) or Twitter and Instagram content analysis (1-5). As one of the leading global search engines for information seeking (6), Google has witnessed a dramatic increase in health and oral health-related information during the COVID-19 pandemic, reflecting the public's interest in understanding novel viral infections (7).

One of the most popular tools for examining online behaviours is GT. This open tool provides information on trends and the variations in online interest of selected keywords and topics over time (8). Online search traffic data from Google have been helpful in analysing human behaviours towards health topics, and forecasting disease occurrence and outbreaks (9). Google introduced the GT tool in 2016 (10), offering free and publicly available data of online search trends related to the Google website search engine. It serves as a leading example of the utilisation and application of big data in infodemiological studies (11). Several global studies have been conducted to measure

the interest in toothache-related information-seeking behaviours among users in the United States, United Kingdom and Brazil (12, 13), including during the COVID-19 pandemic (14, 15).

The COVID-19 pandemic has highlighted the importance of public health measures, including national lockdowns to mitigate the spread of infection. However, such policies have had an impact on oral healthcare services, resulting in limited access and restrictions on elective dental treatments (5). According to Sofi-Mahmudi et al. (15), toothache-related information search volumes increased in Iran during the COVID-19 imposed lockdown. Similarly, social restriction measures over this period in other countries such as Thailand and South Korea were also associated with an increased interest in toothache-related information online (14). During the height of the COVID-19 pandemic, Malaysia was one of many countries heavily affected by the outbreak, recording the highest number of confirmed cases in the Southeast Asia region (16). The Malaysian government implemented several phases of the Movement Control Order (MCO) starting from March 2020 as an effort to control the spread of the COVID-19 virus within the country. During these periods, access to dental services was restricted and limited to emergency care. Consequently, the public may have searched for online information to manage their dental problems and oral health needs. Rizzato et al. (14) showed that it was common for the public to search online for information on the self-resolution of a symptom, especially homemade alternative methods. Since the start of the COVID-19 pandemic, there was a sudden growth of searches combining the terms "toothache" and "COVID-19" over time (14). Apart from searching for homemade remedies, the public may have also sought information online regarding the introduction of standard operating procedures (SOPs) in dental care services.

Existing literature mainly focuses on global data analysis and centres around developed countries. There is a lack of published studies regarding GT in toothache-related information-seeking behaviours in developing countries, including Malaysia. The interest in toothache-related information helps to identify the populations' dental demands and contributes to the planning of specific policies during and after the pandemic (14). Hence it is imperative to study Google search trends of toothache-related information-seeking behaviours keywords during the COVID-19 pandemic among the Malaysian population to understand the public interest and whether these searching trends are associated with other factors such as oral disease burden and population-based preventive measures. In response to the gap in the literature, the present study aims to investigate toothache-related seeking information keywords via GT and their correlation with the different phases of MCO implementation. The findings will be useful for generating evidence about oral health-seeking behaviours and could aid in providing targeted oral health promotion strategies and address the public's need for oral health care both during and after pandemic. Moreover, these findings can offer insights applicable to future public health emergencies, enhancing preparedness and response measures for oral health care.

Materials and Methods

Study design and data collection

This study was a retrospective analysis of computational metadata focusing on the interest related to toothache among Internet users in Malaysia. Data from GT were collected over two years, from 2020 to 2021, using specific keywords identified for this study. The methodological framework of GT was adopted from Mavragani and Ochoa (9). GT is an open online tool that provides information on trends based on users' Google queries. It offers a variety of features such as Trending Searches, Year in Search, and Explore. To refine the results, users can use search filters to focus on specific locations, time ranges, categories, and search types. For this study, Malaysia was selected as the country of interest using the "Location" tab, and the time range was set as 2020 to 2021 under the "Time range" tab. The "Category" tab was utilised to narrow down the search to specific health topics. Data from GT was retrieved using the "Explore" feature, allowing real-time data download from any desired period/timeline. The data were downloaded in .csv format and presented as relative search volume (RSV), which varies from 0 to 100 over a weekly/monthly variation. The value 0 does not necessarily indicate no searches but indicates very low search volumes not included in the results, whereas the value 100 indicates the most popular search (9).

