Have Your Say! Malaysian X (Twitter) Users Speak Their Minds About COVID-19 Vaccination

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Abstract

In this study, Malaysian X (formerly Twitter) users' views were examined on COVID-19 vaccination. The specific objectives were to identify issues that were important to X users, and identify changes in views on COVID-19 vaccination. Tweets were collected from 1 January to 31 December 2021; altogether 5,766 tweets (199,900 words) were collected, and 150 tweets (5,200 words) were systematically selected for analysis. Thematic analysis showed that the tweets were more concerned about administration of the COVID-19 vaccine (56.7%) than its impact (35.3%) or COVID-19 control measures (8%). Positive sentiments increased during the 12 months. In Phase 1 (1 January–23 February 2021), the public were uncertain and sceptical while waiting for vaccination. In Phase 2 (24 February–24 September 2021) when vaccination was underway, the tweets reflected an informed stance, and X users were even proactive in promoting vaccination benefits and correcting misinformation. By Phase 3 (25 September–31 December 2021) when vaccination for teenagers and s booster shot program began, there was a dilemma of wanting to return to normal life vis-à-vis prioritizing health and safety. The study data indicated more anti- than pro-vaccination tweets, but the X community had self-correcting mechanisms when vaccine hesitancy surfaced.

Keywords: *X, Twitter, COVID-19, Malaysia, COVID-19 vaccination*

Introduction

Social media has been a site for the public to exchange health information. During the COVID-19 pandemic, social media became an even more important site for information dissemination (Tsao et al., 2021). Poor knowledge of the new disease at the beginning of the pandemic in March 2020 led to circulation of false information on social media, creating vaccine hesitancy that hampered the immunization program. Although the COVID-19 situation has now been contained, it is crucial to know public views over the timeline of the infectious disease spread because seasonal influenza, like the H_1N_1 strain, can develop into epidemic proportions, and knowledge of public responses can assist in disease control measures. As the pandemic progressed, Malaysians surveyed were found to have good knowledge of how the virus functioned and spread, and held positive perceptions of COVID-19 preventive measures (Elnaem et al., 2021; Hassim et al., 2021; Nor et al., 2020). Nonetheless, questionnaire results are susceptible to social desirability bias. It has been well said by Ninan (2020, p. 1) that "[d]ata from survey questionnaires, focus groups, experiments, and interviews are all collected by the intervention of the researcher."

On the other hand, naturally occurring data like social media posts are written for expression, and can reveal on-the-ground attitudes towards COVID-19. In the early part of 2020 when the COVID-19 pandemic started, social media messages contained more positive sentiments than negative sentiments (Hung et al., 2020). In fact, there were more expressions of negative sentiments among women than men (Saleh et al., 2021), and among X users from US and Europe than those in Asia and South America (Ansari & Khan, 2021). Hussain et al. (2021) found more negative sentiments on X than on Facebook in the UK and the US. The dominant negative emotion shown was fear at that time (Saleh et al., 2021). These were the sentiments about COVID-19 in general.

In the later part of 2020, COVID-19 vaccines were developed. Negative attitudes towards COVID-19 vaccination may have led to low uptake of vaccination and affected disease control. In Malaysia, Jafar et al. (2022) found that vaccine hesitancy was caused by low confidence in the effectiveness of the vaccine and low trust in the ability of authorities to control the disease spread. Newspapers kept

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the public informed about government plans and progress in containing COVID-19, but the four mainstream newspapers analysed also highlighted anti-vaccination views (Iskandar & Mohamed, 2022). The negative sentiments attracted more attention, but studies showed that there were more positive than negative views on vaccination. For example, Adamu et al. (2021) reported that there were more neutral sentiments (47%) in tweets on COVID-19 vaccines than positive (31%) or negative (22%) sentiments. However, in January–February 2022, there were fewer neutral tweets (15.8%) and more positive (49.6%) than negative (34.6%) sentiments (Ong et al., 2022).

Analysing naturally occurring data using techniques like thematic analysis can help researchers uncover new phenomena, particularly when the data are contextualized in the sequence of events. In a pandemic, the timeline of key incidents is important because views change with the progression of events. Previous sentiment studies took snapshots of attitudes towards COVID-19 at a particular point in time, making comparison of findings difficult. Some researchers did not clearly state their data collection period (e.g., Adamu et al., 2021). Thus far, our literature search did not find studies that took into consideration the timeline for the analysis of social media messages on COVID-19 vaccination. Hence, the question remains: How did views of COVID-19 vaccination change from pre- to post-vaccination?

In this study, Malaysian X (Twitter) users' views were examined on COVID-19 vaccination from 1 January to 31 December 2021 covering three phases of vaccine administration. The specific objectives were to identify issues that were important to X users, and identify changes in views on COVID-19 vaccination.

Literature Review

Public views on emerging diseases shift in the wake of events in a pandemic, and they find an outlet in the virtual realm. On March 11, 2020, the World Health Organization declared a pandemic of COVID-19 virus that was first reported in Wuhan, China. Countries implemented strict policies to fight the pandemic, including lockdowns at home, shutdown of schools and workplaces, cancellation of events and public gatherings, and limitations on public transportation.

