Original Research

Public Perception Toward the Malaysian *National COVID-19 Immunisation Programme (PICK)* in the State of Sabah, Malaysia: A Cross-Sectional Survey

Adi Jafar PhD, Ramli Dollah PhD ⓘ, Nordin Sakke PhD, Mohammad Tahir Mapa PhD ⓘ, Colonius Atang PhD, Eko Prayitno Joko PhD, Fauzie Sarjono PhD, Noor Syakirah Zakaria PhD, Fionna George MA and Chong Vun Hung MA

Faculty of Social Sciences and Humanities, Universiti Malaysia Sabah (UMS), Kota Kinabalu, Sabah, 88400, Malaysia

Abstract

The Malaysian Government has initiated the *National COVID-19 Immunisation Programme*, known as *PICK*, to be a national strategy for addressing the spread of the coronavirus disease (COVID-19) pandemic across the country. Although the government intensified public awareness to increase program registration, the total number that registered in the state of Sabah, located in East Malaysia, was relatively low during August 2021, accounting for only 42.9% as compared to that of Peninsular Malaysia. Therefore, this paper examines the public perception toward the PICK program in Sabah based on 4 main components: safety, communication, psychology, and milieu. This study is based on the empirical findings drawn from 1024 respondents across Sabah using online Google Form surveys. This study adopts 5 methodologies for data analysis by using K-means clustering, mean score, Mann–Whitney U test, spatial analysis, and frequency analysis. It has been revealed that the percentage of respondents (categorized as Cluster 1) who have a negative perception toward the vaccination program is higher (55.9%) than those who have a positive perception (44.1%). This study further discovered that Cluster 1 has shown high skepticism regarding the vaccination program, which can be explained through the communication component ($M = 3.33$, $SD = 0.588$), especially Co2, Co3, Co1, and Co4. Following the communication factor, a chain of negative perceptions also affects other components such as safety, psychology, and milieu among Cluster 1, all of which contribute to poor participation in the PICK program. The study outcomes are extremely useful for informing local authorities to establish policies related to public interests, primarily in the areas of public health. Understanding the community's perspectives and their obstacles in participating in such programs may assist local authorities in developing or implementing public policies and campaigns that ensure such related public programs can be conducted more effectively in the future.

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The global community is currently facing a pandemic, the coronavirus disease, better known as COVID-19.[1–3] The first case of the COVID-19 virus was discovered in Wuhan City, Hubei, China, in mid-December 2019.[4,5] Since then, the global transmission of COVID-19 has splurged around the world. By June 1, 2021, the virus had infected over 171 468 758 people worldwide, with 3 565 021 deaths confirmed.[6] The first case of the COVID-19 infection in Malaysia was detected on January 25, 2020, which originally came from China. Although the majority of COVID-19 cases can be traced back from foreign countries, the rise of local clusters in Malaysia began to escalate in early 2020. Several local clusters such as the cluster of religious gathering of Tablighi Jamaat in Kuala Lumpur in February 2020, the cluster of Sabah state election in September 2020, the cluster of Top Glove factory employees in late 2020, followed by the festive season in early 2021 have further worsened the transmission of COVID-19 in Malaysia.[7] From February 2020 to August 2021, the total number of cases reached over 20 000 per day, leading to the downfall of the premiership of Muhyiddin's cabinet which lasted only 17 months.[8] The cases of infection fell to roughly 2000–3000 cases in early January 2022. However, the arrival of the Omicron variant had further again sparked a surge during February 2022. As of March 8 2022, the number of COVID-19 infections in Malaysia has reached 30 000 daily cases.[9] COVID-19 contributes to a significant global fatality[10] and other global concerns such as the global economic crisis,[11,12] issues of mental health,[13–15] and other public health problems.[16,17]

The COVID-19 pandemic has indeed sparked a global calamity, alarmed state governments around the world to increase preparedness and response to halt the transmission of the virus. As a result, state governments around the world had initiated security and public health measures to deal with the COVID-19 pandemic, including the long-term vaccination program. Existing

studies have also demonstrated that the vaccine formulated against COVID-19 increases immunity in human bodies and halts the transmission of the virus. Herd immunity can be achieved if 80 to 90% of the total population in a country receives inoculation against COVID-19.[18] However, the growing resentment among the public against the vaccination program may have decreased global efforts to contain the virus. The rejection of the vaccine program has been recently coined as "vaccine hesitancy."[19] Therefore, understanding the growing reluctance of participating in the immunization program is crucial to ensure the continuity of global preparedness in curbing the spread of the virus.

The Malaysian Government, for instance, has imposed medical and non-medical measures to manage the pandemic. These include border restriction with the implementation of the Movement Control Order (MCO), the declaration of national emergency and the introduction of public health measures such as the banning of mass gathering, social distancing, and the use of face masks, among others.[20,21] In line with the advisory of the World Health Organization (WHO), the Malaysian Government states that the only way to contain the threat of the COVID-19 pandemic is through the implementation of the vaccination program.[22] As a result, the Malaysian Government introduced the *National COVID-19 Immunisation Programme (PICK)* on February 24, 2021.[23] The vaccine brands provided by the Malaysian Government for the Malaysian populations are Pfizer BioNTech,[24] Sinovac (CoronaVac),[25] and Oxford-AstraZeneca.[26] The aim of the PICK program is to contain the transmission of the COVID-19 virus. Controlling transmission is crucial for restoring a safe environment. This would enable the public to resume normal life activities that would certainly help the government in stimulating the national economy.[27]

However, the success of the vaccination program is highly dependent on the attitude and perception of the public: the recipients of the vaccine. Unfortunately, in Malaysia, the response to PICK has been disappointing since most Malaysians are not interested in inoculation,[28] especially the COVID-19 vaccine.[29] The nationwide readiness to participate in the program has largely contributed to the low turnover of the vaccination program. According to Khairy Jamaluddin, the Minister in charge of PICK, only 6.1% of Malaysians have registered for the vaccination program in March 2021. Although the government has pledged to provide free vaccinations to all Malaysians, the low registration indicates that the government has fallen short in achieving herd immunity. The Malaysian Government also introduced consolation (rewards) and other incentives to vaccine recipients in several states throughout Malaysia, signaling its commitment to increase immunization rates among its population.[30] Unfortunately, the issue of vaccine hesitancy still persists today.[31] In fact, as of March 24, 2022, almost 1 year after the government had initiated PICK, only 79% of the total Malaysian population has received 2 doses of the vaccine.

