Illustrating time trends of public's attention towards suicide around the COVID-19 pandemic

Dayle Burnett, Valsamma Eapen, Ping-I Lin

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Dayle Burnett[1] MSc; Valsamma Eapen[2, 3] MBBS, PhD; Ping-I Lin[2, 3] MD, PhD

[1]Department of Women's and Children's Health Uppsala University Uppsala SE
[2]School of Psychiatry University of New South Wales Kensington AU
[3]South Western Sydney Local Health District Liverpool AU

Corresponding Author:
Ping-I Lin MD, PhD
School of Psychiatry
University of New South Wales
Level 1, AGSM Building Gate
11 Botany St
Kensington
AU

Abstract

Background: The COVID-19 pandemic has overwhelmed health care systems around the world. Emerging evidence has suggested that significantly fewer patients seek help for suicidality at clinical settings amidst the COVID-19 pandemic, which elicit concerns of an imminent mental health crisis as the course of the pandemic continues to unfold. Clarifying the relationship between public's attention to the knowledge about suicide and public's attention to the knowledge about the COVID-19 pandemic may shed some insight into prevention strategies for a putative surge of suicidal wave in relation to the impact of COVID-19 pandemic.

Objective: The goal of this retrospective longitudinal time-series study is to understand the relationship between temporal trends of search interests in suicide and COVID-19-related terms, such as social distancing, school closure, and lockdown, etc.

Methods: We used Google Trends platform to collect daily interest levels for the search terms that included suicide and several other mental health-related issues, as well as COVID-19-related search terms, over the period between 14 February 2020 and 13 May 2020. Correlational analysis was performed to determine the association between the search term ‘‘suicide’’ and COVID-19 related search terms in 16 countries. The Mann-Kendall test was used to examine the significance of the search interest levels of suicide before and after school closure.

Results: We found that levels of search interest in ”suicide” was statistically significantly inversely correlated with levels of search interest in the term ”COVID-19” or ”corona virus” in nearly all the countries between 14 February 2020 and 13 May 2020. Additionally, search interest in ‘‘suicide’’ also showed significant negative correlations with many COVID-19 related search terms, albeit which varied among countries. The Mann-Kendall test was used to examine the significance of the search interest levels of suicide before and after school closure. The Netherlands, New Zealand, UK and USA showed significant negative trends in the interest levels of suicide in the two-week period preceding the school closure. In contrast, the interest levels of suicide showed a significant positive trend in Canada and USA after school closures.

Conclusions: The public's attention to suicide might inversely correlate with the public's attention to COVID-19-related issues. Additionally, some anti-contagion policies, such as school closure, might have led to a “turning point” for mental health crisis because the attention to suicidality increased after the restrictions were in place. The results suggest that an increased risk of suicidal ideation may ensue due to the ongoing anti-contagion policies. Timely intervention strategies for suicides, therefore, should be an integral part in the efforts to flatten the epidemic curve. Clinical Trial: Not applicable

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Illustrating time trends of public's attention towards suicide around the COVID-19 pandemic

Dayle Burnett, MS[1], Valsamma Eapen, MBBS, PhD[2,3], Ping-I Lin, MD PhD MHS[2,3*]

1. Department of Women's and Children's Health, Uppsala University, Sweden

2. School of Psychiatry, University of New South Wales, Australia

3. South Western Sydney Local Health District, Australia

* Corresponding author: Ping-I Lin, School of Psychiatry, The University of New South Wales, Kensington NSW 2075, Australia. Email: daniel.lin@unsw.edu.au

Abstract

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countries between 14 February 2020 and 13 May 2020. Additionally, search interest in ‘‘suicide’’ also showed significant negative correlations with many COVID-19 related search terms, albeit which varied among countries. The Mann-Kendall test was used to examine the significance of the search interest levels of suicide before and after school closure. The Netherlands, New Zealand, UK and USA showed significant negative trends in the interest levels of suicide in the two-week period preceding the school closure. In contrast, the interest levels of suicide showed a significant positive trend in Canada and the USA after school closures.