To lower the risks from transmission of the virus, a vaccination program was implemented as soon as countries authorized the use of vaccines in December 2020. Approximately 70% of the population needs to be vaccinated for a country to achieve herd immunity (Aguas et al., 2020). Vaccination and past infection offer protection against an infectious disease.

Conversation on COVID-19 concerns was rife in social media and face-to-face interactions. For instance, the rapid development of COVID-19 vaccines sparked negative responses marked by high levels of worry, uncertainty, and hesitancy. A typical vaccine development timeline takes five to 10 years to assess the vaccine's safety and efficacy in clinical trials (Johns Hopkins University, 2023). The rapid vaccine development caused speculation and incorrect information on vaccinations to spread.

According to some earlier studies on disease outbreaks such as Ebola (Lazard et al., 2015; Mondragon et al., 2017) and H_1N_1 (Chew & Eysenbach, 2014), fear was the most prevalent emotion, and the public's main concerns were the symptoms and prognosis of the virus, disease transmission, and government management of the diseases. However, for more familiar diseases like measles, the main sentiments expressed on social media were irritation, humor, sarcasm, concern, and relief (Mollema et al., 2015). When it first broke out, COVID-19 was a new disease and was not understood, which led to the circulation of inaccurate information. When people are exposed to inaccurate information, it affects their willingness to get vaccinated, but their reluctance and negative tendencies are repressed (Piedrahita-Valdes et al., 2019). The World Health Organization identifies vaccination hesitancy as one of the top 10 global health issues (Kunneman et al., 2020).

As individuals often express their opinions on social media, social media might offer a window into thoughts regarding many aspects of COVID-19 such as control measures and reluctance to get vaccinated. Among the various social media platforms, X (previously Twitter) was one of the key channels (Rufai & Bunce, 2020) utilized to encourage vaccination and decrease the cumulative number of positive COVID-19 cases during the pandemic (Rosli, 2021). According to Google Trend, the terms

"COVID-19" and "COVID-19 vaccination" trended on online search engines from February 2020. During public health outbreaks, social media text analysis can provide first responders with crucial information about public worries and developing issues (Lachlan et al., 2014; Yoon et al., 2013). Analysis of social media communication will provide health authorities with crucial information about public concerns and identify issues.

Methodology

The descriptive study focused on views of Malaysians talking about COVID-19 vaccination on the X platform. The three phases of developments pertaining to COVID-19 vaccination in Malaysia from 1 January to 31 December 2021 were as follows:

1. Phase 1: 1 January–23 February 2021; waiting for the arrival of the COVID-19 vaccine.
2. Phase 2: 24 February–24 September 2021; the beginning of vaccination.
3. Phase 3: 25 September–31 December 2021; implementing vaccination for teenagers and booster shots.

Platform X was selected rather than other social media platforms such as Facebook and LinkedIn for practical reasons. The data could be collected without getting consent to analyse each tweet. In X, the public posts (the default setting) are visible to anyone, and people can follow updates without first getting the approval of the account owner. Furthermore, it is easy to retrieve data, as key incidents and news stories on X are centred around a hashtag. Most importantly, tweets capture discussions of issues by any individual in the society unlike Facebook, which is confined to certain groups.

A one-year data collection period was selected, which allowed analysis of changes in views on COVID-19 vaccination. The period chosen exceeds the duration in other COVID-19 studies such as 10 months (Saleh et al., 2021) and one month (Ansari & Khan, 2021; Hung et al., 2020).

The selection criteria for the tweets were: (a) mention of COVID-19 (e.g., Coronavirus, COVID-19, C-19), and (b) use of vaccination-related words (e.g., vaccine(s), vaccination(s), vaccinate(d), vaccination drive, booster, and immunization). To collect the data, the search terms used were "COVID-19", "vaccine" and type of vaccines (e.g., Pfizer, AstraZeneca, Sinovac, Sputnik V, Moderna, Janssen, Sinopharm, Covaxin, and CanSinoBIO). Malaysian X users were selected by using geo-tagged data in TweetDeck. No restriction was placed on gender and tweet length. There were also no restrictions placed on languages and dialects, which is why there were tweets in English and Malay.

The data collected were 5,766 tweets (199,900 words). Systematic sampling was conducted to select 150 tweets, using the nth name selection technique or 38th tweet in this study. The tweets were spread across the three phases–that is, 50 tweets per phase, amounting to 5,200 words. The average number was 2.88 tweets per week. This was considered adequate to reflect the discussions on COVID-19 vaccination. Moreover, the analysis was conducted manually without the assistance of any software, which is why it was not feasible to analyse a larger number of tweets.

Before analysis, the data were pre-processed following the American Standard Code for Information Interchange procedures to "clean" the tweets. Also referred to as the text normalisation phase, this included filtering the vaccine keywords, removing duplicate tweets, URL links, and usernames.