The search query for this study was developed based on common search terms quoted within the literature (4, 13) followed by related keywords generated from the Google search database in both English and Malay languages. The keywords used were "*Sakit gigi*", "dental pain" and "toothache". RSV of the selected keywords were collected weekly using the GT database between the year 2020 to 2021 over custom selected time intervals to meet the objectives of this study. The time intervals were chosen to reflect the various MCO phases in Malaysia, including three months of pre-MCO period (January to March 2020).

MCO was a series of nationwide quarantine and cordon sanitaire measures implemented by the federal government of Malaysia in response to the COVID-19 pandemic in the country. It was imposed nationwide on 18th March 2020, and was extended and relaxed into different phases between 2020 and 2021, which included the Conditional Movement Control Order (CMCO) and the Recovery Movement Control Order (RMCO). Several phases of CMCO and RMCO were implemented nationwide, depending on the status of the pandemic at the time. The MCO was included in the National Recovery Plan (NRP) launched in June 2021, which aimed to help the country recover from the COVID-19 pandemic and its economic fallout. The relevant MCO phases and timeframes quoted in this study were extracted from the Majlis Keselamatan Negara (MKN) official website (17).

Data management and analysis

The collected data were assessed according to the distribution of categories of toothache related topics by MCO phases and states in Malaysia. Data were also presented using "search volume index graphs" from GT application to show changes between the periods of times investigated. RSV toothache-related keywords were further categorised arbitrarily into four search volume categories; low (RSV < 50); average (RSV: 50 – 65); moderate (RSV: 66 – 80) and high (RSV: 81 – 100) search queries. Several phases of the pandemic control measures imposed by the Malaysian government were categorised based on the type of MCOs: MCO (18th March to 4th May 2020), CMCO (4th May to 9th June 2020), RMCO (10th June 2020 to 31st March 2021), MCO by states (31st March to May 2021), MCO 3.0 (May to 28th June 2021) and NRP (28th June to 31st December 2021). Relevant data were entered into Statistical Package for Social Science (SPSS) version 26 and analysed using descriptive statistics. Pearson Correlation analysis was performed to further explore for the distribution patterns of search trends with MCO phases. Statistically significant was set at $p < 0.05$.

Ethical consideration

This study was registered with the National Medical Research Registration (NMRR) – NMRR ID-22-00898-JGD. No ethical clearance was obtained for this study, based on advice provided by The Medical and Ethics Committee of the Faculty of Dentistry, Universiti Malaya, as the study only involved secondary open-source data with no human involvement.

Results

Figure 1 shows a summary of the overall trends of RSV toothache-related keywords over the study period. A total of 104 RSV data for "*Sakit Gigi*", "Dental Pain" and "Toothache" related keywords were collected weekly between the year 2020 to 2021 from the GT database. The highest RSV for toothache-related keywords was recorded during the week of 25th July 2021 with (RSV = 100). The lowest RSV was during the week of 21st March 2021 with (RSV = 57). The mean value for overall RSV was 74.43 (SD ± 8.46). The highest recorded RSV period was between mid of May 2021 and September 2021 which corresponded with the MCO 3.0 and the early phase of the NRP, with most weeks scoring RSV of > 80.

The RSV trend of toothache-related keywords according to the various phases of MCO implementation is shown in Figure 2a-g. Overall, not much difference was observed in search volumes during the pre-MCO period, with RSV 83 being the highest score being recorded in January 2020 (Figure 2a). The First MCO implementation (Figure 2b) and the CMCO (Figure 2c) showed almost a similar pattern. While the fluctuations in trends were observed during RMCO (Figure 2d) and when analysed by states in Malaysia (Figure 2e). The seasonal peak of RSV toothache-related keywords was noted during the MCO 3.0 period (Figure 2f) and the week of 23rd May 2021 (RSV = 98). Meanwhile, during the NRP period (Figure 2g), the peak was observed at the end of July 2021 (RSV = 100).