Communication deficiencies are one of the causes of vaccine skepticism and can hamper vaccination acceptance in any circumstances. At the same time, communication may be an effective tool, if well planned and integrated, for influencing the behaviors of populations on a variety of health concerns, such as vaccine hesitancy.[32] In middle-income and low-income nations, the lack of communication tools impedes the governments' attempts to prevent the dissemination of misleading information concerning immunization programs. This is one of the greatest challenges to the effectiveness of the population vaccination campaign. Therefore, according to the World Health Organization,[33]

communication skills are lacking across the globe and must be strengthened. In addition to providing excellent targeted communication to explicitly address hesitation and boost vaccine uptake, it is necessary to address inadequate communication to encourage immunization regardless of the circumstances. Moreover, vaccine hesitancy has also been associated with psychological factors such as the presence of paranoid sentiments,[34] disgust sensitivity toward blood and needles,[35] and overly selfish attitudes.[36] Concerns about safety (eg, feeling unsafe by taking vaccines, being concerned about vaccine side effects, and conflicting with religious beliefs) also contribute significantly to the phenomenon of vaccine hesitancy,[37–40] in addition to being triggered by milieu issues such as perceived social norms and perceived susceptibility to COVID-19.[41]

The situation is worrying, particularly in Sabah where the state recorded the lowest registration for PICK.[42] On July 16, 2021, a minuscule rate of 13% from the total state population were vaccinated. The state scored the lowest rate, which is far behind the government's target to achieve herd immunity. On March 24, 2022, only 62% of the total population in Sabah have received 2 vaccination doses.[43] Apparently, rejecting vaccination will reduce the achievement of herd immunity as well as hamper the government's efforts to contain the virus.[44] Therefore, the aim of this study is to understand what fuels the negative perception of the vaccination program among the population of Sabah based on 4 main components: safety, communication, psychology, and milieu. The results of this study are extremely important as supplementary data for assisting the government in increasing public participation in the vaccination program. Once the source of vaccine hesitancy is identified, it will be simple to implement measures to strengthen the vaccination program.

Methods

Data Collection

Due to the constraints of the COVID-19 pandemic, this study employs online questionnaire instruments using Google Form. Google Form, as a medium for data collection, aids in maintaining public health safety and other related security concerns in conducting research during the pandemic. Online instruments are also beneficial in widening the response rate among participants. This study is based on a simple random sampling of 1024 Sabahans who participated in the survey. The sample of this study consisted of Sabah citizens (inclusion criteria), except those 18 years of age and under (exclusion criteria). This is because, when this study was conducted, only individuals ages 18 years and above were eligible to be given the vaccine. On the other hand, children ages 12 to 17 can take the vaccine with their parents' consent.[45] More than half of the respondents were female (n = 551, 53.8%) ages 41 years and under (n = 814, 79.5%).

The total population of Sabah is approximately 3 904 500.[46] Therefore, a minimum of 400 samples is required to be considered as broadly sufficient in representing the entire population of Sabah.[47] In terms of district representation, respondents have been drawn from all zones throughout Sabah, as follows: 9.2% from the Northeast Zone, 9.6% from the Southeast Zone, 13.7% from the Southwest Zone, 17.6% from the Interior Zone, 21.9% from the Northwest Zone, and 28.1% from the Midwest Zone. The purpose of selecting representative responders from each zone is to acquire more comprehensive data. The data collection process was conducted for 2 weeks, starting from March 30, 2021, to April 15, 2021.

Table 1. Variables used to determine the reaction of the Sabah community toward the vaccination program

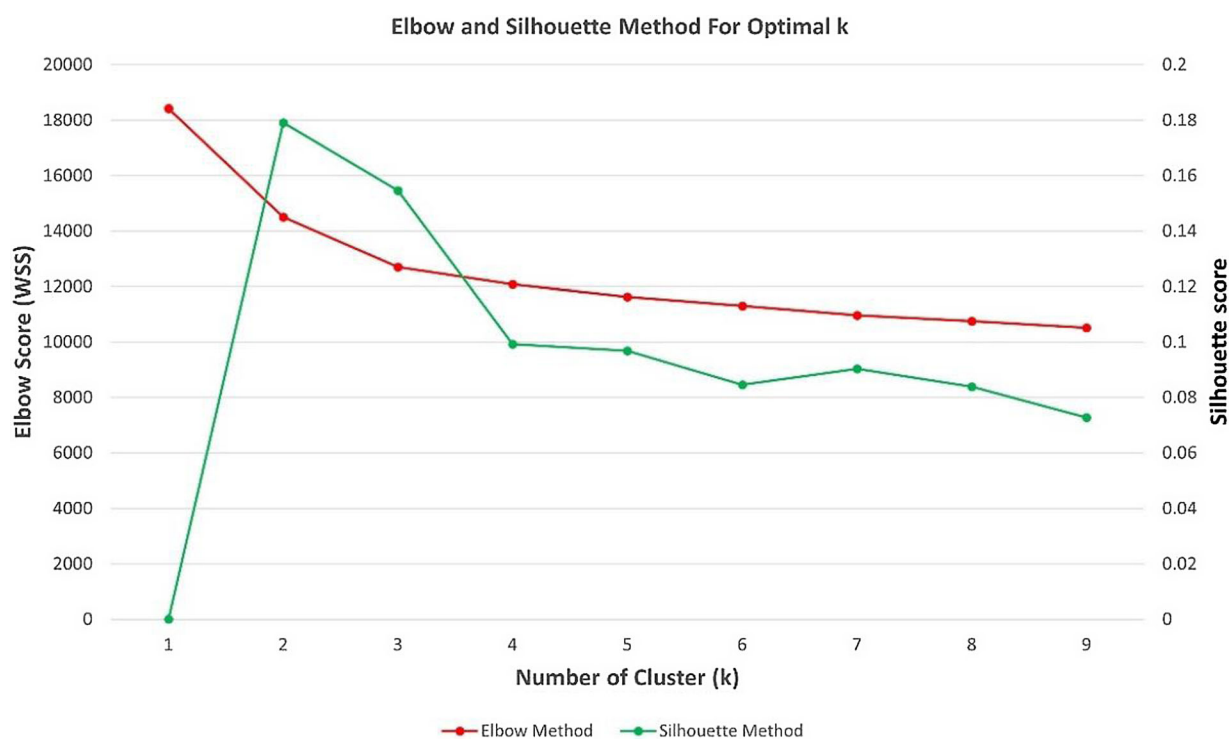| Factors Affecting Public Perception Towards the Vaccination Programme			
Safety	Communication	Psychology	Milieu
Sa1) Not convinced with the legality (halal) of the vaccine. **Sa2)** Vaccine is not safe for my body. **Sa3)** Another alternative is safer compared to the vaccine. **Sa4)** Waiting for vaccines that are safer in the future. **Sa5)** Not convinced if vaccines can prevent Covid-19 transmission.	**Co1)** Limited information regarding the Covid-19 immunisation programme. **Co2)** Limited information regarding the vaccines. **Co3)** Vaccine-related information in the mainstream media is not convincing. **Co4**) Vaccine-related viral issues influenced me not to take the vaccine. **Co5)** Internet access prevented me from registering for the Covid-19 immunisation programme. **Co6)** Difficult registration process for the Covid-19 immunisation programme.	**Ps1)** I am afraid to be injected. **Ps2)** Less interested in vaccines as many recover without vaccines. **Ps3)** The practice of SOPs is sufficient to prevent the transmission of Covid-19 without vaccines. **Ps4)** Still worried about being infected with Covid-19 even after being vaccinated. **Ps5)** Vaccines are just a conspiracy.	**Mi1)** Objection from families for taking the vaccines. **Mi2)** Taking vaccine only on job demands. **Mi3)** Taking vaccines only when it is compulsory. **Mi4)** Taking vaccines for the desire to go overseas. **Mi5)** Taking vaccines only when most people are vaccinated.