The selected data were exported to Microsoft Word and analysed. Following Braun and Clarke (2006), the thematic analysis conducted began with rereading to gain familiarity with the meanings and patterns in the tweets. Then, initial codes for themes were generated (e.g., "sarcasm towards vaccination" and "vaccines as a global issue"), and relationships were identified among themes. The relevance of the initial themes was tested by rereading the tweets, and the coding was refined. For example, the initial theme "vaccines as a global issue" was put under "politics in relation to vaccination" because the remarks were about activities associated with the governance of a country or area pertaining to COVID-19 control. The results were reported in the form of a concept map and examples of tweets for the qualitative analysis, and a table of frequencies for the quantitative analysis.

Results

In this section, the tweets are labelled to indicate the phase (P1 for Phase 1, P2 for Phase 2, and P3 for Phase 3) and tweet number (Tweet 1 to Tweet 150). For example, P2-Tweet 70 refers to tweet number 70 that was written during Phase 2.

Themes and Sub-Themes in Tweets on COVID-19 Vaccination

Figure 1 shows that there were three main themes on the tweets, namely, impact of vaccination, vaccination and COVID-19 control, and vaccine administration by authorities. First, under the impact of vaccination theme, the sub-themes chosen were anti-vaccination views, vaccine benefits, and vaccine side-effects. Second, under the theme of vaccination and COVID-19 control, the sub-themes were travel restriction, safety and health, and impact on personal life. Finally, regarding the question of vaccine administration by authorities, the sub-themes were politics in relation to vaccination, vaccine choice, feelings and vaccine rollout, and vaccine procedures. In the following section, examples are provided for the themes and sub-themes describing Malaysian X users' views on COVID-19 vaccination.

Figure 1 *Concept Map of Themes and Sub-Themes in Tweets on COVID-19 Vaccination*
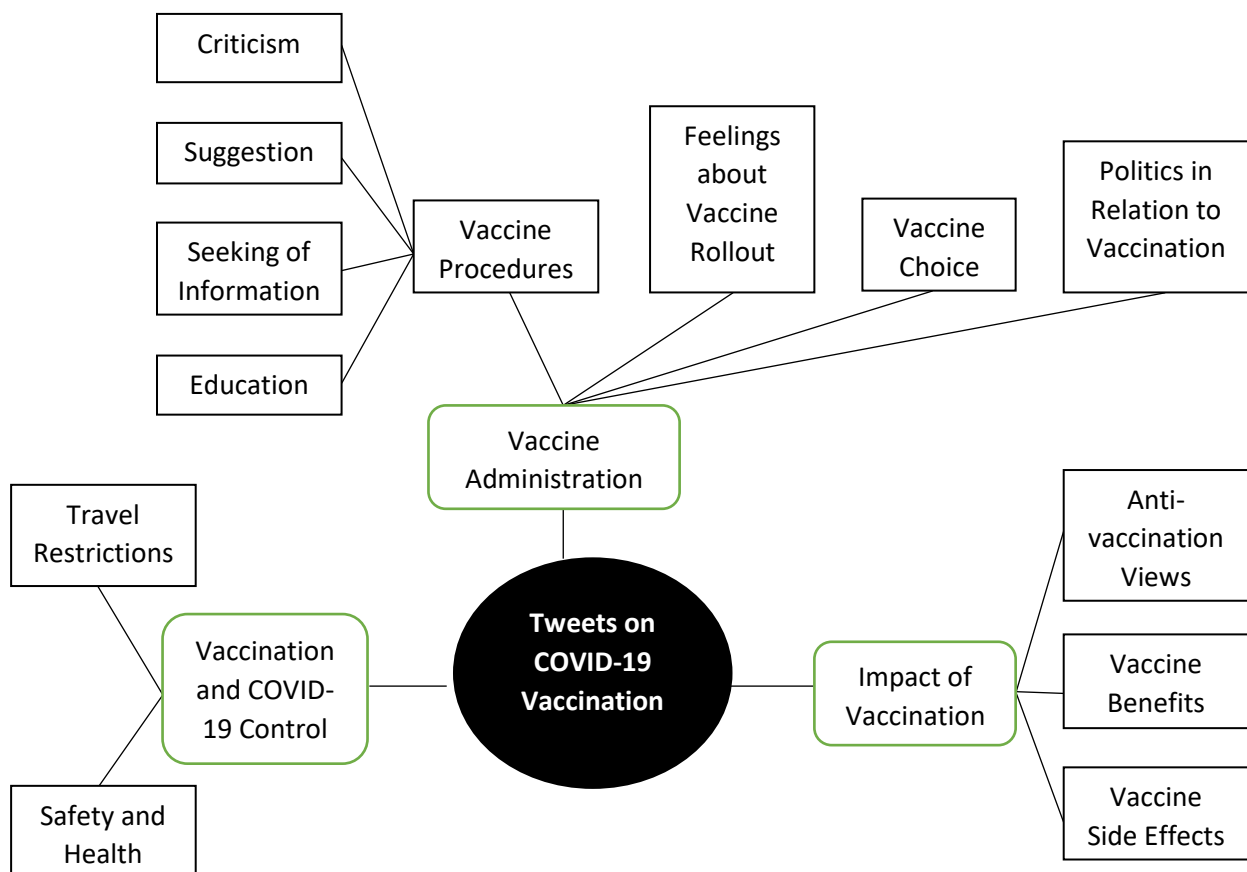
Theme 1: Tweets on Vaccine Administration

