THE LEVEL OF KNOWLEDGE, ATTITUDE AND PRACTICE TOWARDS COVID-19 IMMUNISATION AMONG MEDICAL STUDENTS IN PUBLIC MEDICAL SCHOOLS IN MALAYSIA

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Abstract

COVID-19 is a highly contagious disease that caused a worldwide pandemic in 2020. Medical students are public advocates for COVID-19 vaccination to achieve herd immunity. Our objective is to ascertain the level of knowledge, attitude, and practice toward COVID-19 immunisation among medical students in Malaysia. The online study included four public universities in Peninsular Malaysia: Universiti Putra Malaysia, International Islamic University Malaysia, Universiti Sains Malaysia and Universiti Sains Islam Malaysia. Data collected include sociodemographic characteristics, history of COVID-19 infection, knowledge, attitude and practice towards COVID-19 immunisation. Analytical statistics were analysed with IBM Statistical Package Statistical Package for the Social Science (SPSS) v27.0 using Pearson chi-square or Fisher's exact test (significant if $p < 0.05$). From the total of 427 respondents, 60.2% had good knowledge whereby clinical students 67.0% had a higher proportion of good knowledge as compared to preclinical students 53.5% ($p = 0.004$). Respondents in the age group of 21 to 24 years old ($p < 0.001$) and 25 to 29 years old ($p = 0.016$), and Indian ethnicity ($p = 0.006$) were more likely to have good knowledge. Respondents registered in Malaysia's National COVID-19 vaccination program were considered as having a positive attitude ($n = 264$, 61.8%). A vaccination rate of 100% was observed. In conclusion, 60.2% of medical students had good knowledge, 61.8% had a positive attitude and 100% were vaccinated in these four public medical schools in Malaysia. Sociodemographic factors (age group and Indian ethnicity) have an association with only good knowledge but none with the level of attitude and practice towards COVID-19 immunisation.

Keywords: COVID-19 Immunisation, Knowledge, Attitude, Practice, Medical Students

Introduction

The COVID-19 infection is caused by the 2019 Novel Coronavirus or SARS-CoV2 (1). The first case of COVID-19 was officially reported in Huanan Seafood Market, Wuhan, China on 1st December 2019 involving 41 people (2). Initially, the patients were diagnosed with pneumonia which was later linked with other people in the seafood sale market. The investigations revealed that the patients were infected with a variety of viruses that can cause pneumonia (2). Numerous sequencing tests using samples from the lower respiratory tract were conducted and a genus beta coronavirus was detected. These novel coronaviruses were further named as 2019 Novel-Coronavirus (2019-nCoV).

2019-nCoV spread exponentially and 800 people were infected including healthcare workers in Wuhan by December 2020 (3). By 31st January 2023, 753,479,439 confirmed cases of COVID-19, including 6,812,798 deaths, were reported to World Health Organization (WHO) (4, 5). As of 21 December 2022, a total of 13,073,712,554 vaccine

doses worldwide have been administered (4). According to the U.S Centers for Disease Control and Prevention (CDC), COVID-19 shows a wide range of symptoms ranging from mild to severe illness (6). The symptoms particularly take around 2-14 days to appear depending on the individual. The most common symptoms include cough, fever, fatigue, shortness of breath and loss of taste or smell (6). Prevention treatment and management hold significant roles to reduce the rate of infection and severity of the disease. Precautionary measures such as masks, social distancing and ventilation also work best during this phase (7). Most importantly, immunisation is performed worldwide to increase the immunity of the body (8). According to the previous systematic review by Griffin et al., the ideal time to start active immunisation through vaccination is during "the pre-exposure period" to the SARS-Cov-2 virus (9). Meanwhile, the usage of antivirals and microbial antibodies is best given during the detectable viral replication period to avoid potential harm if given earlier (9).

Our study focuses on COVID-19 immunisation as it plays an important role in controlling the COVID-19 pandemic emerging around the world. Immunisation is defined as a process by which the human body develops immunity to diseases through vaccination (10). Thus, COVID-19 immunisation is a process that develops immunity to COVID-19 by COVID-19 vaccination. Moreover, vaccination is used to combat the COVID-19 pandemic emerging around the world.