Conclusions: The public’s attention to suicide might inversely correlate with the public’s attention to COVID-19-related issues. Additionally, some anti-contagion policies, such as school closure, might have led to a “turning point” for mental health crisis because the attention to suicidality increased after the restrictions were in place. The results suggest that an increased risk of suicidal ideation may ensue due to the ongoing anti-contagion policies. Timely intervention strategies for suicides, therefore, should be an integral part in the efforts to flatten the epidemic curve.

Keywords: COVID-19; suicide; Google Trends; time trend; school closure; attention; mental health; crisis; time-series

Introduction

In March 2020, the World Health Organization (WHO) declared the Coronavirus 2019 (COVID-19) outbreak a pandemic. To curb the spread of the virus, governments worldwide have implemented public health measures such as lockdown, isolation, and social distancing [1,2]. Although these measures are needed to protect physical health, the psychological impact of the pandemic is still emerging. To alleviate the concerns surrounding mental health, there has been a growing interest in telepsychiatry, defined as “the delivery of mental health care in the form of live and interactive videoconferencing’’ [3]. Telepsychiatry has shown to be an effective approach in helping those access mental health services in remote areas and underserved areas [4,5]. Whilst the implementation of such practices may be useful during the pandemic, the full impact of COVID-19 is unlikely to be fully understood for some time.

The ongoing measures such as isolation and social distancing have caused people to be separated from their loved ones, leading to loneliness, boredom and stress. Recent mental health studies on COVID-19 have revealed that these feelings are associated with common mental health disorders such as depression, anxiety [6-8]; the most vulnerable are those with pre-existing mental health disorders [3-5]. Moreover, emerging evidence suggests that the environmental nature, where quarantine is carried out can lead to different effects on mental health; with one study revealing that poor housing is associated with increased risk of depressive symptoms during lockdown [9].

Previous research about the psychological impact of quarantine from past epidemics revealed that fear of infection and lack of clear communication from governments were associated with a high

prevalence of anxiety, exhaustion, psychological distress and depression [10]. Furthermore, the lockdown enforced in many countries around the world will have a substantial impact on the global economy with predictions of an economic crisis and large increases in unemployment worldwide, which is a well-recognised risk factor for suicide [11].

There is a growing body of literature that suggests an increase in suicide rates during and after the pandemic due to anti-contagion policies increasing social isolation and loneliness which are well-known risk factors for suicide [12-15]. Indeed, there have been cases of COVID-19 -related suicides in the USA, UK, Italy, Germany, Bangladesh and India [14]. There are also suggestions that the suicide rate could rise as the full economic and social impact of the pandemic unfolds. For example, higher suicide rates were observed among the elderly in Hong Kong during the 2003 severe respiratory syndrome (SARS) outbreak [16,17].

In addition, a considerable amount of literature has been published examining the effects of the pandemic on the mental health of the general population, vulnerable people, including the elderly and patients with chronic health conditions, patients with previous mental health disorders and healthcare professionals [14, 18-24]. The studies indicate that suicide is likely to become an increasing issue as the pandemic continues and has a longer-term effect on the generation population and not just those who are at an increased risk of suicide. Thus, to reduce suicide during the COVID-19 pandemic, it essential to mitigate the risk factors such as stress, anxiety, fear and loneliness in the general population.

While the reduction of social interactions remains one of the best actions to reduce the total burden of COVID-19, questions have been raised about measures such as school closure. The effectiveness of school closures has been suggested by previous studies of influenza outbreaks, of which transmission is higher in children than in adults [25]. However, in the context of COVID-19, the data indicates that the transmission dynamics are different, with adults and the elderly being more

vulnerable to the disease [26]. Furthermore, school closures can have large implications on society. A recent review of school closure practices found that such measures alone would prevent only 2-4% of deaths, much lower than other social distancing interventions [27]. The authors note the negative consequences of school closures such as economic costs due to parents missing work to look after their children as well as a reduction in the health-care staff resources which in turn could negatively impact health-care systems.

