The impact of the basic dose of the COVID-19 vaccine and the number of COVID-19 patients on Google searches for vaccines

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Article Info

ABSTRACT

Indonesia has distributed the COVID-19 vaccinations to its people starting from January 2021 based on certain priorities to deal with COVID-19 pandemic. News of deaths after the COVID-19 vaccination has made some people hesitate to get vaccinated. This study aims to depict the pattern and determinant of public interest in COVID-19 vaccine information using Google Trends data. The pattern can be used as a suggestion to the government to conduct a campaign on the COVID-19 vaccine. Several topics related to the COVID-19 vaccine were collected from Google Trends and then clustered by the province using K-Means. By total within sum of square, best number of clusters is two. Then, a logistic regression analysis was done with cluster as response variable to find out what factors made people interested in the COVID-19 vaccine topic. As a result, percentage of people who received the first dose of the COVID-19 vaccine and the rate of COVID-19 patients who were treated had influenced public interest in the COVID-19 vaccine. Hence, the campaign must be transparent so that the public can see both the good and bad effects of vaccination. It will help to reduce the number of people dying after receiving vaccinations.

Keywords: Big data, COVID-19, Google Trends, Vaccine

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1. INTRODUCTION

Indonesia has distributed five different types of COVID-19 vaccine, namely Sinofarm, Sinovac, Astrazeneca, Modena, and Pfizer. However, the COVID-19 vaccine has been reported to have some side effects [1], [2]. The side effects that arise are different for each recipient of the COVID-19 vaccine. Some of the mild and short-term side effects include fever, fatigue, headache, muscle aches, chills, diarrhea, and pain at the injection site.

The side effect of the COVID-19 vaccine is one of the factors why people are hesitant to get the COVID-19 vaccine in addition to other reasons such as the effectiveness of the vaccine itself and the safety of the vaccine [3]–[6]. Doubts also occur among health workers [7]. Moreover, there are some negative rumors in 52 countries about vaccines from various sources including Google, Facebook, television, etc that make people reluctant to get them [8]. Another factor that makes people reluctant to receive the COVID-19 vaccine is the lack of information about the vaccine itself, the education level of the respondents, and the gender of the respondents [3], [9]–[12]. Nevertheless, factors that discourage people from being vaccinated need to be minimized by targeted campaign so that the vaccination program runs smoothly during the vaccination period.

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Google Trends has been widely used to measure people's interest in certain issues [13], [14]. In previous research, Google Trends was used to predict a particular event or analyze the impact of an event, especially in the field of health on public interest in a particular issue [15]–[19]. In case of COVID-19, Google Trends has been utilized to monitor public interest related COVID-19, COVID-19 vaccine, and COVID-19 vaccine misinformation topic. So, it can be used as a reference in conducting campaigns to increase public knowledge about COVID-19 [20]–[24]. Public interest in the topic of COVID-19 increased when COVID-19-related events occurred such as the first COVID-19 infection and the first injection of COVID-19 vaccine. Other variables also have affected the interest increase, such as the COVID-19 infection rate [23].

The purpose of this study is to investigate the public's interest in information about the COVID-19 vaccine and the factors that are associated with it to determine vaccine campaign strategy for targeted people. The platform used to analyze the public interest is Google Trends. This research takes the space to cluster provinces using Google Trends based on public interest and uses the cluster to look for other factors that influence public interest in the COVID-19 vaccine besides infection rates of COVID-19. Clustering is used for the purpose of determining the right campaign strategy for each cluster based on their characteristics.