Figure 1. Determination of the optimum number of clusters.

Questionnaire (Google Form)

The questionnaire instrument is divided into 2 sections: A and B. Part A focuses on demographics, whereas Part B focuses on respondent perceptions toward the PICK program. In Part B, the questions were created in the form of a Likert scale with 5 possible responses: "1 (Strongly disagree)," "2 (Disagree)," "3 (Neutral)," "4 (Agree)," and "5 (Strongly agree)." The purpose of the Likert scale is to assess the degree of agreeableness for each question. All questions in Section B have been formatted in the opposite form (Table 1). For instance, respondents who answered "1 (Strongly disagree)" have a high, positive perception toward the PICK program. On the contrary, the score "5 (Strongly agree)" represents a negative perception of the PICK program. The questions have been derived from the previous works of Fauzi et al.,[48] Rumetta et al.,[22] and Sallam.[49]

Statistical Analysis

This study used the statistical analysis consisting of the K-means clustering, the Mann–Whitney U test, the mean score, the spatial analysis, and frequency in extracting the outcomes from the raw data. The K-means algorithm analysis is tailored for group respondents, which can be divided into 2 clusters based on their responses to the PICK program. The function of the K-means algorithm analysis is to produce group variables with a high degree of similarities within each group and a low degree of similarities between groups.[50,51] The Elbow and Silhouette method determines the optimum number of clusters.[52,53] The Elbow and Silhouette graphs are generated through machine learning analysis known as *Python* to determine the optimum number of clusters, which turned out to be 2, as indicated in Figure 1.

The K-means clustering analysis in this study uses the spatial mapping of the Geography Information System (GIS) to identify

Table 2. Sociodemographics of respondents

Item	Category	Cluster 1		Cluster 2	
		Frequency	%	Frequency	%
Registration Status	Registered	229	40	366	81
	Not Registered	343	60	86	19
Gender	Male	263	46	210	46.5
	Female	309	54	242	53.5
Age	18 – 40	471	82.3	343	75.9
	> 41	101	17.7	109	24.1
Educational Status	University	335	58.6	311	68.8
	High school and below	237	41.4	141	31.2
Employment Status	Civil servants	95	16.6	153	33.8
	Private sector employees	133	23.3	77	17
	Self-employed	107	18.7	64	14.2
	Unemployed	77	13.4	49	24.1
	Student	160	28	109	10.9
Total by Cluster		572	100	452	100
Total sample size		1,024 (100%)			

the distribution of each cluster based on the localities in Sabah. The mean score for this study is intended to compare the population's response to the COVID-19 vaccination program for each cluster group. This is to determine whether the responses are more likely to be positive or negative. The mean scores are divided into 5 groups to interpret the data: very low (1.00–1.80), low (1.81–2.60), moderate (2.61–3.40), high (3.41–4.20), and very high (4.21–5.00).[54] The greater the mean score value, the more it reflects on higher negative perceptions of respondents toward the PICK program. Public perception is analyzed using 4 components: communication, safety, psychology, and milieu.

The mean value of Cluster 1 is more than that of Cluster 2 for all 4 attributes, indicating that Cluster 1 can be identified as the "vaccine hesitancy" category. A Mann–Whitney U test with a confidence level of 95% ($P = 0.05$) was used to measure whether any significant link is present between these 4 components and the demographic variables of respondents. However, the normality test using the Kolmogorov–Smirnov test revealed that the data from Cluster 1 are not normally distributed. Therefore, this study suggests that the non-parametric analysis, such as the Mann–Whitney U test, is the most suitable instrument to compare and determine the factors (or components) related to the vaccination program within the clusters identified in this study.

Results

Sociodemographics of Respondents

The K-means analysis indicates that the number of respondents in Cluster 1 consists of 55.9%, whereas Cluster 2 recorded 44.1%. Cluster 1 also has more respondents (a total of 60%) who had not registered for the vaccination program as opposed to the 19% in Cluster 2. In terms of employment, the average respondents within Cluster 1 consist of 24.1% of private employees and 24.1% of unemployed. On the other hand, Cluster 2 is predominantly drawn from government civil servants. Cluster 1 is more affluent in educational background with 41.4% as compared to 31.2% in Cluster 2. Cluster 1 has a higher rate of adults between 18 and 40 years old (82.3%). Cluster 2 also has adults between 18 and 40 years old (75.9%). Gender representation in both clusters has shown a similar trend, with females outnumbering males (Table 2).

Public Response Toward the PICK Program in Sabah

Based on the data, it was found that respondents in the Cluster 1 category displayed a high negative response (M = 3.25, SD = 0.288) toward the vaccination program as compared to Cluster 2 (M = 2.44, SD = 0.375) due to communication problems (M = 3.37, SD = 0.439). In this regard, the Cluster 1 group views that the information related to vaccines (M = 3.88, SD = 0.799) and the immunization program (M = 3.78, SD = 0.787) was difficult to obtain. They also found it difficult to trust the information from the mainstream media (M = 3.86, SD = 0.785). Psychological factors have also influenced this group in becoming more pessimistic toward vaccines (M = 3.33, SD = 0.588). In their opinion, it is sufficient to adhere to the standard operating procedures (SOPs) to prevent COVID-19 transmission (M = 3.69, SD = 0.949). This group also has a negative view of vaccines in relation to their milieu component (M = 3.30, SD = 0.536) and safety (M = 2.99, SD = 0.623).