Due to the fast-moving nature of the pandemic, real-time data collection is needed to assess the public interest in COVID-19. To date, the Internet has been increasingly used as a source of healthcare information, especially Google, which is the world's most used search engine [28]. Google Trends is a website by Google that analyses the popularity of top search queries in Google Search and has shown to be a powerful tool in tracking public interest in infectious diseases [29]. This study aims to explore the trends of COVID-19 related search terms and its association with common mental health disorders. In addition, it aims to determine whether school closure, as a proxy of non-pharmaceutical anti-contagion policies, is associated with the risk of suicide.

Methods

Data Source

We used the web tool Google Trends to quantify online search interests for this study. The methodology designed was based on the Google Trends Methodology Framework in Infodemiology and Infoveillance [30]. Google Trends does not show the actual search volume numbers, but instead provides the number of relative searches, using a scale from 0 to 100, within a specified region and

time for a particular search query. A value of 100 is the peak popularity of the query, whereas a score of 0 means very little searches.

Data from Google Trends was compiled between 14 February 2020 and 13 May 2020. The following 16 countries were used in this study: Australia, Austria, Belgium, Canada, France, Germany, Ireland, Italy, the Netherlands, New Zealand, Portugal, Russia, Spain, Sweden, UK and USA. The countries were chosen to represent locations in Europe with the largest numbers of COVID-19 deaths or those forecasted to experience a considerable number of deaths. We also included English-speaking countries outside of Europe as our study was conducted in English. To examine whether the time since the school closure could correlate the level of stringency of anti-contagion policies, we have extracted the data of stringency index from the "Our World in Data " database (https://ourworldindata.org/coronavirus) [31] and school closure dates from the datasets of United Nations Education, Scientific and Cultural Organization (UNESCO) [32].

Search Terms

We used the following search queries to examine the following common mental health disorders "suicide", "depression" and "anxiety". To investigate any potential confounding factors related to suicide. We performed a manual search of ''suicide'' to find suspected suicides of celebrities in the countries used in this study by using advanced Google searches and online news articles. We tailored the dates to include results between 14 February and 13 May 2020. We also studied the following COVID-19 related search queries "Coronavirus (Virus)", "social distancing", "school closure", "self-isolation" and "lockdown". The search queries were chosen based on a recent review about suicide risk and prevention during the COVID-19 pandemic in addition to keywords which were used in the media and Government and WHO policy briefings [12]. It should be noted, however, that

"Coronavirus (Virus)" was searched as a topic, which is defined as a group of terms that share the same concept in any language. This was to include the different names associated with coronavirus such as COVID-19. Although Google Trends provides users with the opportunity to compare up to five search queries at the same time, we decided to extract each search query individually and compare it in its own distribution. The search was carried out using terms in English.

Data analysis

Primary Analysis

Firstly, we investigated the changes in trends for all the different search queries in Google Trends by using graphical representations for each country. This was carried out using the smooth splines function in the ggplot2 package of R Studio. We used Pearson's correlation test to measure the strength of the association between each search query in each country. A two-sided alpha value < .05 was used as a cut-off to identify the countries that showed a significant association between ''school closure'' and ''suicide'' for the next part of the analysis. The relationship between the time to school closure and the stringency index was examined using a generalized linear model with the generalized estimating equation to correct for intra-country correlations [33].

Secondary Analysis

We then carried out a Mann-Kendall test to compare the trends in suicide interest before and after school closures. We first identified the national school closure date for each of the selected countries and then extracted Google Trends data for the search term ''suicide'' two weeks either side of the school closure date for each country. The Mann-Kendall method is a non-parametric test used to detect statistically significant trends [34,35]. In this test, the null hypothesis (H_0) was that there was

no trend in the number of suicide searches over time, the alternative hypothesis (H_1) was that there had been a trend over time.

The MK S statistic is calculated using the following formula:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sgn\left(X_j - X_i\right) \quad (1)$$

Where x_j and x_i are time series and *n* is the number of data points in the time series and,

$$sgn\left(X_j - X_i\right) = \begin{cases} +1 & if \quad \left(X_j - X_i\right) > 0 \\ 0 & if \quad \left(X_j - X_i\right) = 0 \\ -1 & if \quad \left(X_j - X_i\right) < 0 \end{cases} \quad (2)$$

The variance if the Mann-Kendall test is given by:

$$Var(S) = \frac{1}{18}\left[\mathrm{n(n-1)(2n+5)} - \sum_{p=1}^{q} tp\left(t_p - 1\right)\left(2t_p + 5\right)\right] \quad (3)$$

Where *q* is the number of tied groups and t_i is the number of data values in the pth group.

