

Brief Report

# An Analysis by State on The Effect of Movement Control Order (MCO) 3.0 Due to COVID-19 on Malaysians' Mental Health: Evidence from Google Trends

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**Abstract:** Due to significant social and economic upheavals brought on by the COVID-19 pandemic, there is a great deal of psychological pain. Google Trends data have been seen as a corollary measure to assess population-wide trends via observing trends in search results. Judicious analysis of Google Trends data can have both analytical and predictive capacities. This study aimed to compare nation-wide and inter-state trends in mental health before and after the Malaysian Movement Control Order 3.0 (MCO 3.0) commencing 12 May 2021. This was through assessment of two terms, “stress” and “sleep” in both the Malay and English language. Google Trends daily data between March 6 and 31 May in both 2019 and 2021 was obtained, and both series were re-scaled to be comparable. Searches before and after MCO 3.0 in 2021 were compared to searches before and after the same date in 2019. This was carried out using the differences in difference (DiD) method. This ensured that seasonal variations between states were not the source of our findings. We found that DiD estimates,  $\beta_3$  for “sleep” and “stress” were not significantly different from zero, implying that MCO 3.0 had no effect on psychological distress in all states. Johor was the only state where the DiD estimates  $\beta_3$  were significantly different from zero for the search topic ‘Tidur’. For the topic ‘Tekanan’, there were two states with significant DiD estimates,  $\beta_3$ , namely Penang and Sarawak. This study hence demonstrates that there are particular state-level differences in Google Trend search terms, which gives an indicator as to states to prioritise interventions and increase surveillance for mental health. In conclusion, Google Trends is a powerful tool to examine larger population-based trends especially in monitoring public health parameters such as population-level psychological distress, which can facilitate interventions.

**Keywords:** Google Trends; difference in difference; stress; sleep; psychological distress



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## 1. Introduction

The COVID-19 pandemic has taken a huge toll on the world economy since being identified 3 years ago [1]. Multiple lockdowns have been enforced globally accompanied by quarantines; this has resulted in high levels of distress globally due to economic, healthcare, and social consequences [2]. In Malaysia, national lockdowns were imposed abruptly on 18 March 2020 as part of a Movement Control Order (MCO) [3,4]. Large amounts of evidence have accrued from cross-sectional studies suggesting that depression, anxiety and stress has worsened during this pandemic, both in general adult, and child and adolescent groups [5–7]. Moreover, these psychopathologies have worsened as the pandemic goes by, suggesting that they are not merely reactive to the initial stressor [8]. However, the evidence is limited by the inability to capture larger population findings, and also convenience sampling techniques that may infer unwarranted conclusions from unrepresentative groups.

One innovative and auxiliary way of acquiring a handle on the temperature of larger-scale population sentiments throughout the pandemic is to observe search patterns on Google, the largest search engine by user figures. Language-independent search frequencies on Google for topics are compiled on Google Trends, which serves as a useful repository and insight of the concerns that the population is having. The utilisation of Google Trends data has the following specific benefits. Firstly, there is no problem with data being self-reported by a sub-sample of respondents; rather, what is accurately captured is how lockdown has affected all Google Search users in a specific region. Secondly, the observer-expectation effect and interviewer bias are less likely to affect Google Trends data. Thirdly, small-sample bias is less likely to affect Google Trends data. [9]. Google Trends information has utility in formulation of public health strategies; previous research demonstrates its utility as an epidemiology surveillance tool in studies of influenza as well as being a real-time tracker for specific search data [10,11]. Data on Google searches also correlate well with traditional surveillance data and can even predict outbreaks before they occur, allowing proper planning of timing and location for appropriate risk communication strategies [12,13]. One of the most often employed methods in impact evaluation studies is Difference-in-Differences. The method, which is based on a series of before-and-after comparisons, has an intuitive appeal and has been widely employed in economics, public policy, and health research. [14]. The DiD model is also commonly used in health policy evaluations as they allow causal inference using observational data under the assumption that the trends are parallel [15].