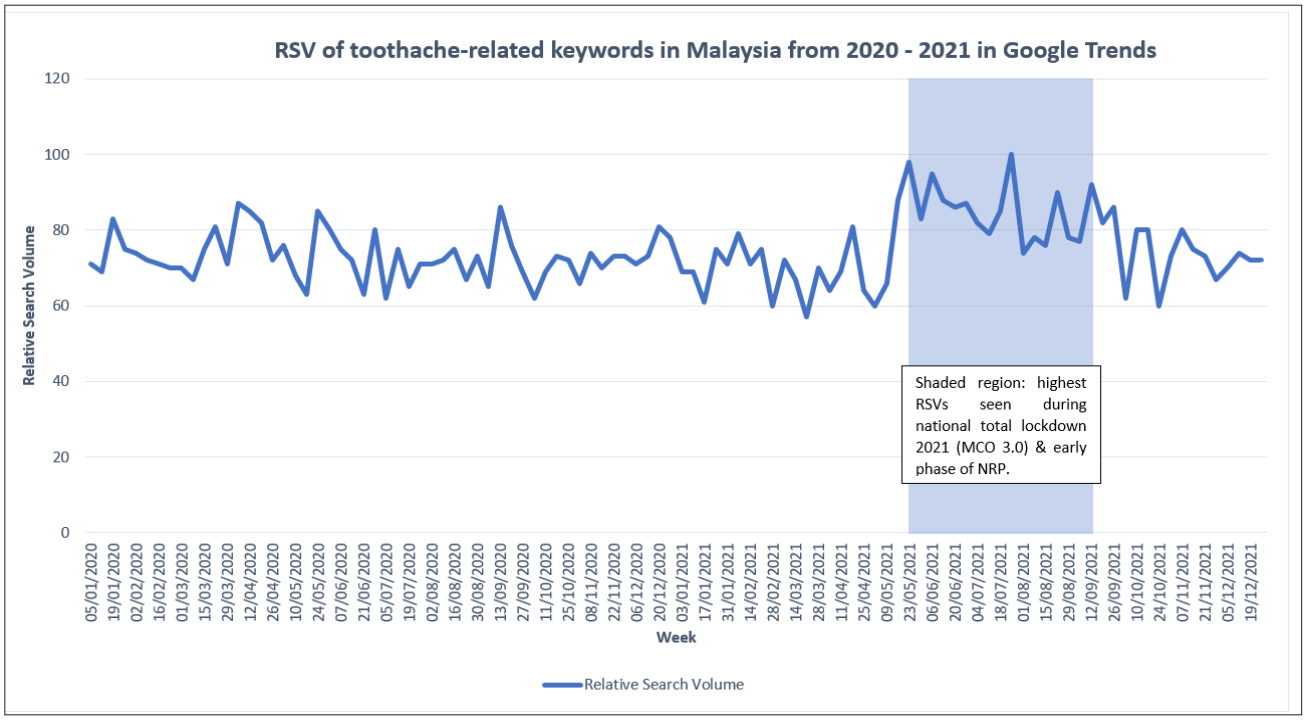

Figure 1: RSV of toothache-related keywords in Malaysia from 2020 - 2021 in Google Trends

Figure 2a-g: Trends of RSV of toothache-related keywords from 2020-2021 according to phases of MCO implementations in Malaysia

Top search queries related to "*Sakit Gigi*", "Dental Pain" and "Toothache" among Malaysian Google users during the year 2020 to 2021 were "*ubat sakit gigi*" and "*ubat gigi*", with both queries scoring RSV of 100. All the top related queries were in Malay language. Only the top three related queries had an RSV ≥ 67, whereas the rest had lower search volumes (RSV ≤ 32) as shown in Table 1. The top search queries were mostly related to relief of toothache related symptoms, conditions of the toothache, and seeking of dental treatments.