The immunisation process initiates and sustains the adaptive immunity of both antibody and T-cell-mediated immune responses (11). Adaptive immunity is responsible for long-lasting and potentially sterilising immunity to SARS-CoV2. It entails the coordination of T and B cell immune responses to the virus (11). Nevertheless, vaccination against COVID-19 can cause some minor side effects and in some rare cases can cause myocarditis and pericarditis (12, 13, 14). A study among individuals in Malaysia aged 18 and above who are eligible to participate in the National COVID-19 Vaccination Program revealed that 76.8% of those who have received their vaccination had experienced vaccine-related side effects (15). The most reported side effects among the vaccine types (Pfizer- Biotech, Sinovac, Oxford-AstraZeneca) that were received by the participants in their study is injection site pain (61.1%) and tiredness (48.8%). Comparing all three types of vaccines, participants who received the Sinovac vaccine had a lower chance of experiencing side effects. Their study also reported that younger ages and females had a higher risk of experiencing side effects after receiving their COVID-19 vaccination effects (15).

Most of the COVID-19 vaccines were designed to utilize the SARS-CoV-2 spike protein (S protein) or part of it to induce an immune response (16, 17). S protein is the viral surface protein that will bind to the angiotensin-converting enzyme 2 (ACE2) which is a protein receptor located on the surface of the human cells. As a result, the binding of the S protein with the ACE2 receptor permits entry of the virus into human cells (16). Three types of established vaccines are being used in Malaysia as of October 2021 which are messenger RNA (mRNA) vaccines, viral vector vaccines and the inactivated and protein subunit vaccines (14, 18). To date, there are seven vaccine brands used in Malaysia: Moderna, Sinovac, Pfizer-BioNTech, Sinopharm, Janssen, Oxford-AstraZeneca and CanSinoBio (14, 19). According to the Malaysian Ministry of Health, as of 27th December 2022, a total of 72,553,565 vaccines had been administered in Malaysia (20). Despite the majority of people showing positivity and acceptance towards the COVID-19 vaccination, studies showed that there was a conflicting result.

Abd Rahim et al. (21) stated that the majority of students at the International Islamic University Malaysia (IIUM) showed a good acceptance of vaccines. This is most probably due to an acceptable level of knowledge, attitude and practice. However, based on a study conducted by Elkalmi et al. (22), most students have hesitancy towards vaccines due to fear of side effects. Therefore, the acceptance of COVID-19 vaccination especially among medical students is an important factor to be studied. Furthermore, during their clinical rotation, medical students may probably come to encounter patients who are apprehensive about getting vaccines. To prevent false information about the COVID-19 vaccine, medical students should gain a more comprehensive understanding of SARS-CoV-2 and the potential vaccine options (22). Medical students as future healthcare providers also act as an important public health measure in controlling communicable diseases like COVID-19. Their acceptance of COVID-19 vaccination could be key to building public trust against vaccination hesitancy. This study focuses on the level of knowledge, attitude and practices towards COVID-19 immunisation amongst medical students in four public universities in Malaysia. Furthermore, we also want to determine their associations with sociodemographic factors and the history of COVID-19 infection. In addition, we also want to determine their associations with sociodemographic factors and history of COVID-19 infection. Therefore, the outcome of the study could potentially help to assess the readiness of medical students in carrying out their role as future healthcare practitioners in advocating for the COVID-19 vaccines.

Materials and Methods

Study location, design, and duration

The research was carried out at the Faculty of Medicine and Health Sciences (FMHS) Universiti Putra Malaysia (UPM), IIUM, Universiti Sains Malaysia USM (USM) and Universiti Sains Islam Malaysia (USIM). This cross-sectional study was undertaken among medical students at these four public medical schools in Peninsular Malaysia. This study was conducted from the 25th of December 2021 until the 25th of July 2022.

Sampling collection

The study population is medical students studying in the four public universities in Malaysia which are UPM,

IIUM, USM and USIM. The exclusion criteria were medical students in these four universities who were on study leave or not in active enrolment or refuse to participate in this study. The cluster sampling method was used as the sampling method. The approximate sample size was calculated using one group and two groups' proportion (age, gender, education level and history of COVID-19 infection) calculation with adjustment consideration of a 10% dropout rate (23). Sample size calculation was determined using previous similar studies conducted (24, 25). The highest sample size calculated among the three objectives is 432 respondents. The dropout rate, which is estimated to be 10%, is added to the sample size. Thus, an appropriate sample size of 476 respondents was targeted for the present study and those who participated in validity testing were excluded to avoid potential bias (26). Approximately 427 medical students consented to this study.