Malaysia is a particularly unique case in point. As Malaysia consists of 13 federated states with various degrees of autonomy with individual state legislatures and executive bodies, different levels of lockdown can be applied in different states, which can contribute to different levels of psychological distress. Malaysia has been in various lockdowns since the first one began on 18 March 2020, but entered the strictest level of lockdown (MCO 3.0) on 12 May 2021, namely the “Full MCO” [6]. There has been burgeoning evidence suggesting increases in depression and anxiety amongst Malaysian populations throughout the various lockdowns [5,16,17]; however, this data is cross-sectional in nature and hence limited by the aforementioned difficulties. This study thus aims to further investigate whether the research evidence of worsening stress and sleep in Malaysians due to the implementation of MCO is reflected through evidence from Google Trends, stratified by state. The aim of this study was to observe how search trends for particular mental health-related keywords such as stress (*tekanan*) and sleep (*tidur*) were distributed, classified by state. This enables comparison of searches conducted before and after MCO 3.0 in 2021 and searches conducted before and after the same date in 2019. This was thus hoped to showcase if stress-related research evidence obtained through convenience or randomised sampling methods would be reflected by larger search trends on a population level.

## 2. Method

### 2.1. Sample Selection

These search data were gathered for states that had implemented Movement Control Order 3.0 as of 12 May 2021. This produced data on all states in Malaysia except Kelantan and Kuala Lumpur.

### 2.2. Difference-in-Differences Estimators of Lockdown Effects

We used a Difference-in-Differences (DiD) estimation to compare searches before and after the COVID-19 pandemic and associated MCO 3.0 in 2021 to searches before and after the same date in 2019, ensuring that seasonal changes within states were not behind our findings. In our analysis, the lockdown date is the date MCO 3.0 was implemented, which is 12 May 2021.

The difference-in-differences regression model for a topic  $Y$  is written as:

$$Y_{it} = \alpha + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Treat} \times \text{Post})_{it} + \epsilon_{it}$$

where  $Treat_t$  equals one for days in 2021 (i.e., the treatment group) and is zero otherwise, and  $Post_t$  equals one for the post-treatment period (i.e., 12 May until 31 May 2019, and 12 May until 31 May 2021) and is zero otherwise. The parameter  $\beta_3$  then estimates the DiD.

### 2.3. Google Trends Data

An unfiltered sample of Google search requests is collected from Google Trends data. As a result, it offers an index for search intensity by topic throughout the required time period in a particular region [9]. This is calculated by dividing the number of daily searches for the given topic by the highest number of daily searches for this topic for the relevant time period in that geographic area. This is scaled from 0 to 100, where 100 represents the day with the most searches for that subject, and 0 denotes that a certain day did not have enough searches for the specified phrase. [18]. In contrast to a topic query, which includes related search terms, a search-term query on Google Trends returns searches for an exact search term (in any language). For our research, we used Google Trends to submit the four following psychopathology-related topic search terms: sleep, tidur (the Malay word for sleep), stress, and tekanan (Malay Language of Stress). These four search terms were chosen as we were examining the prevalence of general levels of psychological distress in Google Trends; sleep is a common denominator of all psychological disorders [19], whereas stress is a common pathway that underlied psychopathology [20]. Sleep disturbances have been demonstrated to be a cause of stress, resulting in a cyclical effect that deteriorates mental health [21]. Additionally, both stress and sleep disorders have a bidirectional connection that can have an impact on the central nervous system [22]. Furthermore, we did not specify in which categories of web queries Google Trend was included. This search takes a sample of all web-based search queries and determines the region from which the majority of queries originated.

According to the National Health and Morbidity Survey, 500,000 Malaysians suffered from depression in 2019, and the COVID-19 pandemic and MCO made the situation far worse [23]. Therefore, we retrieved daily data between 6 March and 31 May in both 2019 and 2021 to determine daily search trends between those dates. We rescaled the two series to make them comparable because the daily data for 2019 came from a different request than the daily data for 2021.

### 2.4. Scaling Procedure

Let's use the numbers  $Y_{is2019}$  and  $Y_{is2021}$  to represent the number of Google daily searches for a topic on day  $i$  in state  $s$  from 6 March to 31 May 2019 and from 6 March to 31 May 2021, respectively. However, since their denominator (the maximum number of searches during one day in the period) differs, we were unable to directly compare the numbers from 2019 and 2021. For the purpose of comparing these numbers, we rescaled the daily data for each period by the corresponding week search interest weights that we determined using weekly data that was continuously available throughout the study period.