Table 1: RSV of top queries related with "*Sakit Gigi*", "Dental Pain" and "Toothache" in Malaysia (2020 – 2021)

Top related queries	RSV
ubat sakit gigi	100
ubat gigi	100
hilangkan sakit gigi	67
gigi berlubang	32
sakit gigi berlubang	32
petua sakit gigi	31
cara hilangkan sakit gigi	30
doa sakit gigi	20
sakit gusi	16
cabut gigi	11
sakit gigi geraham	10
gigi geraham	10
klinik gigi	10
petua hilangkan sakit gigi	10

The crosstabulation between the different categories of RSV of toothache-related keywords with the types of MCO implementations is shown in Table 2. The frequency of moderate (RSV:66-80) range category of RSV toothache-related keywords was the highest throughout the two-year period (64.42%), followed by the total high range (22.12%) and the total average range (13.46%) categories. Within the high range RSV toothache-related keywords category (RSV = 81-100), the highest frequency was observed during the MCO 3.0 and NRP period where both scored 6.73%. Within the moderate range search category (RSV = 66-80), the most searched frequency was observed during the RMCO and NRP period.

A Pearson correlation coefficient was computed to assess the linear relationship between RSV toothache-related keywords and RSV of toothache-related keywords with different types of MCO phases. There was a positive correlation between the two variables, $r = 0.206$ and $p = 0.036$ ($p < 0.05$).

The highest RSV of toothache-related keywords based on states in Malaysia were from Kelantan, Sabah and Terengganu, with each scoring RSV of 100, 97 and 91 respectively. The lowest RSV were from Selangor, Pulau Pinang and Federal Territory of Labuan with RSV 48, 46 and 0. The RSV for each state is shown in Table 3.

Discussion

This study aimed to determine Google search frequencies for toothache-related keywords throughout the different phases of MCO implementation in Malaysia during the

Table 2: Crosstabulation between the Recode RSV of toothache-related keywords with different phases of MCO

	Recode RSV									
Types of MCO	Low (RSV <50)	%	Average (RSV: 50-65)	%	Moderate (RSV: 66-80)	%	High (RSV: 81-100)	%	Total	%
Pre MCO	0	0.00	0	0.00	10	9.62	1	0.96	11	10.58
MCO	0	0.00	0	0.00	3	2.88	4	3.84	7	6.73
CMCO	0	0.00	1	0.96	3	2.88	1	0.96	5	4.80
RMCO	0	0.00	5	4.80	23	22.12	2	1.92	30	28.85
MCO by States	0	0.00	6	5.77	11	10.58	1	0.96	18	17.31
MCO 3.0	0	0.00	0	0.00	0	0.00	7	6.73	7	6.73
NRP	0	0.00	2	1.92	17	16.35	7	6.73	26	25
Total	0	0.00	14	13.46	67	64.42	23	22.12	104	100.00

CMCO: Conditional Movement Control Order
MCO: Movement Control Order
NRP: National Recovery Plan
RMCO: Recovery Movement Control Order
RSV: Relative Search Volumes

Table 3: The RSV of toothache-related keywords based on states in Malaysia (2020 –2021)

States in Malaysia	RSV
Kelantan	100
Sabah	97
Terengganu	91
Perlis	79
Pahang	76
Kedah	70
Sarawak	67
Malacca	64
Negeri Sembilan	57
Johor	56
Perak	55
Federal Territory of Kuala Lumpur	50
Federal Territory of Putrajaya	50
Selangor	48
Pulau Pinang	46
Federal Territory of Labuan	0