Cluster 2, on the other hand, warmly welcomes the COVID-19 vaccination program, which can be identified through the psychology components (M = 2.01, SD = 0.562) and safety (M = 2.37, SD = 0.406). They do not consider vaccines as a conspiracy (M = 1.81, SD = 0.844) and are safe to use (M = 1.71, SD = 0.658). In addition, this group was not affected by the viral trends of social media in illustrating the negative aspects of the vaccine campaign (M = 2.19, SD = 1.01) (Table 3).

The geographical space domain reveals that the Cluster 1 population dominated 17 out of 26 total districts in this study. The average population identified in Cluster 2 covers 7 districts: Kuala Penyu, Beaufort, Papar, Keningau, Tambunan, Ranau, and Lahad Datu. Most of these districts in Cluster 2 are situated within the Southwest and Interior Zones (Figure 2).

Table 4 presents a comparison of the community's reaction to the COVID-19 immunization program based on the characteristics of sociodemographic information in Cluster 1. According to Table 4, there is a substantial difference between respondents who have not registered for the vaccination program compared to those who have registered, and this can be measured from the component of safety (0.001, $P < 0.05$) and psychological components (0.001, $P < 0.05$). In this case, the mean value of respondents who have not registered for the vaccine is higher (MR = 325.9) than those who have registered for the vaccine (MR = 227.4) based

Table 3. Perceptions of the COVID-19 vaccination program in Sabah

Components	Item	Cluster 1				Cluster 2			
		Mean (M)	Std. Deviation (SD)	M & SD	Level	Mean (M)	Std. Deviation (SD)	M & SD	Level
Safety	Sa1	2.60	1.111	2.99 & .623	Moderate	1.54	.573	2.37 & .406	Low
	Sa2	3.08	1.145			1.71	v.658		
	Sa3	2.60	1.170			3.49	1.125		
	Sa4	3.89	.866			3.51	1.075		
	Sa5	2.76	1.108			1.59	.556		
Communication	Co1	3.78	.787	3.37 & .439	Moderate	3.02	.970	2.60 & .568	Low
	Co2	3.88	.799			3.23	.962		
	Co3	3.86	.785			2.97	.970		
	Co4	3.44	1.027			2.19	1.010		
	Co5	2.95	1.123			2.41	1.071		
	Co6	2.31	1.067			1.73	.829		
Psychology	Ps1	3.03	1.224	3.33 & .588	Moderate	1.98	.975	2.01 & .562	Low
	Ps2	3.65	.893			2.10	.872		
	Ps3	3.69	.949			2.51	1.060		
	Ps4	3.10	1.182			1.68	.655		
	Ps5	3.20	.976			1.81	.844		
Milieu	Mi1	3.07	1.190	3.30 & .536	Moderate	1.91	.939	2.74 & .683	Moderate
	Mi2	3.25	1.041			3.08	1.219		
	Mi3	3.69	.972			2.93	1.107		
	Mi4	2.89	1.169			2.83	1.259		
	Mi5	3.61	.941			2.93	1.127		
All Components	He	2.99	.623	3.25 & .288	Moderate	2.37	.406	2.44 & .375	Low
	Co	3.37	.439			2.60	.568		
	Ps	3.33	.588			2.01	.562		
	Mi	3.30	.536			2.74	.683		
Sample Size		n = 572 (55.9%)				n = 452 (44.1%)			
Total sample		n = 1,024 (100%)							

on their perception of the safety component. Similarly, the mean value for the psychological component among respondents who have not registered for the vaccine is higher (MR = 319.1) than those who have registered for the vaccine (MR = 237.7).

These findings indicate that individuals who have not registered for the vaccines are more skeptical toward the safety of the vaccine as they have been influenced by psychological elements compared to those who have registered for the vaccine. This study also found that there is a substantial difference in the educational background ($P < 0.05$) between respondents with low education and highly educated respondents, which can be measured through the safety component. This reflects on their negative perceptions regarding the vaccination program. The group with a low education background also has a higher mean value in the safety component (MR = 310.6) than the highly educated group (MR = 269.4). The analysis from this result indicates that those with low education have high negative perceptions in relation to the safety component of the vaccine as compared to the highly educated group.

Discussion

Based on the findings from this study, the majority of the local population in Sabah have suffered from "vaccine hesitancy," referring to a delay in responses on whether to accept or deny vaccination, despite the availability of immunization facilities.[56] This situation is clearly observed with the higher total percentage of Cluster 1 as compared to Cluster 2 (see Table 2). Based on the spatial analysis, Cluster 1 dominates most of the district distribution in Sabah (see Figure 1). Cluster 1 also demonstrates a higher negative response as opposed to Cluster 2 in terms of acceptance toward the vaccination program (see Table 3).

However, the trend of "vaccine hesitancy" displayed in Cluster 1 is not an anomaly as similar problems can be observed elsewhere in developed countries such as France and South Korea. For example, on April 30, 2021, only about half of the population of France and South Korea were vaccinated. The reasons may vary from the refusal to receive the vaccination or psychological reasons such as a fear of getting inoculated.[57] A similarly high level of skepticism toward vaccination programs can be seen among the population in Los Angeles in the United States,[58] the Republic of Congo,[59] and Russia.[60] Therefore, it is not surprising that the WHO identified "vaccine hesitancy" as a global health threat.

Regarding the local population in Sabah, based on the demographics, the average respondents in the private sector have an unfavorable perception of the immunization program. However, the unemployed and government employees generally favor the vaccination program (see Table 2). Therefore, the results of this study are in tandem with other existing research such as

Table 4. Comparison of public reactions toward the COVID-19 immunization program with sociodemographic factors in Cluster 1