Data instrument

The questionnaire includes four sections: socio-demographic and COVID-19 infection history, knowledge, attitude, and practice (Appendix 1). The questionnaire used closed-ended questions. For questions with the Likert scale scoring under attitude, 5 options were included which are Strongly Disagree/Disagree/Neutral/Agree/ Strongly Agree. A maximum of 5 points to 1 point was given respectively from 'Strongly Agree' to 'Strongly Disagree' to assess positive attitude. In the knowledge section with true/ false/I do not know questions, 1 point was given for correct answers. Then, respective mean scores for knowledge and attitude were calculated. Respondents who scored above the mean score were considered to have good knowledge/ positive attitude and those below the mean score as poor knowledge/negative attitude.

Meanwhile, to assess practice, filtered questions with yes/no options were used. 'No' responses would have to answer a subsequent question. Vaccine acceptance, hesitancy and refusal were then operationalised based on the responses as stated in Table 1. The calculations for the scores and KAP assessments were adapted from the study by Wong et al. (24).

Table 1: Assessment of level of practice

	1. Are you registered for Malaysia's National COVID-19 Vaccination Programme? (Yes/ No)	**2. If not, will you register for Malaysia's National COVID-19 Vaccination Programme? (Yes/ No/I have already registered)**
Vaccine Acceptance	Yes	Yes/ I have already registered
Vaccine Hesitancy	No	Yes
Vaccine Refusal	No	No

Data collection

The data of this research was collected by conducting questionnaires distributed through Google Forms online. The link to the Google Form was distributed to the medical students in UPM, IIUM, USM and USIM via WhatsApp. Consent from the participants was gained when they willingly enter a valid email address and completed the questionnaire in the Google Form. Responses from the participants were automatically recorded by Google Forms to be used for data analysis. The data collection process was conducted online to ensure easy and quick access to the questionnaire as the participants can fill up the form at any place or time if they had internet access. The participants were given 5 days to complete the questionnaire before we did a follow-up.

Validity and reliability

Based on previous studies, the questionnaires were adapted from sets of pretested and face-validated questionnaires (15, 24, 25, 27-29). The validity testing was conducted beforehand on 41 intended medical students who full-fill the selection criteria (10% of the calculated sample size) from the four universities involved. This was to ensure the respondents understand and to measure the reliability of the questionnaire. The instrument was reviewed and revised based on the feedback received. The questionnaire reliability was tested using the alpha Cronbach's value. From the data collected, the alpha Cronbach's value will be determined and if the value is between 0.65 – 0.8, the questionnaire is reliable. A value less than 0.5 shows an unreliable questionnaire.

Data analysis

Data analysis was carried out using IBM Statistical Package SPSS version 27.0. Descriptive statistics were used to find out population characteristics, knowledge, attitude and practice towards COVID-19 immunisation. The variables for categorical data were shown as percentage and frequency. Using the Kolmogorov-Smirnov method, the data's normality was examined, and it was discovered that the data were not normally distributed. Therefore, the variables for continuous data were reported as interquartile range and median.

For analytical statistics, the level of knowledge, attitude, and practice of COVID-19 immunisation among medical students in UPM, IIUM, USM, and USIM was tested for associations with the independent variables that had two groups using either the Pearson chi-square or Fisher's exact test. In achieving the assumptions in these statistical tests, the chi-square test was chosen when no more than 20% of the expected count with less than 5, while Fisher's exact test was chosen when more than 20% of the expected count with less than 5. For independent variables that had more than two groups, simple logistic regression followed by multiple logistic regression was used. In our findings, simple & multiple logistic regression tests and Pearson's chi-squared test were used to investigate the association between dependent (sociodemographic characteristics

and history of COVID-19 infection among medical students in four public universities in Malaysia) and independent variables (knowledge, attitude, and practice towards COVID-19 immunisation). The alpha value was set at 0.05.

Ethical clearance

The study was conducted with post-approval from the Dean of the FMHS UPM and post-ethical clearance from the Ethics Committee for Research Involving Human Subject UPM (JKEUPM-2022-139). The Deans of the three medical schools of IIUM, USM and USIM consented to the prerequisite of UPM's ethical clearance.

Results

Sociodemographic distribution

Out of 2475 medical students, 427 responses were collected with a response rate of 17.25%. Data analysis was done using a total of 427 responses which was 90% of the calculated sample size. Table 2 shows the sociodemographic characteristics of the respondents. The study population was dominated by respondents of age group 21-24 years old (61.6%), female (69.6%), Malay (70.3%), from UPM (48.2%), in their first year of study (28.8%) and preclinical studies (50.4%) with no history of COVID-19 infection (64.9%).