For each week between 6 March 2019, and 31 May 2021, we first calculated the corresponding weekly search interest weights. We calculated the weekly average searches for the topic in states over this time period by averaging the daily data from 6 March to 31 May:  $\bar{Y}_{is2019}$ . We then repeated the procedure for the time period of 6 March 2021, to 31 May 2021:  $\bar{Y}_{is2021}$ . We also observed from the weekly data downloaded over the entire period:  $\bar{Y}_{is2019-2021}$ . We calculated the weekly search interest weights using the information provided above,  $w_{s2019}$  and  $w_{s2021}$ :

$$w_{s2019} = \frac{\bar{Y}_{is2019-2021}}{\bar{Y}_{is2019}} \text{ and } w_{s2021} = \frac{\bar{Y}_{is2019-2021}}{\bar{Y}_{is2021}}.$$

We could now rescale the daily data for each distinct period using these weekly search interest weights by multiplying  $Y_{is2019}$  by  $w_{s2019}$  in 2019, and  $Y_{is2021}$  by  $w_{s2021}$  in 2021. There was no normalization applied to obtain figures between 0 and 100.

### 3. Results

#### 3.1. Difference-in-Differences Estimation Results

We begin our investigation by comparing the raw data searches conducted in 2021 before and after MCO 3.0 to those conducted in 2019 before and after the same date, as reported by the state. As shown in Table 1, all DiD estimates,  $\beta_3$  for topic Sleep and Stress were not significantly different from zero which implied that the MCO 3.0 had no effect on psychological distress in Malaysians (i.e., Sleep and Stress) in all states. Johor was the only state where the DiD estimates  $\beta_3$  were significantly different from zero for the search topic ‘Tidur’. For the topic ‘Tekanan’, there were two states with significant DiD estimates,  $\beta_3$ , namely Penang and Sarawak.

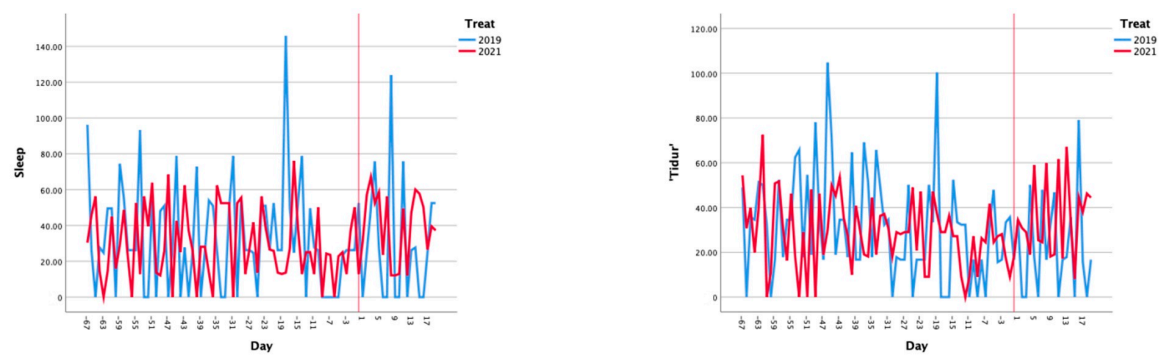
**Table 1.** The DiD estimates for four of the search topics.

State	DiD Estimates, $\beta_3$			
	Sleep	‘Tidur’	Stress	‘Tekanan’
	B (t Value)	B (t Value)	B (t Value)	B (t Value)
Johor	10.564 (1.139)	16.512 (2.278) *	9.012 (1.162)	−5.780 (−0.685)
Kedah	12.186 (1.205)	−8.802 (−0.963)	−3.476 (−0.404)	5.890 (1.610)
Kelantan	N/I	N/I	N/I	N/I
Kuala Lumpur	N/I	N/I	N/I	N/I
Labuan	N/A	N/A	0.597 (0.123)	N/A
Malacca	2.084 (0.276)	12.587 (1.423)	4.740 (0.653)	3.174 (0.533)
Negeri Sembilan	−4.550 (−0.562)	11.621 (1.420)	9.169 (0.954)	7.510 (1.155)
Pahang	2.392 (0.303)	−7.968 (−1.087)	13.335 (1.649)	−1.307 (−0.163)
Penang	−2.272 (−0.244)	13.128 (1.346)	−3.636 (−0.380)	17.065 (2.222) *
Perak	N/A	11.556 (1.501)	11.735 (1.191)	16.357 (1.461)
Perlis	6.018 (0.698)	−4.033 (−0.536)	N/A	3.087 (0.499)
Putrajaya	−6.632 (−1.016)	4.935 (0.777)	4.797 (1.028)	9.516 (0.492)
Sabah	3.743 (0.485)	9.808 (1.635)	−4.916 (−0.655)	−2.598 (−0.383)
Sarawak	0.359 (0.047)	16.891 (1.913)	0.172 (0.022)	15.203 (2.447) *
Selangor	0.129 (0.018)	5.108 (0.787)	6.862 (0.950)	−3.295 (−.343)
Terengganu	1.813 (0.204)	8.039 (0.843)	7.348 (0.974)	9.585 (1.076)