Figure 1 shows that the tweets on "vaccine administration" (Theme 1, 85 tweets) revolved around four sub-themes: Vaccine procedures, feelings about vaccine rollout, politics in relation to vaccination, and vaccine choice. The tweets were full of ideas on how Malaysia should handle the vaccination procedures.

The first sub-theme "vaccination procedures" was prominent from before the arrival of the vaccine (Phase 1) to implementation of booster shots (Phase 3). This is because in COVID-19 control,

vaccination was crucial for people to develop immunity against the disease, considering that lockdowns and movement control could not be enforced indefinitely.

The first aspect of vaccination procedures was criticism and the second aspect was suggestions, both of which were negative because suggestions were veiled criticisms. To the public, the sooner they got vaccinated, the sooner normal life could return. Excerpt 1 showed P1-Tweet 21 expressing envy that Singaporeans were ahead and Malaysians were still waiting for the arrival of the vaccine.

> Excerpt 1: "I am very jealous that people in Singapore have gotten the vaccine already. It's just pure incompetence for the delay here in Malaysia, nothing else." (P1-Tweet 21)

Other tweets written in Phase 1 also criticized the shortage of vaccine stock that caused the delay. In fact, suggestions on vaccine procedures can also be seen as indirect criticisms, which were particularly frequent during the implementation of the first shot. The tweets were often triggered by problems in the vaccination process, either experienced first-hand or gathered from recounts by other people. However, by the time everyone knew how to register for the vaccination (end of Phase 2, September 2021), the criticisms of the vaccine procedures came to an end.

The third aspect of the sub-theme vaccine procedures was seeking information, and the fourth aspect was provision of information. The tweets gradually shifted from seeking information, particularly in Phase 1 (Excerpt 2), to providing information in Phase 3 (Excerpt 3). In Excerpt 2, P3-Tweet 106 highlighted a glitch in MySejahtera, an application developed by the Malaysian government to record COVID-19 vaccination and health status (infected or not). This was a direct request for assistance, although the tweet was not directed at any particular authority. However, other X users came in to share their experiences of how to resolve the problem.

> Excerpt 2: "@JKJAVMY my fully vaccinated status in mySJ has been changed to not vaccinated after i updated my COVID-19's self-test result. Please assist. Thank you in advance." (P3-Tweet 106)

The contents of Excerpt 3 illustrate how X users played a role in helping authorities to educate the community, indicating that the constant dissemination of information on vaccine efficacy and logistics of administering vaccines had increased the knowledge of some members of the public. P1-Tweet 48 explained the government's target to have 80% of the population vaccinated.

> Excerpt 3: "Our National Vaccination Programme main objective & mission is to vaccinate a sufficient percentage of population e.g. 80%, with an end view to buildup herd immunity." (P1-Tweet 48)

The second sub-theme of "vaccine administration" involved "feelings about the vaccine rollout." The tweets in this category were mostly positive. Excerpt 4 illustrated the optimism and support for the vaccination efforts among Malaysian Twitter users from before the arrival of the vaccine to the implementation of booster shots. The P2-Tweet 76 was an up-to-date on the government's vaccination plans and acted as a "government voicebox."

> Excerpt 4: "Glad they've opened another rollout for registration for senior citizens this Sunday. Register your elderly loved ones!" (P2-Tweet 76)

Interestingly, in Phase 1 when people did not have any idea of the vaccine procedures, there were also no expressions of negative feelings. When the vaccination began in Phase 2, dissatisfaction about preferential treatment in the vaccine rollout surfaced, as illustrated in Excerpt (5).

> Excerpt 5: "So sad like this, even if you want a vaccine, you have been discriminated." (P2-Tweet 79)

The third sub-theme of "vaccine administration" involved "politics in relation to vaccination." We saw a need to differentiate the politics rather than categorizing the blame with "feelings about the vaccine rollout." This is because the negative feelings were targeted at the government agencies involved in administering the vaccine. For example, the tweet in Excerpt 6 was written before the vaccine rollout, and questioned the Ministry of Health and the Director-General of Health on the decision to give priority to certain groups.

Excerpt 6: "Who has priority over vaccination, MPs Ministers and their families, or OKUs?" (P2-Tweet 57)

The first group to be vaccinated was the frontliners, followed by the senior citizens aged 60 and above, and the public accepted the rationale. However, there were cases where ministers' families jumped the queue, and the preferential treatment came to the knowledge of the public. By September 2021 (end of Phase 2), when the population had the opportunity to get their second vaccination, there were no more politics-related tweets. The very presence of the politically related sub-theme indicates that X users were aware of the role of political actors in shaping the distribution, access, and uptake of vaccines, and they were concerned because vaccination is a public health intervention that can have significant health, social, and economic implications.