| Aspect	Sociodemographic		Frequency	Mean Rank (MR)	P-value
Safety	Registration Status	Registered	229	227.4	<.001*
		Not Registered	343	325.9	
	Education Status	Non-University	335	310.6	.003*
		University	237	269.4	
Communication	Registration Status	Registered	229	286.4	.990
		Not Registered	343	286.6	
	Education Status	Non-University	335	282.1	.590
		University	237	289.6	
Psychology	Registration Status	Registered	229	237.7	<.001*
		Not Registered	343	319.1	
	Education Status	Non-University	335	294.8	.309
		University	237	280.6	
Milieu	Registration Status	Registered	229	296.2	.246
		Not Registered	343	280.0	
	Education Level	Non-University	335	287	.951
		University	237	286.2	
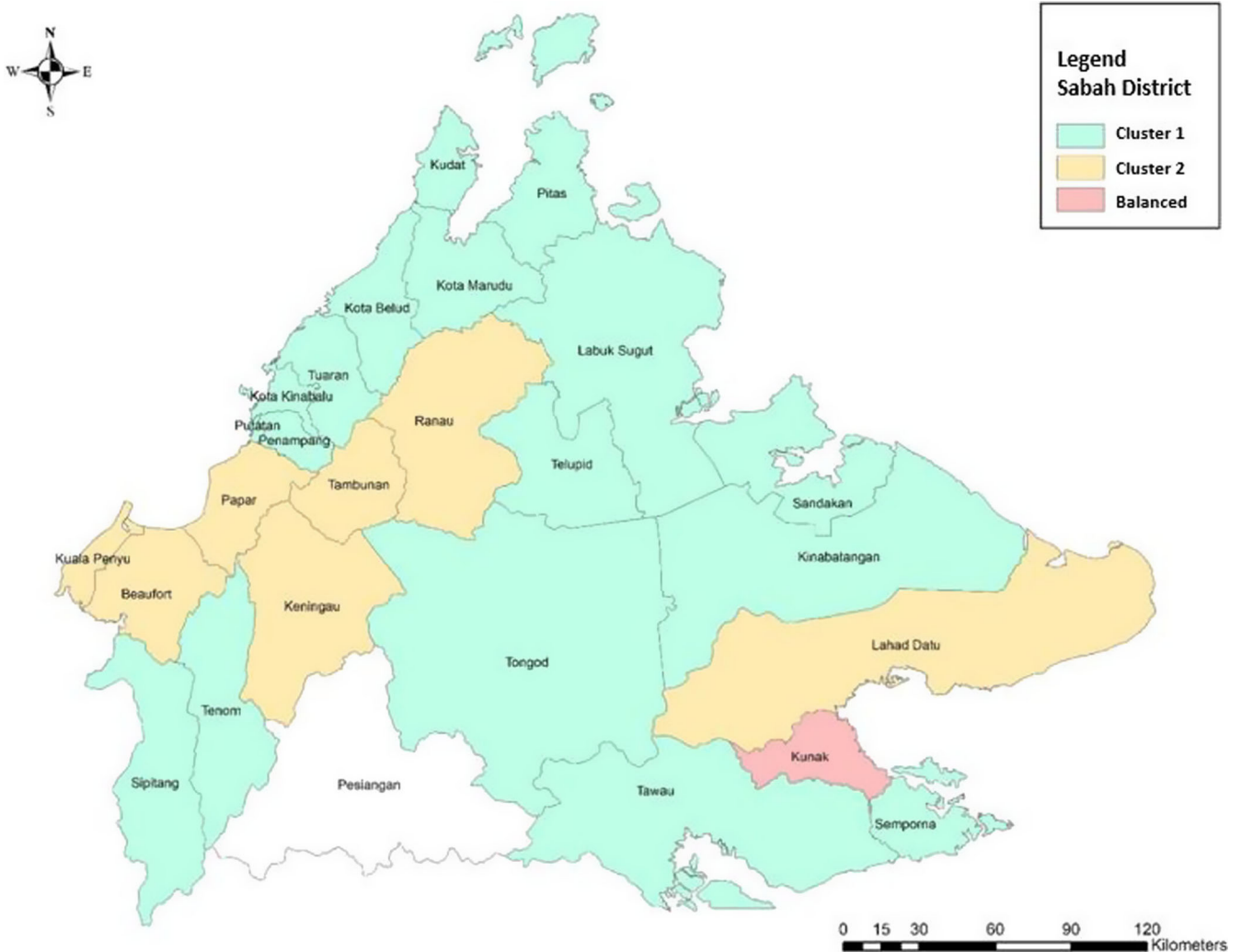
Figure 2. The distribution of Cluster 1 and Cluster 2 based on the districts of Sabah.
Source: modified from the Department of Sabah Town and Regional Planning, 2021.[55]

Zigron et al.[61] who found that there is a positive relationship between the unemployment rate and readiness to receive the COVID-19 vaccination.

One of the mandatory requirements to return to work among frontliners and essential services in Malaysia throughout the Movement Control Order (MCO) is that workers should at least have taken 1 dose of the vaccine. In several major towns in Sabah, such as in Sandakan district, local authorities issued a mandatory vaccination requirement for all its workers.[62] This factor is considered to affect employees in becoming more likely to take the vaccine since it is obligatory for employment.

Apart from that, the study outcomes revealed that challenges in communication are the primary reason for "vaccine hesitancy" in Sabah (M = 3.37, SD = 0.439). This is clear since most respondents in Cluster 1 believe that the negative information from social media regarding the vaccine has penetrated and influenced their decision to not participate in the immunization campaign. This group also finds it difficult to trust the information concerning vaccine sources from the mainstream media, in addition to their belief that it is difficult to access the immunization program (see Table 3). Vaccine apprehension appears to be a global issue due to the spread of misinformation on social media.[63] Therefore, specific strategies should be conducted to overcome the problem.[64] Vaccine hesitancy among respondents in this study initially stemmed from communication issues and later escalated into psychological problems (M = 3.33, SD = 0.588), triggering feelings of insecurity (M = 2.99, SD = 0.623). For most respondents, the practice of SOPs is sufficient to prevent the transmission of the COVID-19 virus without the vaccines (see Table 3).

According to Geldsetzer et al.,[65] due to safety concerns, misinformation on vaccines in social media further raises people's mistrust of the immunization program. Anti-vaccine groups (known as *anti-vaxxers*) have issued false statements to distort public attitude, such as claiming that the vaccine will induce irreversible damage to human health or modify human genomes and human immunodeficiency toward virus particles.[53] Therefore, it is not surprising that the average Cluster 1 consider vaccines to be harmful to their health. They eventually decided to take an approach of "wait-and-see" for a safer vaccine. Part of the increase of anti-vaccine or vaccine hesitancy is also due to the belief that the vaccines were formulated in a short period of time and its long-term ramifications remain uncertain. A similar perception is also prevalent among health care workers in other countries such as the United States,[66] France, Belgium, Canada,[67] and Poland.[68]

Most respondents in this study decided to take the vaccine according to 2 factors: first, if the government decides to make the vaccination program mandatory and, second, if the majority of the populations have been fully vaccinated (see Table 3). Unfortunately, this will be detrimental to the public health risk if public decision is driven based on these 2 factors (see Table 3). To mitigate this problem, priorities should be allocated toward the group with lower education. This is due to the tendency of this group developing a negative perception of the safety of the vaccine as compared to the highly educated group (see Table 4). A similar phenomenon has been seen in the case of low turnout of vaccine recipients in the United Kingdom.[69] This study also found that respondents who have not registered for the vaccine have higher prejudice than those who have registered due to their concern of the safety of the vaccine as well as psychological issues (see Table 4).