Table 2: Sociodemographic characteristics and history of COVID-19 infection among respondents

Sociodemographic factors & history of COVID-19 Infection	Frequency	Percentage (%)
Age		
18 - 20	111	26.0
21 - 24	263	61.6
25 - 29	53	12.4
Gender		
Male	130	30.4
Female	297	69.6
Ethnicity		
Malay	300	70.3
Chinese	67	15.7
Indian	51	11.9
Bumiputera Sabah	3	0.7
Bumiputera Sarawak	1	0.2
Others	5	1.2
University		
UPM	206	48.2
IIUM	60	14.1
USM	108	24.4
USIM	57	13.3
Year of study		
1	123	28.8
2	92	21.5
3	93	21.8
4	43	10.1
5	67	15.7
6	9	2.1
Preclinical	215	50.4
Clinical	212	49.6
History of COVID-19 infection		
Yes	150	35.1
No	277	64.9

Level of knowledge and sociodemographic factors

The level of knowledge, attitude, and practice among the respondents toward COVID-19 immunisation is shown in Figure 1.

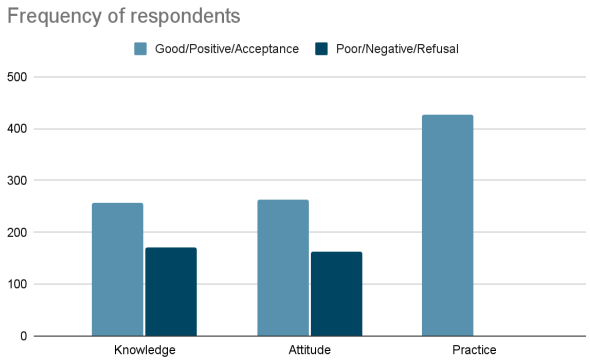

Figure 1: Distribution of respondents for the level of knowledge, attitude and practice towards COVID-19 immunisation

The knowledge of the respondents was calculated individually and graded according to the level of good or poor knowledge. By using the Kolmogorov-Smirnov method, the knowledge score was found to be not normally distributed ($p < 0.001$). The median and the interquartile range of the score were 13 and 2 respectively. The mean score was 12.53 which was the indicator for good knowledge, scores that were below the mean score were considered poor knowledge. The number of respondents with good knowledge was 257 respondents (60.2%) while the number of respondents with poor knowledge was 170 respondents (39.8%)

Using the chi-square test, a significantly higher proportion of clinical students showed good knowledge towards COVID-19 immunisation compared to the preclinical students (χ^2 = 8.110, p = 0.004) in the four public universities as shown in Table 3. Moreover, from multiple logistic regression, Indian respondents had a 2.691 higher probability of having good knowledge compared to Malay respondents (OR = 2.691, 95% CI: 1.335, 5.422, p = 0.006) (Table 4). In addition, the age group 21-24 had a statistically significant 2.347 times higher probability of having good knowledge compared to respondents who were 18-20 years old (OR = 2.347, 95%CI: 1.455, 3.785, p < 0.001) (Table 5). Lastly, respondents who were 25-29 years old had a statistically significant 2.363 times higher probability of having good knowledge compared to respondents who were 18-20 (OR = 2.363, 95% CI: 1.171, 4.769, p = 0.016) as shown in Table 5.

Table 3: Associations between sociodemographic factors and level of knowledge among respondents using the chi-square test (N = 427)

Sociodemographic Factors	Poor Knowledge N (%)	Good Knowledge N (%)	X^2 (df)	p-value
Year of study			8.110 (1)	**0.004***
Pre-clinical	100 (46.5%)	115 (53.5%)		
Clinical	70 (33.0%)	142 (67.0%)		
Genders			2.422 (1)	0.120
Male	59 (45.4%)	71 (54.6%)		
Female	111 (37.4%)	186 (62.6%)		
History of COVID-19 infection			0.786 (1)	0.375
Yes	64 (42.7%)	86 (57.3%)		
No	106 (38.3%)	171 (61.7%)		

*p < 0.05

Table 4: Associations between sociodemographic factors and level of knowledge among respondents using simple logistic regression (N = 427)