The final sub-theme for "vaccine administration" was "vaccine choice." Malaysia started with the administration of the Pfizer vaccine to frontliners and senior citizens, and the Sinovac vaccine for the general public. Different individuals had different preferences, and P1-Tweet 50 preferred Pfizer (Excerpt 7). However, at that point in time for the first and second vaccine shots, Malaysians could only choose AstraZeneca if they did not want Sinovac.

Excerpt 7: "If apply for the vaccination programme, can we choose only Pfizer brand? Hahahaha." (P1-Tweet 50)

By Phase 3, when the booster shot (third shot) program was implemented, there was little talk about vaccine choice in X. The Malaysian public were given the Pfizer vaccine for their booster shots.

Theme 2: Tweets on Impact of Vaccine

Theme 2 on the "Impact of vaccine" was categorized into three sub-themes, namely, "anti-vaccine views," "vaccine benefits," and "vaccine side effects." "Anti-vaccine views" was needed as a sub-theme because the views were not necessarily medical information about vaccine benefits and side effects. For each sub-theme, there were positive and negative aspects recorded on the impact of vaccine.

For the first sub-theme "anti-vaccine views," there were more positive tweets in support of vaccination than anti-vaccination views. Excerpt 8 (P1-Tweet 6) appeared to be written by a very well-informed X user, and addressed views that the COVID-19 vaccines were sub-standard (not shown in the excerpts, but found in other tweets) because of the speed with which they were released for use (Excerpt 8). On the other hand, Excerpt 9 showed that P1-Tweet 34 did not understand the traditional way of making vaccines (e.g., Sinovac) using weakened bacteria/viruses. In view of this, the public would have even greater challenges in understanding how Pfizer and AstraZeneca vaccines were made.

Excerpt 8: Summary: "The vaccine was able to be completed in a short time with equally good quality because we spent more money & scientists spent less time waiting for money to come in or for volunteers to sign up. There was also a lot more collaboration & better technology made it faster." (P1-Tweet 6)

Excerpt 9: "Vaccines contain weakened bacteria/viruses. In other words, injecting a vaccine into the body means injecting bacteria/viruses! How can the injection of bacteria/viruses into the body become immunization when the injection contains bacteria?" (P1-Tweet 34)

The second sub-theme used for "Impact of vaccine" was "vaccine benefits." As more information about the effectiveness of vaccines became available in the year 2021, X users shared their personal experiences on how vaccination protected them from developing severe COVID-19 symptoms, such as P3-Tweet 117 in Excerpt 10.

Excerpt 10: "Candidly, I had Covid infection early last month, but luckily, my symptoms were just minimal. I think it's because of my 2 doses of Pfizer vaccination." TQ Pfizer! (P3-Tweet 117)

The tweets categorized under the sub-theme "vaccine benefits" were not all positive and in favour of vaccination. There were also some tweets doubting the use of vaccinations, but the concerns were different early and later in the year 2021. In Phase 1, the doubts were with the effectiveness of the

vaccine as a protective measure, but in Phase 3, the doubts were with the need for a third dose of the vaccine when the body had already developed immunity. By that time, the Omicron variant of COVID-19 had surfaced, and individuals who had two doses of the Sinovac vaccine were urged to take a third dose as the efficacy of the vaccine waned in three months.

The final sub-theme chosen for "Impact of vaccine" was "vaccine side effects." This consisted of tweets that highlight the side effects of vaccines and tweets that refuted them. These tweets were particularly pronounced in Phase 3 when individuals experienced side effects. Some individuals like P3-Tweet 124 (Excerpt 11) said that the booster dose made him develop symptoms that were like COVID-19, while P3-Tweet 133 (Excerpt 12), who experienced the same symptoms, brushed them aside and even urged all Malaysians to go for the Pfizer booster shot.

Excerpt 11: "The booster dose felt the worst for me, my whole body was just weak, and I had fever. Then I went to the KK [Klinik Kesihatan, Health Clinic], they didn't wanna accept me, said I had covid-like symptoms." (P3-Tweet 124)

Excerpt 12: "How do I feel after my Pfizer booster shot? 6 Common Side Effects after 24hrs Injection site pain, Muscle Pain, Fatigue – Yes. Headache, Fever & Chills - No. All Malaysian go for it." (P3-Tweet 133)

There are some tweets describing severe side effects of COVID-19 vaccination, usually involving males younger than 30 years and after the second dose of the vaccine. Excerpt 13 (P3-Tweet 122) linked a death to COVID-19 vaccination.