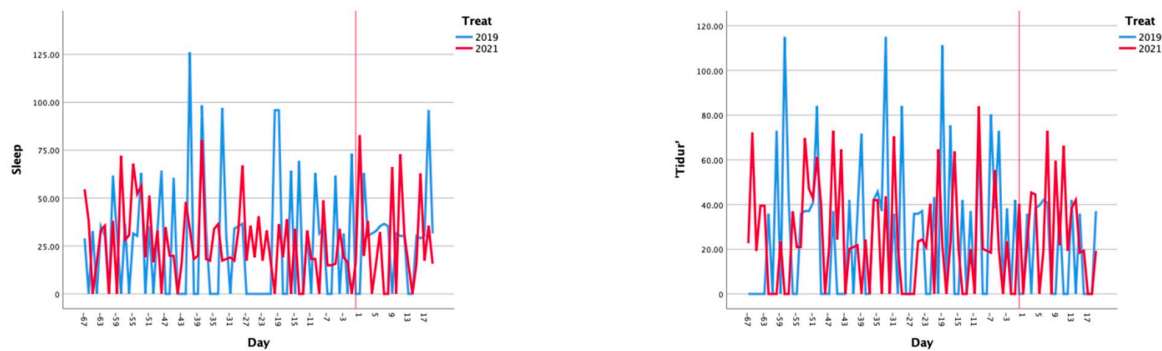
\* Significance at  $\alpha = 0.05$ . N/I denotes that the state did not implement MCO 3.0 on 12 May 2021. N/A denotes no raw data searches.

#### 3.2. Graphical Analysis

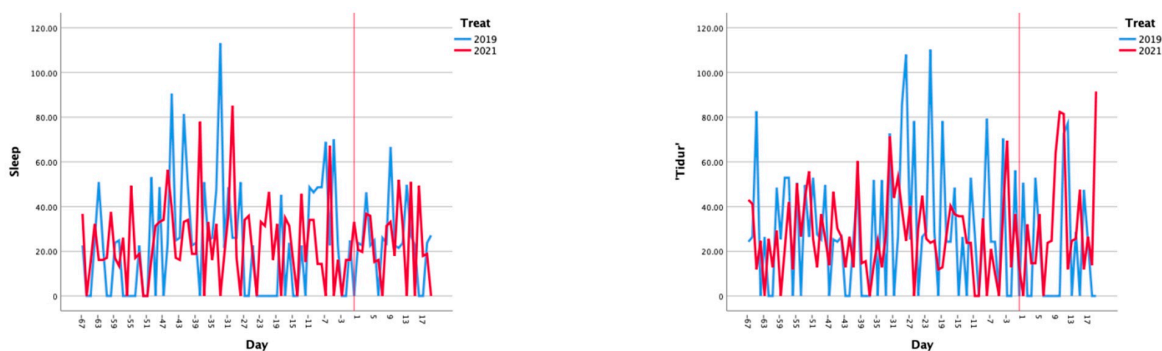
The daily search activity for four of our search topics—sleep, “tidur”, stress, and “tekanan”—is plotted in Figures 1 and 2. As the Table 1 indicates, there are no significant differences in DID for the remaining states, with the exception of Johor, Penang, and Sarawak; therefore, we have omitted unnecessary images and graphical data of these states from the paper.



(a)

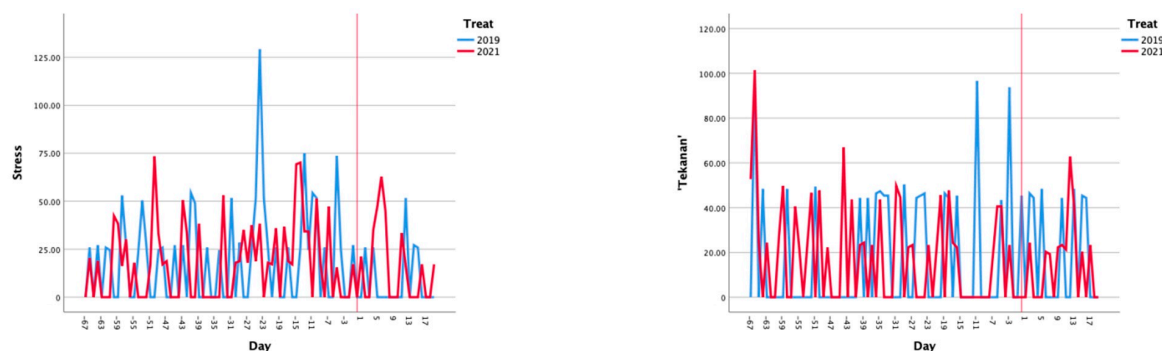


(b)