2. RESEARCH METHOD
2.1. Data
This study used two main data sets for analysis. The first data used in this study comes from https://trends.google.co.id/, Statistics Indonesia, and Ministry of Health. Google Trends data collected in the following topic “coronavirus”, “AstraZeneca”, “COVID 19 vaccine”, and “Sinovac Biotech” between November 15, 2020 to June 30, 2021. Interest data over time is an index created by Google Trends, which can be used to compare the search popularity of a keyword in an area [25]. The topic is used because the topic is a compilation of various keywords. The data taken is worth 0 to 100. The number 100 shows the highest interest from the period. Interest data by subregion is also taken to compare public interest in each province. Interest data by region shows 100 for the region with the highest search interest compared to other regions. The higher the value means the higher the proportion of a query compared to other queries [25]. To find out the determinants that influence people's interest in topics related to the COVID-19 vaccine, this study used variables on Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Data Type</th>
<th>Source</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of population who have received dose 1 of COVID-19 vaccine</td>
<td>Percentage of total population who have received doses 1 COVID-19 vaccine per total population in province on June 30th, 2021</td>
<td>numerical</td>
<td><a href="https://covid19.bps.go.id">https://covid19.bps.go.id</a></td>
<td>-</td>
</tr>
<tr>
<td>Percentage of population who have received dose 2 of COVID-19 vaccine</td>
<td>Percentage of total population who have received doses 2 COVID-19 vaccine per total population in province on June 30th, 2021</td>
<td>numerical</td>
<td><a href="https://covid19.bps.go.id">https://covid19.bps.go.id</a></td>
<td>-</td>
</tr>
<tr>
<td>COVID-19 cases percentage</td>
<td>Total COVID-19 cases per total population in province on June 30th, 2021</td>
<td>numerical</td>
<td><a href="https://covid19.bps.go.id">https://covid19.bps.go.id</a></td>
<td>-</td>
</tr>
<tr>
<td>Percentage of COVID-19 cases under treatment</td>
<td>Total COVID-19 cases which under treatment per total COVID-19 cases on June 30th, 2021</td>
<td>numerical</td>
<td><a href="https://covid19.bps.go.id">https://covid19.bps.go.id</a></td>
<td>-</td>
</tr>
<tr>
<td>COVID-19 recovery rate</td>
<td>Total recovered cases per total COVID-19 cases on June 30th, 2021</td>
<td>numerical</td>
<td><a href="https://covid19.bps.go.id">https://covid19.bps.go.id</a></td>
<td>-</td>
</tr>
<tr>
<td>COVID-19 mortality rate</td>
<td>Total death cases per total COVID-19 cases on June 30th, 2021</td>
<td>numerical</td>
<td><a href="https://covid19.bps.go.id">https://covid19.bps.go.id</a></td>
<td>-</td>
</tr>
<tr>
<td>Average Years of Schooling</td>
<td>The average number of years of education a student has actually received</td>
<td>numerical</td>
<td><a href="https://bps.go.id">https://bps.go.id</a></td>
<td>[26]</td>
</tr>
<tr>
<td>Number of public health center</td>
<td>Number of first-level health care facilities that carry out individual health efforts</td>
<td>numerical</td>
<td><a href="https://pusdatin.kemkes.go.id/">https://pusdatin.kemkes.go.id/</a></td>
<td>[27]</td>
</tr>
</tbody>
</table>

2.2. K-Means
Clustering on the k-means algorithm is done by minimizing the sum of squares from the cluster [28], [29]. The k-means algorithm requires the number of clusters. Determination of the number of clusters is conducted by looking at the total within sum of square. The calculation of total within sum of square is done by the following formula (1):

\[ \sum_{i=1}^{k} \sum_{x \in S_i} (x - \mu_i)^2 \]
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Note:
\( x_{ij} \) : the value of the i-th observation in the j-th cluster
\( \bar{x}_j \) : the centroid of the j-th cluster

In this study, k-means was used to create the dependent variable in finding the determinants of public interest in searching for topics related to the COVID-19 vaccine.

2.3. Chi-square test

The Chi-square test is one of the non-parametric methods used to see associations between variables. The Chi-square test does not require assumptions to do so [30], [31]. This study used Chi-square to look at the variables that affected respondents who claimed to experience side effects from the COVID-19 vaccine.

2.4. Binary logistics regression and odd ratio

Binary Logistic regression is a data analysis method for response variables of categorical type with 2 category [32], [33]. In binary logistic regression, the success event is denoted by \( Y=1 \) and the failure event is denoted by \( Y=0 \).

Odd ratio is a measure to express the tendency of the independent variable to the dependent variable. The odd ratio value states the tendency of the results that arise as a result of certain treatments [34], [35]. The odd ratio formula is written as (2):

\[
OR = \frac{\text{cumulative incidence of exposed group}}{\text{cumulative incidence of unexposed group}}
\]

(2)

2.5. Framework

Based on the background, this research seeks to find patterns of public interest in the COVID-19 vaccine from google trends data. Public interest data is used as the basis for making provincial clusters to group each province with similar characteristics. Furthermore, an analysis of the variables that influence the public's interest in finding information related to the COVID-19 vaccine is carried out based on the province cluster. A diagram of this research framework is depicted in Figure 1.