The standard test statistic Z is calculated as follows:

$$Z = \begin{cases} \frac{S-1}{\sqrt{Var(S)}} & if \quad S > 0 \\ 0 & if \quad S = 0 \\ \frac{S+1}{\sqrt{Var(S)}} & if \quad S < 0 \end{cases} \tag{4}$$

Z follows the standard normal distribution. A positive value indicates a positive trend, whereas a negative value indicates a negative trend.

Results

Graphical Analysis

We first explored Google Trends data for the selected search queries between 14th Feb 2020 and 13th May in the selected countries displayed in Figure 1. What stands out in all the figures are the common trends in the COVID-19-related search queries across several countries. Focusing on the search query ‘‘Coronavirus (Virus)’’, most of the countries showed a noticeable increase in searches

related to coronavirus from the end of February until the middle of March where it peaked, followed by a decline in the level of searches. The peak in interest is most likely due to the WHO declaring COVID-19 a pandemic.

Although lockdown, social distancing and self-isolation have been the main strategies for reducing the spread of COVID-19, it is clear from the graphs in the figures that the public's level of interest varies between countries and the different measures taken to combat the virus. For example, there was a greater interest in searches for lockdown in Germany, New Zealand, Portugal and Russia compared to other public health measures. Surprisingly, there was a large number of searches in Sweden for lockdown, despite the fact that the government decided against imposing a lockdown but instead relying on voluntary co-operation from its citizens [36].

In Australia, Austria and Belgium, there was a greater interest in social distancing measures. While in the UK and Ireland, self-isolation generated greater interest. However, in Canada, the Netherlands, Spain and the USA, the interest levels for self-isolation and social distancing produced very similar relative searches.

Closer inspection in the graphs reveals that in Austria, France, Ireland, Russia, Spain and Sweden, searches for ‘‘lockdown’’ peaked at around the end of March followed by a plateau, while in other countries the searches decreased over time. In fact, in Germany, Portugal and the UK, the interest levels of lockdown increased throughout the period. Interestingly, searches for ‘‘lockdown’’ in Italy peaked in the middle of April. This could be due to Italy starting to ease lockdown with the public interested in what activities could be carried out.

The interest levels for ‘‘school closures’’ varied among countries, although most showed a bell-shaped trend. The variation is most likely due to different countries announcing and enforcing school closures on different dates as well as some countries imposing regional lockdowns before a national

lockdown.

In most of the countries, searches for suicide began to fall towards the end of February and at the beginning of March, with searches starting to increase again in some countries, namely France, Spain, Russia, New Zealand and the Netherlands. While in other countries such as Australia, Belgium and the UK the search levels for suicide remained constant. It should be noted, however, that the peak in the suicide-related search terms in February in the UK, and to a lesser extent, Ireland could correspond to the suicide death of TV presenter Caroline Flack (15th February 2020), which was also highlighted in a similar study [37].

Levels of anxiety varied among the countries. In Ireland, the UK and USA, search interest levels for anxiety remained high throughout the whole period. While in Australia, Germany, New Zealand and Portugal, the interest increased after the public health measures were implemented.

Correlation Analysis

The results of the correlational analysis for selected countries are shown in Figures 2. The most interesting aspect of these figures is that searches for ‘‘suicide’’ did not show any significant positive correlations with COVID-19-related queries. In Australia, Canada, Ireland, New Zealand, UK and USA (all the English-speaking countries), and the Netherlands, all the COVID-19-related search queries were negatively associated with ‘‘suicide’’. Whereas in Belgium, France, Italy, Spain and Russia, searches for ‘‘suicide’’ were only significantly negatively associated with some of the other COVID-19-related queries.