(c)

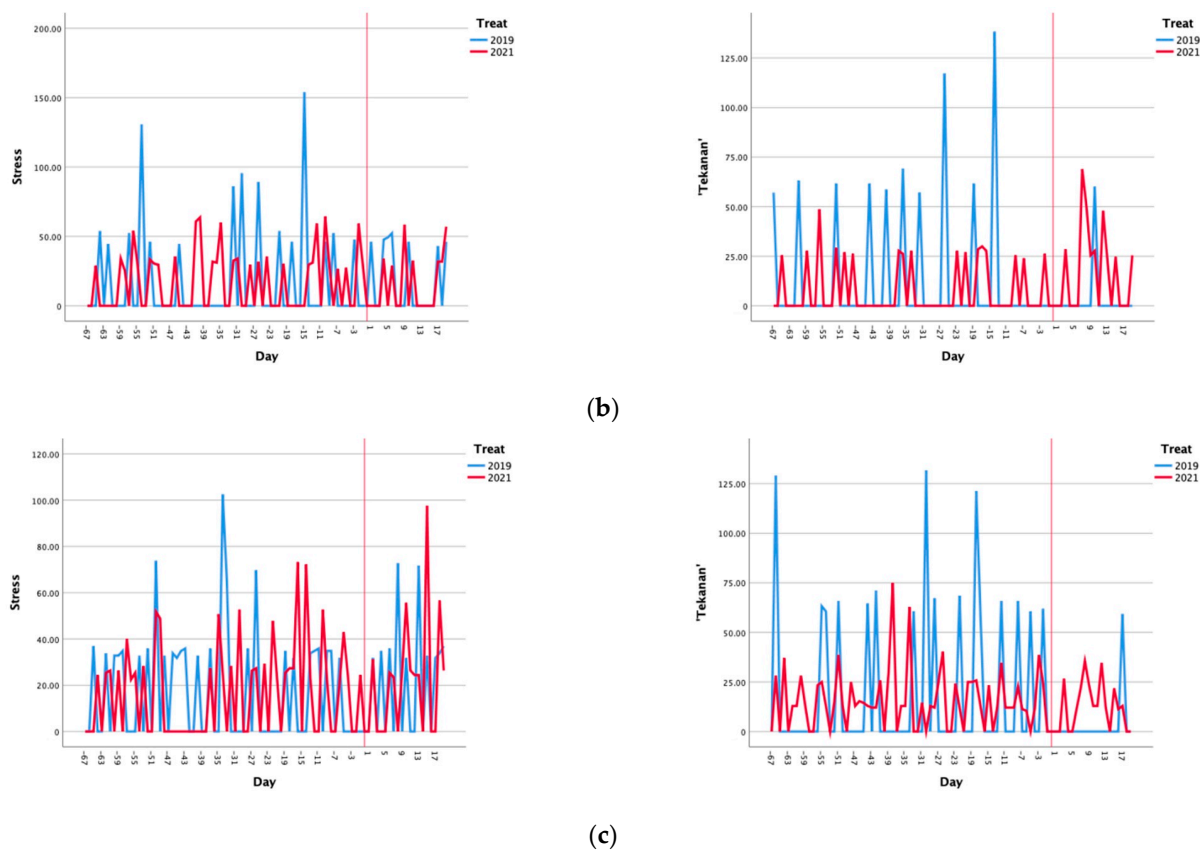
**Figure 1.** Daily search activity for Sleep and 'Tidur' in three states in Malaysia: (a) Johor, (b) Penang, and (c) Sarawak.



(a)

**Figure 2.** Cont.





**Figure 2.** Daily search activity for Stress and ‘Tekanan’ in three states in Malaysia: (a) Johor, (b) Penang, and (c) Sarawak.