![Figure 1. Research framework](image)

3. RESULT AND DISCUSSION

3.1. COVID-19 vaccine search trends

Based on Figure 2, search volume on the topics of Coronavirus, Astrazeneza, COVID-19 Vaccine, and Sinovac Biotech seem to have an increasing trend at certain times. The topic of coronavirus tends to be stable and has increased several times on April 6, 2021, May 1, 2021, and May 12-13, 2021. The increase in the trend of searching for the topic of coronavirus occurs due to restrictions on access between regions to prevent the homecoming culture that occurs every Eid Al-Fitr, hoping that the rate of transmission of COVID-19 will not increase.
The search for the topic of Sinovac Biotech began to increase in early December 2020 since the news that the Indonesian government would use a vaccine from Sinovac and the peak of the search trend occurred on January 13, 2021, coinciding with the injection of the first vaccine in Indonesia to the President of Indonesia. Searches related to the AstraZeneca topic began to increase in March 2021 due to news of the AstraZeneca vaccine arriving in Indonesia. Finally, searches related to the COVID-19 Vaccine showed the highest increase in searches that occurred on June 1, 2021. On that date, there was news from WHO that issued a permit for vaccines of Sinovac to be used.

Observing the trend of public interest regarding the COVID-19 vaccine, events related to the topic of the COVID-19 and COVID-19 vaccines are thought to increase public interest in finding information about the COVID-19 vaccine topic through the Google. This can be seen from the increase in searches related to the topic of Sinovac Biotech on January 13, 2021, when the president of Indonesia, Joko Widodo, received the 1st dose of the vaccine. The increase in searches related to the topic of AstraZeneca also increased after the injection of the first AstraZeneca vaccine. The topic of COVID-19 vaccines also increased when Sinovac received recommendations from WHO. This increase is positive because people's curiosity about the COVID-19 vaccine is rising. Like previous research, Google Trends can describe the public's response to particular news [14] and news about COVID-19 influencing public interest about COVID-19 depicted by Google Trends [20], [22].

If we look at the public's interest in information related to the COVID-19 vaccine, there are differences at the provincial level as shown in Table 2. There are provinces with low interest and there are high ones. Provinces with a high interest in information related to the COVID-19 vaccine include the provinces like Riau Islands, DKI Jakarta, and Bali. Meanwhile, provinces with low interest in information related to the COVID-19 vaccine are Gorontalo, West Sulawesi, and North Kalimantan.
3.2. COVID-19 vaccine search cluster

From the interest of the people per province, a cluster was created with the variables of interest in the public’s search for the topics of AstraZeneca, COVID-19 Vaccine, and Sinovac Biotech. The results of this cluster are used as the dependent variable to find the determinants of public interest in topics related to the COVID-19 vaccine. Clusters were created using the K-means method. Figure 3 shows the optimal cluster to divide provinces based on the search volume is 2 seen from the Total Within Sum of Square graph. Cluster chosen as the basis for cluster formation is 2 because an increase in the number of clusters can be carried out as long as the estimation error decreases significantly [36].

![Figure 3. Total within sum of square](image)

From the cluster centroid shown in Table 3, it can be seen that cluster 1 has a higher search volume across all topics than cluster 2. The rest are in cluster 2. The number of provinces in cluster 1 is five provinces, including DKI Jakarta, DI Yogyakarta, Riau Islands, Banten, and North Sulawesi. Other provinces are in cluster 2 as in Figure 4.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>AstraZeneca Topic</th>
<th>COVID-19 Vaccine Topic</th>
<th>Sinovac Biotech Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>74.17</td>
<td>76.67</td>
<td>68.67</td>
</tr>
<tr>
<td>2</td>
<td>13.64</td>
<td>41.29</td>
<td>23.46</td>
</tr>
</tbody>
</table>

![Figure 4. Cluster of COVID-19 vaccine topic search per province](image)
Riau Islands, DKI Jakarta, DI Yogyakarta, and North Sulawesi are included in the top 5 largest percentage of receiving COVID-19 vaccine dose 1 in Indonesia. Based on cluster, Banten is in cluster 1, however, the percentage of receiving COVID-19 vaccine dose 1 is still low, in contrast to Bali, which received the highest dose of COVID-19 vaccine in Indonesia despite being in cluster 2. It indicates that percentage of receiving COVID-19 could be one of the determinants of people searching for information about COVID-19.