The association between searches for ‘‘suicide’’ and the other mental health disorders varied between countries. Searches for ‘‘suicide showed significant positive correlations with ‘‘depression’’ in France, Germany, Russia and UK (r=0.3-0.51, P<.05) which is to be expected as depression is a well-known risk factor for suicide [12]. Although in Australia, a negative correlation was observed

(*r*=-0.4, *P*<.001). In addition, there was a weak significant correlation between the interest levels of ‘‘suicide’’ and ‘‘anxiety’’ in the USA. Significant associations were observed between ‘‘anxiety’’ and ‘‘depression’’ (r=0.24-0.6, *P*<.05) in Canada, Russia, UK and USA.

In most countries, strong positive correlations were observed between the ‘‘Coronavirus (Virus)’’ and the other COVID-19-related searches - which suggests that the public are continuing to seek information about the virus and the measures taken to curb the spread of the virus. The results obtained from the correlational analysis between ‘‘school closure’’ and ‘‘suicide’’ are show in Table 1, only countries showing a significant relationship are shown.

Mann-Kendall Analysis

The time to school closures was found to positively correlate with the level of stringency index (coefficient: 0.97, *P*< 0.001). Figure 3 shows the trend in suicide search queries during the school closure period in countries where a significant association between ‘‘suicide’’ and ‘‘school closure’’ was found in Google Trends. From the graphs, we can see that there is a decrease in the interest of suicide in all the countries, whereas there appears to be an increase in the interest levels of suicide after school closure.

The Mann-Kendall test was applied on a daily scale to detect trends in the interest levels of suicide in different countries before and after their respective school closure period. Table 2 shows the results in terms of the Kendall Score (S) and the Z statistic. Out of the six countries, the Netherlands, New Zealand, UK and USA showed a significant negative trend in the interest levels of suicide in the two-week period leading up school closure. New Zealand showed the largest decrease in the searches related to suicide in the two weeks leading up to the school closure. No significant trends were found in other countries. In contrast, the interest levels of suicide showed a significant positive trend in Canada and the USA after the schools closed. The trend was larger in Canada than in the USA.

Discussions

Principal findings

Using online search interest as a proxy for public's attention to specific terms, we found that attention to terms related to COVID-19 surged following the outbreak in February and reached the peak between late March and mid-April when attention to suicide and other mental health issues continued to decline. Attention seemed to have shifted from COVID-19 to suicide and other mental health-related issues after anti-contagion policies, such as school closures, were enacted in many countries.

The initial results are in line with recent studies indicating that searches related to COVID-19 rose during the peak of the pandemic [38-40]. However, we also found variations between different COVID-19 search terms between countries. This is most likely due to different countries being at different stages during the pandemic. Italy was the first country in Europe to implement a lockdown which was swiftly followed by many Western European countries. Moreover, it is important to take into consideration the different strategies executed by different countries when interpreting these results. For example, while most countries in Europe implemented a full or partial lockdown, Sweden took a different route and emphasised the importance of social distancing.

In addition, the current study found that searches for suicide increased after anti-contagion measures, such as school closures, were enforced. These findings are consistent with studies that used Google Trends to explore the changes in the public's search behaviours during the pandemic [37,41]. A note of caution is due, however, when comparing this study to previous research as our study used school closure as a proxy during the pandemic whereas most studies focused on lockdown. Nonetheless, school closures can be regarded as a form of quarantine, with the adverse effects mainly impacting

certain population groups such as children and adolescents, parents and health-care workers [26].

Limitations

Despite the strengths of this study, there are several limitations to consider when interpreting these results. First, the current study focused on the 90-day period ensuing the outbreak. The results might have shown different conclusions if data over a longer period of time were analysed. However, we intended to evaluate the short-term impact of the anti-contagion policies using school closure as a proxy, so the selected period of time might provide more relevant information. Second, the data was extracted from Google Trends which only provides data on relative searches. If absolute numbers were provided instead of relative searches, a better comparison between countries could have been made which could have yielded more accurate results. Third, we did not adjust for possible confounding effects of socio-demographic factors in the analyses. Economic downturn factors, such as job loss, may mediate or confound the association between the COVID-19-related events and public's interest in suicidality. However, the goal of this study is to identify patterns of public attention towards suicidality in relation to COVID-19 instead of focusing on their causal relationship. Therefore, the lack of taking mediators or confounder into consideration would not affect our conclusions. Although the validity of Google trends search interest for behavioural forecasting of suicide rates may be low because users' characteristics and motivation are unknown [42], a recent study shows that online search interests level associated with suicidality may still concurrently correlate with the volume of aggregate incidents of suicidality at the population level [43]. Therefore, we believe that this study can shed some insight into the temporal trend of imminent suicidal risk in different populations. Fourth, only English language search terms were used in this study which could potentially mean the ability to make generalisations from the findings is restricted. We chose not to translate search terms because this approach requires a comprehensive understanding of each of the languages to ensure the key concepts of the search terms are studied sufficiently. Although