#### 4. Discussion

The results of the above study are fascinating because they illustrate variations in the frequency of particular Google search terms (stress and sleep) across Malaysian states. This supports the notion that geographic differences may mirror variations in the public’s interest in stress and sleep and, based on this interpretation, raises the possibility of a greater impact of MCO 3.0 on mental health related to stress and sleep in varying ways across states. This may be attributed to the fact that Malaysia has been placed under multiple lockdowns, each of which has been extended multiple times and has seen numerous rule changes, all of which may have desensitised the population [24]. Johor state on the other hand, had a significant difference between pre- and post-MCO 3.0 searches for ‘tidur’ (sleep). Sarawak and Penang both have significant pre- and post- MCO 3.0 differences on searches for ‘tekanan’ (stress). This could be potentially explained as Sarawak went through a particularly high case load and led case figures in the country during the third wave of COVID-19 in April to May 2021 [4]. Sarawak state recorded the greatest number of deaths in a single day due to COVID-19 on May 31, which was 2 weeks after the initiation of the MCO 3.0 (The full Movement Control Order which Malaysian Government imposed for the third time). The increase in searches for ‘tidur’ (sleep) and ‘tekanan’ (stress) for Johor and Penang, respectively, may be associated with the fact that during the 3rd MCO, interstate and inter-district travel was not permitted. This posed unique travel restrictions for both areas; Penang is a state with half its population on the mainland and half its population on a separate island which is a separate district. Johor state on the other hand borders Singapore, which is a different sovereign nation, and a large proportion of residents in the capital of Johor, Johor Bahru City, commute to work in Singapore pre-pandemic. Hence, this increase in searches for stress and sleep might be reflective of the particular difficulty imposed upon Penangites and Johorians as the majority of residents in these two states need to travel to the mainland and Singapore, respectively, for work [25]. When the MCO

became stricter, this was precluded, and there would be large socioeconomic ramifications due to loss of income and loss of ability to access the usual coping strategies such as family or friends who could be on the other side of the district or national boundaries.

Our results are similar to other existing studies in which they are able to identify drops in searches of ‘stress’. This is likely due to the presence of multiple mental health care services that have been initiated and expanded widely by the non-government sector, such as Befrienders and various other community-run mental health hotlines, in order to help the people of Malaysia cope with their 3rd lockdown [26]. Our results for ‘sleep’, on the other hand, shows disparity with current studies (except with Europe). This may be owing to more and more companies implementing a ‘Work from Home’ approach for their workers as employers gain experience in employee management across multiple lockdowns. This however potentially results in large disturbances of sleep-wake cycles due to concurrent childcare requirements at home and large shifts in education online leaving parents unable to work during standard hours [27]. This results in disrupted productivity, potentially exacerbating the search figures for stress or “tekanan”.

Nonetheless, it is evident that Google Trends data has significant limitations. First, Google Trends is limited to only comparing keywords and does not offer any objective indicator as to how popular a phrase actually is. On Google Trends, we are only able to figure out an approximate number of individuals that looked for a certain phrase over a given time period because Google only provides a relative number of searches. There are no absolute statistics that can be accessed using Google Trends, notwithstanding the user’s input; nonetheless, relative data can provide a promising insight into the interests of the general public [28]. Second, Google Trends offers anonymous data, limiting the ability to analyse age groups and socioeconomic variables [29]. When compared to people of older generations, younger generations are more likely to make use of Google Search [30]. Third, it is to be anticipated that the majority of rural areas in developing countries such as Malaysia will not have access to an adequate amount of internet, which will limit the amount of data that is available from Google Trends [31]. Lastly, in order to maintain the exact meaning of each search phrase, we limited our use of search phrases to English and Malay. According to [32], the definition of search keywords is an extremely important step in the process of retrieving information from search databases. Although Google’s search engine is the most widely used, and English words and phrases continue to be the most common official language in a great number of countries around the world, other languages and cultures could have varying terms regarding sleep and stress. Due to the fact that Malaysia is characterised by its multilingualism [33], the difficulty that comes with conducting an analysis in a number of different languages may have an effect on our findings.

## 5. Conclusions

This study demonstrates an innovative methodology in looking at Google Trends as a proxy measure of the psychological distress in Malaysia, using difference in difference methods to examine the changes pre-COVID and post-COVID 19 lockdowns. It also stratifies data by state, allowing us to capture regional changes in temperature of the population, thus allowing more geographically focused interventions to take place. As Malaysia moves away from the pandemic towards a more endemic phase of COVID-19, there will still be ebbs and falls of trending searches in Google that relate to particular facets of psychological distress revolving around COVID-19. It is hence crucial that academia work closely with governments and public policy or health risk communication units to use publicly available big data judiciously to feel the pulse of the people, map it against the state of affairs prevalent in various states in Malaysia, in order to react more quickly and more presciently to population concerns. This thus allows us to use Google Trends as a powerful tool for population-level behaviour prediction.

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