Excerpt 13: "A close family friend passed away today morning. Stroke n diabetic patient was forced to take Pfizer vaccination if not no salary. He was unconscious at 5am today, called 999 for emergency assistance, took 40min to reach. Pronounced dead." (P3-Tweet 122)

This was unverified news because no postmortem was performed on the deceased to determine if the cause of death involved comorbidities like stroke and diabetes. P3-Tweet 122 not only reported a death, but made it known that some organisations were forcing their employees to be vaccinated.

Theme 3: Tweets on Vaccination and COVID-19 Control

Theme 3, "Vaccination and COVID-19 Control," revolved around the return to normal life and how certain aspects of life were affected by the aftermath of the pandemic, namely, "travel restrictions," "safety and health," and "personal life."

The first sub-theme of "Vaccination and COVID-19 Control" was "Travel restrictions," and reflected the eagerness of people to travel to other countries. In 2020, the Malaysian government restricted travel within the country, but in 2021 Malaysians were allowed to visit family during the Hari Raya (Muslim New Year), and in May and June, Kaamantan and Gawai harvest festivals. As for international travel, P3-Tweet 116 (shown in Excerpt 14) had found out that Sinovac vaccinations were not recognized by Saudi Arabia, and this would prevent them from travelling there for their pilgrimage.

Excerpt 14: "Sinovac hasn't approved yet from Arabic Saudi how to perform Umrah." (P3-Tweet 116)

However, this issue was resolved on 12 October, 2021, when Saudi Arabia announced that individuals vaccinated with Sinovac would be permitted to conduct the *umrah* if they had received a third dose.

Based on the analysis of the tweets, Twitter users were more concerned about the health aspects of COVID-19 control in Phase 3 rather than the travel restrictions, when vaccination for teenagers and booster shot program began in Malaysia. Tweets on "safety and health" were about wearing face masks and staying away from big gatherings. As an example, P3-Tweet 126 operator tried to educate other Twitter users that vaccination does not prevent infections, but it was the physical distancing, masks, and hand hygiene (Excerpt 15).

Excerpt 15: "Vaccine alone don't prevent the spread of infections. Combining them with other measures/SOPs do i.e ventilation, mask usage, avoid crowd, TRIIS, reduce risk factors, boosters' vax, etc." (P3-Tweet 126)

Overall, the analysis of the tweets revealed a shift from uncertainties and skepticism while waiting for the vaccines to arrive (Phase 1) to an informed stance when vaccination began (Phase 2). The X users were even proactive in promoting the benefits of vaccination and refuting doubts about the vaccine. Phase 3 tweets showed awareness of how returning to normal life might affect health and safety.

Changes in Views on COVID-19 Vaccination in Tweets in the Year 2021

Table 1 shows that the Malaysian X users were more concerned about administration of the COVID-19 vaccine, indicated by 56.7% of the tweets on this, compared to the impact of the vaccine (35.3%), and other COVID-19 control measures (8%). Interest in vaccine administration climbed from Phase 1 to Phase 2 when vaccination was underway, but dropped in Phase 3 when procedures had been tested and were smooth. Interest in the impact of vaccines was higher in Phases 1 and 3 when X users were speculating and sharing about the effects of the vaccination, respectively, than when the vaccination program was underway. Interest in vaccination as a COVID-19 control measure was high in Phase 3, as X users were discussing how vaccination could help them return to a normal life as before the pandemic. The rest of this section focused on the frequencies of the sub-themes to provide details on changes in views on COVID-19 vaccination.

Table 1 *Frequency of Themes and Sub-Themes Based on Phase (N = 150)*

Theme		Sentiment	Phase 1	Phase 2	Phase 3	Freq.	%
1. Vaccine Administration			**30**	**35**	**20**	**85**	**56.7**
Vaccine procedures	Criticise	Negative	7	9	0	16	
(*n* = 47)	Suggest	Negative	3	8	4	15	
	Seek information	Neutral	4	2	2	8	
	Providing information	Positive	2	2	4	8	
Feelings about vaccine rollout (*n* = 23)		Positive	6	7	5	18	
		Negative	0	3	2	5	
Politics in relation to vaccination (*n* = 8)		Negative	5	3	0	8	
Vaccine choice (*n* = 7)		Neutral	3	1	3	7	
2. Impact of Vaccines			**18**	**13**	**22**	**53**	**35.3**
Anti-vaccine views	Advocate	Negative	10	1	4	15	
(*n* = 33)	Refute	Positive	5	7	6	18	
Vaccine benefits	Advocate	Positive	2	3	5	10	
(*n* = 13)	Doubts	Negative	1	0	2	3	
Vaccine side effects	Advocate	Negative	0	1	4	5	
(*n* = 7)	Refute	Positive	0	1	1	2	
3. Vaccination and COVID-19 Control			**2**	**2**	**8**	**12**	**8.0**
Travel restrictions (*n* = 5)		Neutral	1	1	3	5	
Safety and health (*n* = 7)		Positive	1	1	5	7	
Total			**50**	**50**	**50**	**150**	**100**

Notes. Phase 1: 1 January–23 February 2021; waiting for the arrival of the COVID-19 vaccine.
Phase 2: 24 February–24 September 2021; beginning of vaccination.
Phase 3: 25 September–31 December 2021; implementing vaccination for teenagers and booster shots.