Google Trends provides users with the option of using topics, a group of search terms identified by Google to share similar meanings across language and countries, search terms such as school closure and self-isolation were unavailable at the time of writing. This approach could lead to the observations of only users that searched for the term in English in non-English-speaking countries (e.g., France). We further used "lockdown" as an example in France to examine the search interest levels using "Topics" and "Search Term" separately and found these two values were highly correlated with each other (Pearson correlation coefficient: 0.95, $p < .0001$) in countries such as France, where English is not the primary language. Since our study did not intend to compare search interest levels between different countries, this limitation would not affect our conclusion. Finally, this study only used Google Trends to compare time trends during the pandemic, though we do recognise that other platforms such as Twitter may have also been useful to identify the public's concerns.

Public and clinical implications

It is clear from the growing body of literature from the impact of COVID-19 that mental health and psychological considerations are paramount. Findings from this study validate and extend previous work that has been carried out using Google Trends to track public concerns.

The use of Google Trends in this study has important policy implications. For example, school closure led to an increase in the search for the term suicide which suggests that people's mental health may have been affected. Thus, policymakers will need to face the challenges of combating the virus by anti-contagion policies while reducing unintended consequences, particularly on mental health.

To conclude, these findings suggest that the consequences of the pandemic vary depending on countries' public health anti-contagion measures. Although this study focused on high-income

countries, it is important to recognise the potential impact in resource-poor settings where mental health support is lacking. We believe that the results have shed some insight into the importance of integrating mental health service into anti-contagion policies, there is an urgent need to address how mental health consequences can be mitigated should similar outbreaks occur in the future [44].

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Conflicts of Interest: The authors declare no conflict of interest.

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Table 1 Results of Pearson's Coefficient test between the interest levels of ''school closure'' and ''suicide'' from Google Trends in countries that showed a significant relationship.

Country	Pearson Coefficient	*P* value
Australia	-0.33	<.001
Canada	-0.48	<.001
Netherlands	-0.32	.002
New Zealand	-0.3	.003
UK	-0.33	.001
USA	-0.64	<.001

Table 2: Mann-Kendall results of countries comparing the suicide interest level two weeks before the school closure and two weeks after the school closure.

Country	Before school closure			After school closure		
	S	Z	*P* value	S	Z	*P* value
Australia	-25	-1.31	.189	13	0.66	.511
Canada	-23	-1.21	.227	72	3.9	<.001
Netherlands	-25	-1.32	.186	34	1.81	.07
New Zealand	-54	-2.91	.003	29	1.53	.125