Some respondents have registered for the vaccine while exhibiting an indecisive attitude. They also belong in Cluster 1 (see Table 2). Their decision to register is mainly due to employment requirements rather than their own personal choice (see Table 4). Nevertheless, respondents who register is not a guarantee that they will agree to be inoculated in the end. There has been a steady case of people signing up for the immunization program and not showing up for their vaccination.[70]

Limitations

Several drawbacks are present in this study, especially regarding data collection. One hurdle is the difficulty of handing out the survey face-to-face due to travel and social restrictions. In addition, Internet coverage is relatively poor in both urban and rural areas throughout Sabah. Therefore, physical distribution of the survey is required. If the survey can be conducted both face-to-face and online, there may have been more potential insights to collect further determinants of "vaccine hesitancy." Poor Internet access and other telecommunication glitches should be taken into consideration since this may also influence the pattern of "vaccine hesitancy" in Sabah.

Moreover, the vaccine registration method is through online registration, thus further dwindling the local access in Sabah, making it difficult to enable citizens to register for the immunization program.[71] Other than Google Form, data collection through face-to-face interaction can cover remote areas such as in Kuala Penyu, Beaufort, and Kota Belud. However, the sampling size from the face-to-face method is less than the sampling size obtained from Google Form. Nevertheless, the sampling size based on face-to-face is adequate to complement the online sampling size.

Conclusion

This study concludes that 4 major components are present that lead to "vaccine hesitancy" in Sabah: communication, psychology, milieu, and safety. Out of these 4 factors, communication and psychological components are the most significant in explaining "vaccine hesitancy." This suggests that ineffective communication, especially by government-controlled media outlets, to prevent misinformation through other social media platforms such as WhatsApp and Facebook, will ultimately lead to the failure in raising public awareness regarding the importance of vaccines in curbing the COVID-19 pandemic. These platforms can be seen as failing agents of change in disseminating information on the vaccination program, ultimately influencing the broader perception of society. Some people refuse to take the vaccine because they believe they will recover from COVID-19 without inoculation. Groups under "vaccine hesitancy" also believe that SOP practices such as face masks and social distancing are sufficient in preventing the transmission of the COVID-19 virus. If this condition persists, it will undoubtedly hinder the progress toward herd immunity to boost the community's resistance against COVID-19. The outcomes of this study are crucial to inform relevant local authorities in identifying the major elements that lead to "vaccine hesitancy" in Sabah. It is hoped that this study will inform the Malaysian Government to revise and improve the efficacy of the awareness program to increase public participation in the immunization program, including the recent implementation of the booster vaccine dose. This requires an extensive understanding of the underlying causes of "vaccine hesitancy." Apparently, social media have played a critical role in influencing society's perception and the people's decision to take the COVID-19 vaccination. Social awareness through the empowerment of the mainstream media

can also be used to create awareness on the efficacy, safety, and reliability of the vaccination program so that it can be warmly received by people from all levels of society.

References

1. **Płusa T.** The actual threat of COVID-19. *Pol Merkur Lekarski (Med J).* 2020;48(287):354-360. doi:10.1615/CritRevBiomedEng.2021036595

2. **Saha S, Chakrabarti S.** The non-traditional security threat of COVID-19 in South Asia: an analysis of the Indian and Chinese leverage in health diplomacy. *South Asian Survey.* 2021;28(1):111-132. doi:10.1177/0971523121998027

3. **Faber P.** Why pandemics are national security threats. *CNA.* Published May 4, 2021. Accessed May 20, 2021. https://www.cna.org/news/indepth/2021/05/why-pandemics-are-national-security-threats

4. **She J, Jiang J, Ye L, *et al.*** 2019 novel coronavirus of pneumonia in Wuhan, China: emerging attack and management strategies. *Clin Transl Med.* 2020;9(1):1-7. doi:10.1186/s40169-020-00271-z

5. **Wu Y-C, Chen C-S, Chan Y-J.** The outbreak of COVID-19: an overview. *J Sci Med Assoc.* 2020;83(3):217-220. doi:10.1097/JCMA.0000000000000270

6. **Reported Cases and Deaths by Country or Territory.** *Worldometer.* Published June 1, 2021. Accessed June 21, 2021. https://www.worldometers.info/coronavirus/?utm_campaign=homeAdvegas1

7. **Dollah R, Jafar A, Joko EP, *et al.*** Perception of youth in East Malaysia (Sabah) towards the Malaysia National COVID-19 Immunisation Programme (PICK). *J Public Health Dev.* 2022;20(1):203-217. doi:10.55131/jphd/2022/200116

8. **The Rise and Fall of Malaysia's Muhyiddin Yassin.** *Reuters.* Published August 16, 2021. Accessed March 24, 2022. https://www.reuters.com/world/asia-pacific/rise-fall-malaysias-muhyiddin-yassin-2021-08-16/

9. **Vaccination Progress by State.** Ministry of Health Malaysia. Published March 24, 2022. Accessed March 25, 2022. https://covidnow.moh.gov.my/vaccinations/

10. **Nuryana Z, Fauzi NAF.** The Fiqh of disaster: the mitigation of COVID-19 in the perspective of Islamic education-neuroscience. *Int J Disaster Risk Reduct.* 2020;51:101848. doi:10.1016/j.ijdrr.2020.101848

11. **Real-time Data Show Virus Hit to Global Economic Activity.** *Financial Times.* Published March 22, 2020. Accessed April 13, 2021. https://www.ft.com/content/d184fa0a-6904-11ea-800d-da70cff6e4d3

12. **Asia Sees First Regional Recession in 60 Years.** *BBC News.* Published September 15, 2020. Accessed December 30, 2020. https://www.bbc.com/news/business-54157000

13. **Sheek-Hussein M, Abu-Zidan FM, Stip E.** Disaster management of the psychological impact of the COVID-19 pandemic. *Int J Emerg Med.* 2021;14(1):1-10. doi:10.1186/s12245-021-00342-z

14. **Xiong J, Lipsitz O, Nasri F, *et al.*** Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *J Affect Disord.* 2020;277:55-64. doi:10.1016/j.jad.2020.08.001

15. **Miki T, Yamamoto S, Inoue Y, *et al.*** Association between living with others and depressive symptoms in Japanese hospital workers during the COVID-19 pandemic. *Psychiatry Clin Neurosci.* 2021;75(4):148-149. doi:10.1111/pcn.13206

16. **Sharma S, Bhatta J.** Public health challenges during the COVID-19 outbreak in Nepal: a commentary. *J Health Res.* 2020;34(4):373-376. doi:10.1108/JHR-05-2020-0124

17. **Pausé C, Parker G, Gray L.** Resisting the problematisation of fatness in COVID-19: in pursuit of health justice. *Int J Disaster Risk Reduct.* 2021;54:102021. doi:10.1016/j.ijdrr.2020.102021