3.3. Determinants of interest in searching for a COVID-19 vaccine

To find out the variables that affect the search for topics related to the COVID-19 vaccine in all provinces, we used logistic regression with the response variables is province cluster that have been formed. Cluster 1 as a succeed condition on this model. The selection of variables used a two-way stepwise method using Akaike’s information criterion (AIC) as the evaluation value. The variables included all variable that have been mentioned in Table 1. The best model formed is shown in Table 4 with an AIC value of 0.52612.

Table 4. Variables that influence the proportion of topics searched for COVID-19 vaccines

<table>
<thead>
<tr>
<th>Model</th>
<th>β</th>
<th>Exp(β)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-0.44</td>
<td>0.64</td>
<td>0.00</td>
</tr>
<tr>
<td>Percentage of Dose 1</td>
<td>2.12</td>
<td>8.29</td>
<td>0.00 *</td>
</tr>
<tr>
<td>Percentage of COVID-19 patients in treatment</td>
<td>1.12</td>
<td>3.07</td>
<td>0.02 *</td>
</tr>
</tbody>
</table>

Note: significant to α = 5%

Based on the model, the influencing variables are the percentage of the population who have received dose 1 of the COVID-19 vaccine and the percentage of COVID-19 patients in treatment. Based on this model, it can be concluded that a one percent increase in the population that has received dose 1 of the COVID-19 vaccine will result in an 8.2896-fold increase in search volume. Then, a one percent increase in COVID-19 patients who are still being treated will result in a 3.0707-fold increase in search volume.

From the result, we can conclude that people start to seek information regarding the COVID-19 vaccine after more people have received the vaccine in their neighborhood and when there is an increase in patients being treated. This shows that in addition to public announcements about vaccines, neighborhood conditions in the community also influence people’s willingness to seek information about the COVID-19 vaccine. This is in line with other studies that state that environmental conditions such as the vulnerability of an area exposed to COVID-19 can affect people's knowledge and desire to be vaccinated [4], [37]. As previous research, infected number of COVID-19 influence public interest on COVID-19 topic [23]. This can be a concern for the government in conducting a campaign for the COVID-19 vaccine so that before receiving the vaccine, the public already knows the requirements for getting the vaccine until the post-vaccine handling. The campaign can be carried out with targeted campaigns for certain population groups need due to differences in knowledge and characteristics of certain population [38]. Besides, the campaign for the COVID-19 vaccine can be focused on areas where there are still few people who receive the COVID-19 vaccine. Transparent campaigns can be carried out by building public trust in vaccines, providing vaccine-related facts, providing clear information about the benefits and risks of receiving vaccines, using visual aids, and testing outreach tools before going into the field [39], [40].

4. CONCLUSION

This study has shown that every event related to the COVID-19 vaccine will increase the trend of searching for topics related to the COVID-19 vaccine. This could indicate the public's curiosity about the COVID-19 vaccine. Public interest related to COVID-19 vaccine depends on the variables of the percentage of the population who received dose 1 of the COVID-19 vaccine and the percentage of COVID-19 patients who are still being treated. This could show that people tend to seek information related to vaccines when a lot of people in their environment have received the COVID-19 vaccine. Moreover, the results of this study could be used for consideration in the implementation of campaigns to the public regarding COVID-19 vaccine information. The campaign needs to look at the clusters of public interest in the COVID-19 vaccine topic and be carried out transparently so that people in cluster 2 areas have sufficient information about the COVID-19 vaccine. Delivering a campaign by looking at the characteristics of the target group can also be executed to increase public awareness regarding the COVID-19 vaccine.

The drawback of this approach is the lack of representation from all community groups, especially people who do not have access to internet. The absence of information about the method used by Google Trends in forming an index of Google users' interest in a topic is also a weakness in this study. Future research should combine Google Trends data with survey data to reach out to people who have no access to internet.
REFERENCES


The impact of the basic dose of the COVID-19 vaccine and the number of... (Ignatius Sandyawan)
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