UK	-51	-2.75	.006	17	0.88	.378
USA	-36	-1.97	.049	57	3.07	.002

Figures and Legends

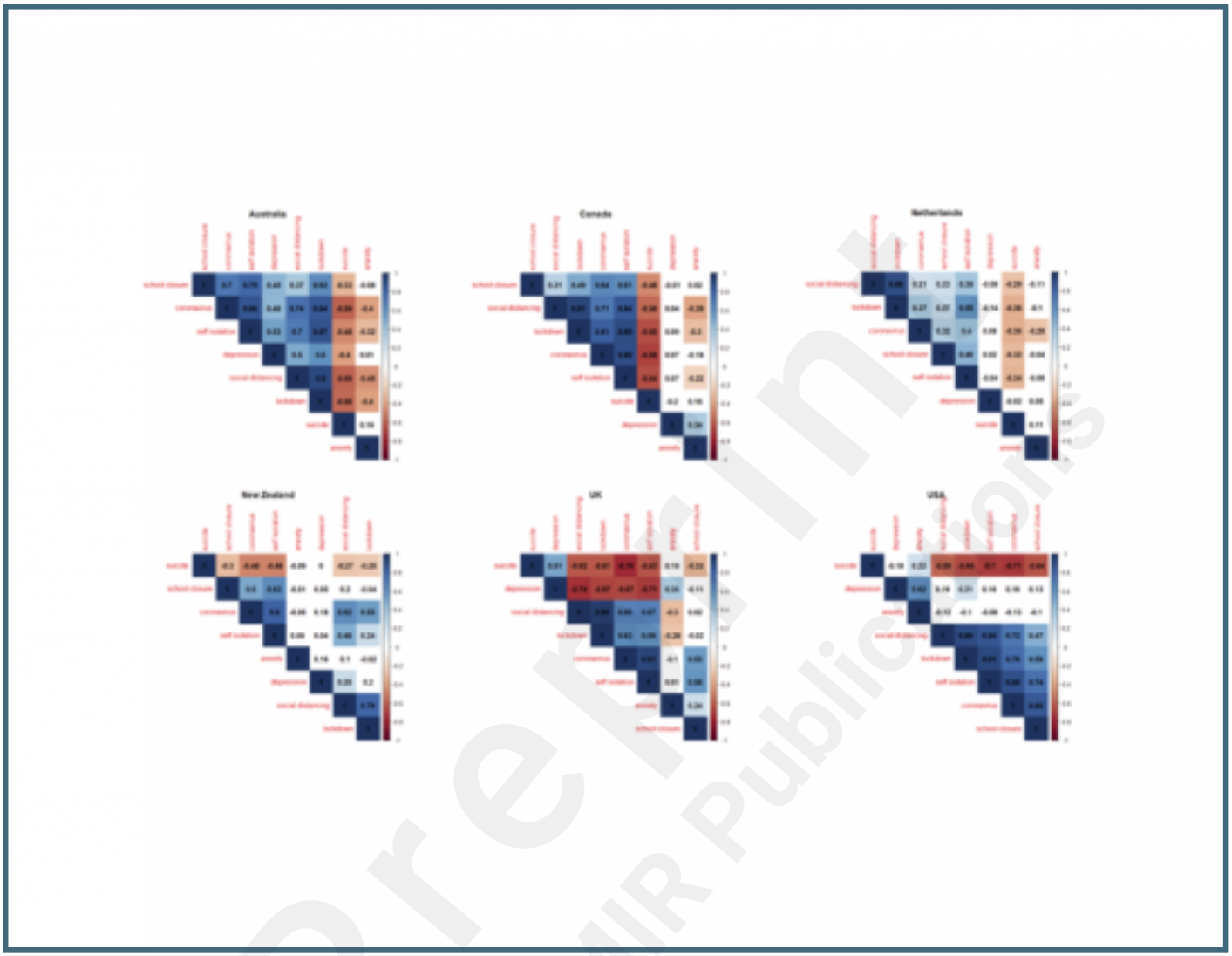
Figure 1. Google Trends data for the selected six countries from between 14 February 2020 and 13 May 2020. The grey curve represents ‘‘suicide’’, the orange curve represents ‘‘depression’’, the light blue curve represents ‘‘anxiety’’ the green curve represents “Coronavirus (Virus)”, the yellow curve represents “social distancing”, the dark blue curve represents ‘‘lockdown’’, the red curve represents “school closure” and the purple curve represents ‘‘self-isolation.’’

Figure 2. Correlation matrix representing pairwise Pearson’s correlation coefficients of the search queries from Google Trends in 6 selected countries. Coloured cells show significance $P<.05$.