COVID-19 pandemic. Similar patterns in search trends related to toothaches were observed during the first quarter of 2020 (pre-MCO) and throughout a year and a half of the MCO period, with the RSV fluctuating between 60 and 85. This findings contradicts the GT analysis reported in other countries including Brazil, Egypt, India, Iran, Philippines, South Africa, Thailand, Turkey, the United Kingdom, and the United States America, where an increase in RSV for toothache-related keywords was observed due to COVID-19 imposed lockdowns in their respective regions (14, 15). The onset of restrictions seemed to hasten the toothache-related search trend, leading to a sudden and significant increase in search volume (14, 15). Unlike other countries, the initial onset of restrictions in Malaysia did not seem to accelerate the toothache-related search trend. It can be postulated that the increased activity of Google users seeking information on the outbreak of COVID-19, could have reduced the significance of searches for other health conditions such as toothache-related information at that time (14).

However, the search trend related to toothache-information in Malaysia increased during relaxation periods of the MCO. The highest recorded RSV period was between May 2021 and September 2021, corresponding with the MCO 3.0 and the early phase of the NRP. Unlike the initial phase of MCO, which had higher restrictions, MCO 3.0 allowed for some relaxation, with limited movement within infected local areas or between them. Public movement was permitted for specific scenarios such as seeking healthcare or medical services, work-related activities, and obtaining daily necessities (18). The transition from early phase of MCO and subsequent relaxation rules may have influenced the information seeking behaviours and interest in dental-related topics among Malaysian Internet users. It is expected that during the earliest phase of MCO, the public may have focused on COVID-19 related issues. However, as time progressed, there seemed to be a shift in search behaviours, potentially indicating a growing interest in other health concerns, including oral health issues. Following the implementation of MCO 3.0, the NRP was initiated in July 2021 and was slowly introduced in phases to various states in Malaysia. Perlis, Kelantan, Terengganu, Pahang and Perak were the earliest states to implement NRP. During the early phases of NRP, RSV for toothache-related keywords remained high. This could have been attributed to the reopening of several economic sectors and relaxation of restrictions seen in health care facilities. Additionally, during this period, more dental procedures and appointment slots were made available to cover the

backlog of treatments as elective dental services were suspended during the first phase of MCO (18, 19). This situation may explain the increased interest in seeking further information or treatment related to toothache symptoms especially for individuals with oral diseases such as caries, as these conditions may have progressed or worsened after more than one year of pandemic-related disruptions.

The increase in RSV of toothache-related keywords cannot be solely attributed to specific movement restrictions or MCOs. Other factors such as extensive media coverage and high disease rates, can also contribute to the increase in search volumes on GT (6). Untreated tooth decay and treatment delays during MCOs may further contribute to the increased RSV. These factors demonstrate the complex influences on online information-seeking behaviours during times of restrictions and health crisis. Seasonal interests likely played a role in the increased RSV of toothache-related keywords seen in this study. A possible explanation for the high RSV is the seasonal interest during Eid celebration. Studies have shown that Muslims may seek toothache relief or treatment after the one-month fasting period (20-22). The Eid festive season, is often accompanied with long breaks in Malaysia, resulting in the closure of dental clinics, affecting both Muslim and non-Muslim communities. For non-Muslims, the long breaks during festive seasons might have limited their access to dental services, leading to increased reliance on online platforms to seek information on toothache remedies and management. Additionally, the highest RSV period in this study coincided with Malaysia's Oral Health Promotion Week, which aimed to raise awareness on routine dental check-ups. The RSV increase may be due to both the public seeking information and dental professionals preparing materials for promotional activities. However, GT lacks sociodemographic data, limiting verification of this assumption. Nonetheless, studies in other countries suggest that RSV reflects interest or media coverage in healthcare issues among specific populations (23-26).