18. **Fine P, Eames K, Heymann DL.** "Herd immunity": a rough guide. *Clin Infect.* 2011;52(7): 911-916. doi:10.1093/cid/cir007

19. **Sonawane K, Troisi CL, Deshmukh AA.** COVID-19 vaccination in the UK: addressing vaccine hesitancy. *Lancet Reg Health Eur.* 2021;1:100016. doi:10.1016/j.lanepe.2020.100016

20. **Aziz NA, Othman J, Lugova H, Suleiman A.** Malaysia's approach in handling COVID-19 onslaught: report on the Movement Control Order (MCO) and targeted screening to reduce community infection rate and impact on public health and economy. *J Infect Public Health.* 2020;13(12):1823-1829. doi:10.1016/j.jiph.2020.08.007

21. **Kuok Ho DT.** Movement control as an effective measure against COVID-19 spread in Malaysia: an overview. *J Public Health Theory Pract.* 2020;30(3):1-4. doi:10.1007/s10389-020-01316-w

22. **Jafar A, Dambul R, Dollah R, *et al.*** COVID-19 vaccine hesitancy in Malaysia: Exploring factors and identifying highly vulnerable groups. *PloS One.* 2022;17(7):e0270868. doi:10.1371/journal.pone.0270868

23. **National COVID-19 Immunisation Programme.** The Special Committee for Ensuring Access to COVID-19 Vaccine Supply (JKJAV). Published February 18, 2021. Accessed February 18, 2021. https://intl.upm.edu.my/upload/dokumen/menul320210301113819Program_Imunisasi_COVID-19_Kebangsaan_Versi_Bahasa_Inggeris_(1).pdf

24. **Tee K.** First shipment of Pfizer-BioNTech COVID-19 vaccine arrives in Malaysia. *MalayMail.* Published February 21, 2021. Accessed May 24, 2021. https://www.malaymail.com/news/malaysia/2021/02/21/first-shipment-of-pfizer-biontech-covid-19-vaccine-arrives-in-malaysia/1951544

25. **Chung C.** CoronaVac vaccine arrives in Malaysia. *The Star.* Published February 28, 2021. Accessed May 25, 2021. https://www.thestar.com.my/news/nation/2021/02/28/coronavac-vaccine-arrives-in-malaysia

26. **First Batch of AstraZeneca COVID-19 Vaccine to Malaysia Expected in First Half of 2021.** *The Straits Times.* Published December 23, 2020. Accessed February 18, 2021. https://www.straitstimes.com/asia/se-asia/first-batch-of-astrazeneca-covid-19-vaccine-to-malaysia-expected-in-first-half-of-2021

27. **Schuchat A.** Human vaccines and their importance to public health. *Procedia Vaccinol.* 2011;5:120-126. doi:10.1016/j.provac.2011.10.008

28. **Rumetta J, Abdul-Hadi H, Lee YK.** A qualitative study on parents' reasons and recommendations for childhood vaccination refusal in Malaysia. *J Infect Public Health.* 2020;13(2):199-203. doi:10.1016/j.jiph.2019.07.027

29. **Rodzi NH.** Some Malaysians uncertain of COVID-19 vaccine: survey. *The Straits Times.* Published January 3, 2021. Accessed April 25, 2021. https://www.straitstimes.com/asia/se-asia/some-malaysians-have-reservations-about-taking-covid-19-vaccine-survey

30. **Abdullah SM.** Takiyuddin offers RM20 to KB folk to vaccinate. *New Straits Times.* Published May 28, 2021. Accessed May 28, 2021. https://www.nst.com.my/news/nation/2021/05/694031/takiyuddin-offers-rm20-kb-folk-vaccinate

31. **Pauzi SSA.** Kerajaan tidak berhasrat tangguh pemberian dos penggalak. *Astro Awani.* Published January 21, 2022. Accessed March 25, 2022. https://www.hmetro.com.my/mutakhir/2022/01/802723/kerajaan-tidak-berhasrat-tangguh-pemberian-dos-penggalak-metrotv

32. **Goldstein S, MacDonald NE, Guirguis S.** Health communication and vaccine hesitancy. *Vaccine.* 2015;33(34):4212-4214. doi:10.1016/j.vaccine.2015.04.042

33. **World Health Organization (WHO).** Global polio eradication initiative: 8th meeting of the Independent Monitoring Board. *Wkly Epidemiol Rec (Relevé Épidémiologique Hebdomadaire).* 2013;88(28):297-300.

34. **Murphy J, Vallières F, Bentall RP, *et al.*** Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nat Commun.* 2021;12(1):29. doi:10.1038/s41467-020-20226-9

35. **Hornsey MJ, Harris EA, Fielding KS.** The psychological roots of anti-vaccination attitudes: a 24-nation investigation. *Health Psychol.* 2018;37:307-315. doi:10.1037/hea0000586

36. **Rieger MO.** Triggering altruism increases the willingness to get vaccinated against COVID-19. *Soc Health Behav.* 2020;3(3):78. doi:10.4103/SHB.SHB_39_20

37. **Kanyanda S, Markhof Y, Wollburg P, Zezza A.** Acceptance of COVID-19 vaccines in sub-Saharan Africa: evidence from six national phone surveys. *BMJ Open.* 2021;11(12):e055159. doi:10.1136/bmjopen-2021-055159

38. **Agyekum MW, Afrifa-Anane GF, Kyei-Arthur F, Addo B.** Acceptability of COVID-19 vaccination among health care workers in Ghana. *Adv Public Health.* 2021;(2021):1-8. doi:10.1155/2021/9998176

39. **Chinawa AT, Chinawa JM, Ossai EN, *et al.*** Maternal level of awareness and predictors of willingness to vaccinate children against COVID-19: a

multi-center study. *Hum Vaccin.* 2021;17(11):3982-3988. doi:10.1080/21645515.2021.1963172

40. **Ackah BBB, Woo M, Stallwood L, et al.** COVID-19 vaccine hesitancy in Africa: a scoping review. *Glob Health Res Policy.* 2022;7:21. doi:10.1186/s41256-022-00255-1

41. **Davis TP Jr, Yimam AK, Kalam MA, et al.** Behavioural determinants of COVID-19-vaccine acceptance in rural areas of six lower-and middle-income countries. *Vaccines.* 2022;10(2):214. doi:10.3390/vaccines10020214

42. **Jafar A, Mapa MT, Sakke N, et al.** Vaccine hesitancy in East Malaysia (Sabah): a survey of the National COVID-19 Immunisation Programme. *Geospat Health.* 2022;17(S1):1037. doi:10.4081/gh.2022.1037

43. **Vaccination Progress by State**. Ministry of Health Malaysia. Published March 24, 2022. Accessed March 25, 2022. https://covidnow.moh.gov.my/vaccinations/

44. **Salathé M, Bonhoeffer S.** The effect of opinion clustering on disease outbreaks. *J R Soc Interface.* 2008;5:1505-1508. doi:10.1098/rsif.2008.0271

45. **Adnan A, Remaja S.** 12-17 tahun perlu izin ibu bapa sebelum daftar vaksin. *Berita Harian.* Published August 14, 2021. Accessed January 23, 2023. https://www.bharian.com.my/berita/nasional/2021/08/851208/remaja-12-17-tahun-perlu-izin-ibu-bapa-sebelum-daftar-vaksin

46. **Department of Statistics Malaysia**. Population and housing census of Malaysia. DOSM; 2021.