There were 85 tweets on Theme 1, "Vaccine administration." For the first sub-theme on "vaccine procedures," the tweets were mostly criticism (16 tweets) and suggestions (15 tweets), particularly in Phase 1 and Phase 2 (implementation of the first shot). Suggestions were veiled criticisms, and this tended to surface in Phase 2 when the X users had experienced or heard of how the vaccines were administered, and had counter suggestions on better ways of implementation. Before the arrival of vaccines in Malaysia, X users did not show much interest in seeking information (8 tweets) or in giving

information to educate others (8 tweets). Seeking information was neutral, but providing information on vaccine procedures was considered positive, as the latter helped other individuals to correctly register for the vaccination without hassle. Interest in vaccine administration was initially high in Phase 1 (30 tweets) and Phase 2 (35 tweets), but became a matter of routine by Phase 3 (20 tweets).

For the second sub-theme under "vaccine administration," the positive "feelings about vaccine rollout" were stable throughout the year 2021 (Phase 1, 6 tweets; Phase 2, 7 tweets; Phase 3, 5 tweets). There were no expressions of negative feelings about the vaccine rollout when X users were waiting for the vaccines to arrive, but they expressed some dissatisfaction when vaccination began.

The third and fourth sub-themes for "vaccine administration" were "politics in relation to vaccination" and "vaccine choice," respectively. The eight tweets about politics in relation to vaccination were negative because they brought up unfairness in allocation of turns for vaccination, but such issues decreased as the vaccination program progressed. Interest in vaccine choice was low mainly because people were not given a choice. These tweets were considered neutral as they were not clearly pro- or anti-vaccination.

Next, there were 53 tweets on Theme 2, "Impact of vaccines." For this, there were more anti-vaccine views (33 tweets) than medical aspects of vaccine benefits (13 tweets) or vaccine side effects (7 tweets). Table 1 shows a clear decrease in anti-vaccine views as soon as the vaccination program began. The results obtained indicate that lack of knowledge can lead to unhealthy speculation about vaccination and spur talk about vaccine hesitancy, but once people were vaccinated, they could experience the benefits for themselves. This was shown by a steady increase in tweets about vaccine benefits across the three phases (from 2 in Phase 1 to 5 in Phase 3). Altogether, there were 10 tweets advocating benefits of vaccination versus three that expressed doubts.

The X users did not post any tweets on vaccine side effects before the arrival of the vaccines. By Phase 3, when the booster shots were administered, there were five tweets on vaccine side effects, most of which were negative. Earlier, Excerpts 11 to 13 highlighted sharing about symptoms like fever and fatigue, to alleged fatality. The increasing number of tweets "advocating vaccine benefits" across the three phases suggested a growing understanding of the positive impacts of vaccination.

Finally, there were only 12 out of 85 tweets on Theme 3, "Vaccination and COVID-19 control," and mostly posted in Phase 3. Interest in talking about COVID-19 vaccination had waned and revolved around relaxation of travel restriction and consequences for safety and health.

The changes in views on COVID-19 vaccination in tweets during the year 2021 are summarized by adding up the positive (63 or 42%), negative (72 or 48%) and neutral tweets (15 or 10%) in Table 1 above. Figure 2 shows an increase in positive sentiments, a decrease in negative sentiments, and stability in neutral sentiments across the three phases. Based on Figure 2, the increase in positive sentiments was mostly from vaccine procedures (providing information), impact of vaccines (advocating vaccine benefits), and vaccination and COVID-19 control (safety and health). The increase reflects an awareness of the usefulness of vaccination as a protective health measure. The decrease in negative sentiments was mostly about vaccine procedures (criticism, suggestions, politics in relation to vaccination) and the impact of vaccines (anti-vaccine views). The results suggest that as the vaccination program progressed, negative views decreased. Problems in implementation were ironed out, and evidence about the benefits of vaccination reduced reservations. There were only slight fluctuations in the number of neutral tweets.