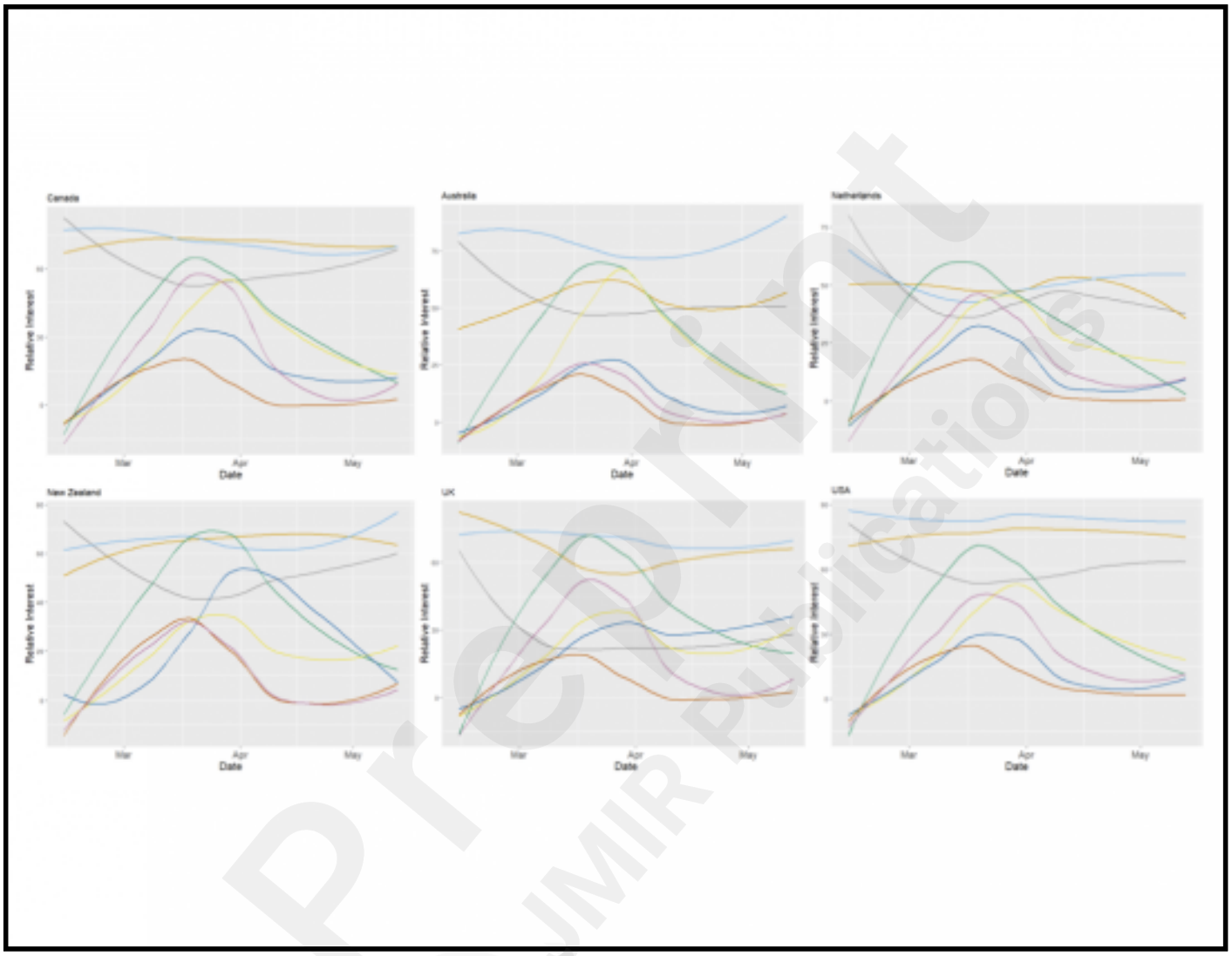
Figure 3. Relative search level interest for ‘‘suicide’’ during the school closure period in the selected countries. The dashed vertical line indicates the national school closure date.

Supplementary Files

Figures



Google Trends data for the selected six countries from between 14 February 2020 and 13 May 2020. The grey curve represents ‘‘suicide’’, the orange curve represents ‘‘depression’’, the light blue curve represents ‘‘anxiety’’ the green curve represents “Coronavirus (Virus)”, the yellow curve represents “social distancing”, the dark blue curve represents ‘‘lockdown’’, the red curve represents “school closure” and the purple curve represents ‘‘self-isolation".



Relative search level interest for ‘‘suicide’’ during the school closure period in the selected countries. The dashed vertical line indicates the national school closure date.