Top search queries of toothache-related keywords among Malaysians during the year 2020 to 2021 were mostly related to relieving the symptoms of toothaches (i.e. *ubat sakit gigi, ubat gigi, hilangkan sakit gigi, petua sakit gigi, cara hilangkan sakit gigi, doa sakit gigi),* condition of the tooth (*gigi berlubang, sakit gigi berlubang, sakit gusi, sakit gigi geraham, gigi geraham*) and seeking dental treatments (*cabut gigi, klinik gigi*). These findings indicate that Malaysian Google users experiencing toothache symptoms had a higher tendency to search for information on how to relieve the pain. Furthermore, it reflects the prevalence of traditional and religious beliefs in pain relief, such as praying, seeking appropriate tips and home remedies. Similar findings were reported in a study by Rizzato et al. (14) where toothache-related searches in Google were mainly related to self-treatment, self-resolution of pain and home strategies to solve such problems. This behaviour is commonly observed in low-income and rural communities with a higher prevalence of oral diseases and increased barriers to dental services (27). Data from the National Health and Morbidity Survey 2019 supported this study's findings as it too reported that some Malaysians with oral health problems sought self-medication (10.1%) or advice from sources other than healthcare practitioners (8.7%) (27). In addition, a recent local study reported that the majority of adults gained information on self-medication for dental problems mainly from the internet (62.0%), and 76.0% of them practiced self-medication for toothaches (28). This data supports the present findings on the top queries of toothache-related keywords with the public's tendency to seek alternative remedies for toothache symptoms.

The top search queries for toothache-related keywords were predominantly in the Malay language. Given the significant Malay population and the Malay language being the national language in Malaysia, it is expected that most users prefer Malay keywords to English (29). Similar trends have been observed in other regions, as communities in Asia and Western Europe tend to search for health-related information using their native language (30). It is important to note that this study does not imply that Malaysians did not search for toothache-related keywords in English. However, the RSV of English terms was low and did not rank among the top or trending search queries in GT during the study period.

When analysing the RSV at state level, the states with the highest RSV for toothache-related keywords were Kelantan, Sabah, and Terengganu. All three states have previously been reported as having high caries prevalence and low coverage of water fluoridation (WF), as reported by the Malaysian Ministry of Health (20). In contrast, affluent states in Malaysia, such as Pulau Pinang, Selangor, Federal Territories Kuala Lumpur and Putrajaya, and Perak, showed low RSV for toothache-related keywords. This suggests that better oral health status and improved accessibility to oral health care services may influence their oral health information-seeking behaviours. Populations with higher oral disease prevalence may search for more toothache information to manage their conditions.

This study has a few limitations. Firstly, the choice of search keywords could impact the study's outcomes. However, specific toothache-related keywords were selected based on the literature review to minimise this bias. Secondly, the findings may not fully represent the entire population, as GT data only includes users with internet access, potentially excluding certain segments of the population from the analysis. Thirdly, the data obtained from GT does not provide demographic background information about the users. Therefore, it is not possible to determine whether the search queries were made by the general public or dental professionals seeking information. Lastly, one may argue that the arbitrary categorisation of RSV. To date, there are no established or widely accepted criteria for categorising RSV in the existing literature. Considering the recent development of Google Trend analysis research, employing arbitrary categorisation can assist researchers

in conducting initial analyses to identify trends or outliers. Further in-depth analyses can be explored to confirm the criteria for these categories in future research.

Conclusion

The search trend concerning to toothache-related information in Malaysia demonstrated an increase during the relaxation periods of the MCO 3.0 and early phase of the NRP as opposed to the initial phase of MCO implementation. Factors such as different MCO phases and seasonal interests appeared to influence the seeking behaviour of Google users in Malaysia for toothache-related information. Top search queries in Malaysia during 2020-2021 were related to relieving toothache symptoms, tooth conditions, and seeking dental treatments. In addition, the RSV of toothache-related keywords was higher in the states with higher dental caries burden. The findings may be useful for oral health care providers in adapting their services and educational initiatives (e.g., usage online and social media platform) to better address the public's oral health needs during future pandemic situations and relaxation period in the country.

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Competing interests

The authors declare that they have no competing interests.

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