Figure 2 *Positive, Negative, and Neutral Sentiments on COVID-19 Vaccination Across Three Phases*
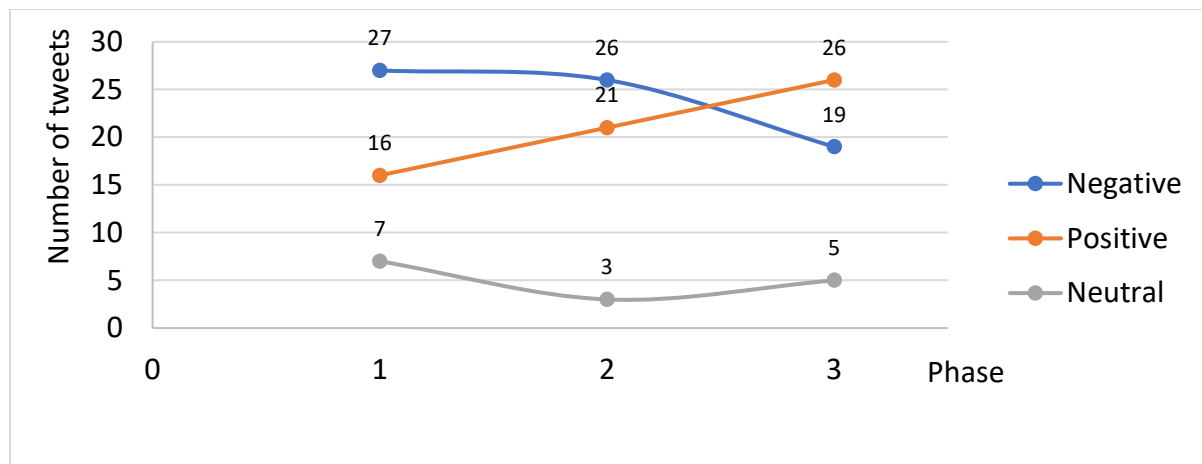
Discussion

Two findings from the analysis of tweets related to COVID-19 vaccination written by Malaysian X users are discussed. First, there were more negative tweets (48%) than positive tweets (42%) in 2021. Before this period, there were fewer negative sentiments (22%) and more positive (31%) and neutral sentiments (47%), based on Adamu et al.'s (2021) analysis of 7,608 tweets on COVID-19 vaccines in Malaysia. In the United States, Hung et al.'s (2020) machine learning analysis of 902,138 tweets revealed that 48.2% were positive, 31.1% negative, and 20.7% neutral; the dominant themes were health care environment, emotional support, business economy, social change, and psychological stress. Negative sentiments increased further after 2021. From January–February 2022, when Ong et al. (2022) collected 788 tweets in Malaysia containing COVID-19 vaccine booster keywords of analysis, they found 49.6% positive sentiments, 34.6% negative, and 15.8% neutral sentiments for three important topics: (a) type of vaccination booster, (b) effects of vaccination booster, and (c) vaccination program operation. A comparison of these four studies (including the present study) shows that vaccine hesitancy was evident in tweets, particularly from 2021 to early 2022.

Second, the analysis of tweets on COVID-19 vaccination, according to phase in the vaccine administration, produced insights that were hitherto not available because other researchers (Adamu et al., 2021; Hung et al., 2020; Ong et al., 2022) did not demarcate the tweets according to a timeline. In social media, negative views on COVID-19 vaccination initially overshadowed positive views. The present study showed that at the height of negative views about COVID-19 vaccination, the issues were with vaccine procedures and the impact of vaccines. A newspaper article said that anti-vaxxers were preventing Malaysia from achieving the target of having 100% of the adult population vaccinated with at least the first dose (Babulal, 2021). Based on their framing analysis of 287 news articles in four mainstream Malaysian newspapers from 1 January 2019–30 September 2021, Iskandar and Mohamed (2022) concluded that anti-vaccination views may have been sensationalised, and suggested that newspapers should include interviews with researchers and lecturers to provide the public with sufficient scientific and credible information. However, the present study showed that when vaccination was underway in late 2021, more X users themselves were explaining scientific details on the virus, transmission, and containment in response to negative views about vaccination. This reflects the success of public service announcements and other efforts by the government to educate the public on COVID-19, but this process took time. The World Health Organization report (Lo & Safinaz, 2021) showed that in 2020, 78% of individuals in Malaysia believed that the virus was "not too dangerous", but in 2021, 99% of individuals considered the virus to be "dangerous" to "very dangerous." It is also a case of "seeing is believing." When the public experienced vaccination for themselves, they believed in its benefits as a COVID-19 preventive measure and stopped bashing vaccination in social media.

Conclusion

This study on COVID-19 vaccination tweets posted by Malaysian X users in 2021 showed that there were more negative tweets than positive and neutral tweets. There was a change in views from the time people waited for the vaccine to arrive. After February 2021, the uncertainties and skepticism in the pre-vaccination period turned to an informed stance during the vaccination period, and X users were even proactive in promoting the benefits of vaccination and correcting misinformation. By September 2021 when vaccination for teenagers and the booster shot program began, the tweets showed an eagerness to move on with life. Analysis according to the phase of vaccine administration revealed the ebb and flow of positive and negative sentiments, and the key points of concern for the public. Monitoring and analyzing social media communication in real-time will produce valuable on-the-ground feedback for authorities to plan for public health. The World Health Organisation stated that in times of uncertainty when the public has doubts and worries about the virus and the vaccines, listening to public concerns is central to a successful immunization campaign (Lo & Safinaz, 2021). However, the present study was limited by the small number of tweets that could be feasibly analyzed using thematic analysis. Using a machine learning approach in future studies may provide more speedy feedback on concerns in real-time for interventions. Text mining can be employed to determine the public's rejection and acceptance of vaccination to contain the spread of diseases, as well as media representation of the disease, and control measures to find out if media content manipulates the public's sentiments.

Acknowledgments/Information

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