47. **Yamane T.** *Statistics: an introductory analysis.* 2nd ed. Harper and Row; 1967.

48. **Fauzi TFATM, Razif NFM, Ramli MA.** Polemics between acceptance and rejection of children's vaccination: an analysis from Islamic perspective. *Shariah J.* 2018;26(2):201-230. doi:10.22452/js.vol26no2.2

49. **Sallam M.** COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. *Vaccines.* 2021;9(2):160. doi:10.3390/vaccines9050515

50. **Hastie T, Tibshirani R, Friedman J.** *The elements of statistical learning: data mining, inference, and prediction.* Springer Science & Business Media; 2009.

51. **Morissette L, Chartier S.** The k-means clustering technique: general considerations and implementation in Mathematica. *Tutor Quant Methods Psychol.* 2013;9(1):15-24. doi:10.20982/tqmp.09.1.p015

52. **Rousseeuw P.** Silhouettes: a graphical aid to the interpretation and validation of cluster analysis. *J Comput Appl Math.* 1987;20:53-65. doi:10.1016/0377-0427(87)90125-7

53. **Damayanti AR, Wijayanto AW.** Comparison of hierarchical and non-hierarchical methods in clustering cities in Java Island using the human development index indicators, year 2018. *Eigen Math.* 2021;4:8-17. doi:10.29303/emj.v4i1.89

54. **Baba A.** *Statistik penyelidikan dalam pendidikan sains sosial (Research statistics in social science education).* Penerbit Universiti Kebangsaan Malaysia; 1997.

55. **Department of Sabah Town and Regional Planning**. Sabah map. Sabah Town and Regional Planning; 2021.

56. **Gagneux-Brunon A, Detoc M, Bruel S, et al.** Intention to get vaccinations against COVID-19 in French healthcare workers during the first pandemic wave: a cross-sectional survey. *J Hosp Infect.* 2021;108:168-173. doi:10.1016/j.jhin.2020.11.020

57. **Data on COVID-19 (Coronavirus) Vaccinations**. Our World in Data. Published May 20, 2020. Accessed May 20, 2020. https://ourworldindata.org/covid-vaccinations

58. **Gadoth A, Halbrook M, Martin-Blais R, et al.** Assessment of COVID-19 vaccine acceptance among healthcare workers in Los Angeles. *medRxiv.* 2020;174(6):882-885. doi:10.1101/2020.11.18.20234468

59. **Nzaji MK, Ngombe LK, Mwamba GN, et al.** Acceptability of vaccination against COVID-19 among healthcare workers in the Democratic Republic of the Congo. *Pragmat Obs Res.* 2020;11:103. doi:10.2147/POR.S271096

60. **Lazarus JV, Ratzan SC, Palayew A, et al.** A global survey of potential acceptance of a COVID-19 vaccine. *Nat Med.* 2021;27(2):225-228. doi:10.1038/s41591-020-01226-0

61. **Zigron A, Dror AA, Morozov N, et al.** COVID-19 vaccine acceptance among dental professionals based on employment status during the pandemic. *Front Med.* 2021;8:13. doi:10.3389/fmed.2021.618403

62. **Sandakan Municipal Council**. Makluman syarat-syarat keluar bekerja bagi kategori front liner dan essential services di semua lokaliti yang dilaksanakan Perintah Kawalan Pergerakan DiPerketat (PKPD) Di Daerah Sandakan. Memo Kerajaan Tempatan. Accessed July 30, 2021. https://mps.sabah.gov.my/portal/

63. **Johnson NF, Velásquez N, Restrepo NJ, et al.** The online competition between pro-and anti-vaccination views. *Nature.* 2020;582(7811):230-233. doi:10.1038/s41586-020-2281-1

64. **Rzymski P, Borkowski L, Drąg M, et al.** The strategies to support the COVID-19 vaccination with evidence-based communication and tackling misinformation. *Vaccines.* 2021;9(2):109. doi:10.3390/vaccines9020109

65. **Geldsetzer P.** Knowledge and perceptions of COVID-19 among the general public in the United States and the United Kingdom: a cross-sectional online survey. *Ann Intern Med.* 2020;173:157-160. doi:10.1101/2020.03.13.20035568

66. **Shekhar R, Sheikh AB, Upadhyay S, et al.** COVID-19 vaccine acceptance among health care workers in the United States. *Vaccines.* 2021;9(2):119. doi:10.3390/vaccines9020119

67. **Verger P, Scronias D, Dauby N, et al.** Attitudes of healthcare workers towards COVID-19 vaccination: a survey in France and French-speaking parts of Belgium and Canada, 2020. *Eurosurveillance.* 2021;26(3):2002047. doi:10.2807/1560-7917.ES.2021.26.3.2002047

68. **Konopińska J, Obuchowska I, Lisowski Ł, et al.** Intention to get COVID-19 vaccinations among ophthalmology residents in Poland: a cross-sectional survey. *Vaccines.* 2021;9(4):371. doi:10.3390/vaccines9040371

69. **Paul E, Steptoe A, Fancourt D.** Attitudes towards vaccines and intention to vaccinate against COVID-19: implications for public health communications. *Lancet Reg Health Eur.* 2021;1:100012. doi:10.1016/j.lanepe.2020.100012

70. **Bernama**. Many fail to show up for their vaccination appointment. Published May 28, 2021. Accessed May 28, 2021. https://themalaysianreserve.com/2021/05/28/many-fail-to-show-up-for-their-vaccination-appointment/

71. **Jafar A, George F, Meri A, et al.** Keberkesanan Program Imunisasi COVID-19 Kebangsaan di Malaysia Timur. *Malaysian Journal of Social Sciences and Humanities (MJSSH).* 2021;6(7):1-11. doi:10.47405/mjssh.v6i7.859