Variables	Unadjusted B	SE	OR	95%CI		p-value
Age Group						
18-20	Ref					
21-24	0.657	0.230	1.930	1.230	3.026	**0.004***
25-29	0.555	0.341	1.742	0.892	3.399	0.104
Ethnics						
Malay	Ref					
Chinese	0.210	0.278	1.233	0.715	2.128	0.451
Indian	0.764	0.342	2.146	1.098	4.194	**0.026***
Bumiputera Sabah	-1.002	1.230	0.367	0.033	4.092	0.415
Bumiputera Sarawak	20.894	40192.969	1185926619	<0.001	-	1.000
Others	-0.715	0.920	0.489	0.081	2.972	0.437
University						
UPM	Ref					
IIUM	-0.269	0.298	0.764	0.764	0.764	0.367
USM	-0.187	0.246	0.829	0.829	0.829	0.447
USIM	-0.290	0.303	0.748	0.748	0.748	0.339

*p < 0.05, B=Coefficient, SE=Standard Error, CI=Confidence Interval, OR=t Statistic, Ref=Reference

Table 5: Associations between sociodemographic factors and level of knowledge towards COVID-19 infection among respondents using multiple logistic regression (N = 427)

Variables	Adjusted B	SE	Adjusted OR	95%CI		p-value
Age Group						
18-20	Ref					
21-24	0.853	0.244	2.347	1.455	3.785	**<0.001***
25-29	0.860	0.358	2.363	1.171	4.769	**0.016***
Ethnics						
Malay	Ref					
Chinese	0.446	0.294	1.561	0.878	2.776	0.129
Indian	0.990	0.358	2.691	1.335	5.422	**0.006***
Bumiputera Sabah	-1.170	1.233	0.310	0.028	3.477	0.343
Bumiputera Sarawak	21.579	40192.969	2353440032.373	<0.001	.	1.000
Others	-0.729	0.932	0.483	0.078	2.996	0.434
Intercept	-0.376	0.226	0.686			0.096

*p < 0.05, B=Coefficient, SE=Standard Error, CI=Confidence Interval, OR=t Statistic, Ref=Reference group

Level of attitude and sociodemographic factors

The attitude score of the respondents was calculated individually and graded according to the level of a good or poor attitude. By using the Kolmogorov-Smirnov method, the knowledge score was found to be not normally distributed ($p < 0.001$). As for the attitude score, the median and the interquartile range of the score were 69.00 for both. The mean score was 67.70 which was the indicator of a good attitude, scores that were below the mean score were considered a poor attitude. The number of respondents with a positive attitude was 264 respondents (61.8%) while the number of respondents with a negative attitude was 163 respondents (38.2%).

Level of practice and sociodemographic factors

As for practice, all 427 of the respondents (100%) in our study had a good level of practice towards COVID-19 immunisation. The study has shown that there was no significant association between sociodemographic factors and the level of knowledge or the level of attitude towards COVID-19 immunisation. Moreover, there was no association between knowledge, attitude and practice towards COVID-19 immunisation among medical students. Lastly, the association between sociodemographic factors and level of practice could not be tested because all 427 respondents had good practices. The association between the level of knowledge and level of practice, level of attitude and level of practice could not be tested as well due to the same reason.

Discussion

Sociodemographic distribution

The age groups of 21 to 24 years old and 25 to 29 years old had a higher probability of having good knowledge compared to the other age groups. There is a lack of literature discussing the significant relationship between these two age groups and the level of knowledge towards COVID-19 immunisation. Nonetheless, we believe that the clinical students are also mainly in this age group. Hence, this result can support the fact that the proportion of good knowledge is significantly higher among clinical students compared to preclinical students. The result is similar to a study by Habib et al. among medical students in Saudi Arabia which stated that clinical students have greater knowledge towards the COVID-19 vaccine compared to preclinical students (30). This may be caused by clinical students having more exposure towards COVID-19 cases in hospitals which allowed them to have a higher understanding and knowledge regarding the COVID-19 vaccines (30). Another reason for clinical students having better knowledge towards COVID-19 immunisation is that the preclinical students are still in their first few years of medical school, hence, their knowledge towards immunisation and vaccines, in general, may be poorer and not as in-depth compared to clinical students who are in their last few years of medical school.

Ethnicity was significantly associated with the level of knowledge towards COVID-19 immunisation among

medical students in the four public universities in Malaysia. Indians had a higher probability of having good knowledge. This might be due to the proportion of racial distribution of respondents in this study. However, there is a lack of literature discussing the significant relationship between ethnicity and the level of knowledge towards COVID-19 immunisation.

Factors associated with the level of knowledge towards COVID-19 immunisation

In terms of knowledge and attitude towards COVID-19 immunisation, more than half of the respondents demonstrated good levels. This may be due to medical students having prior knowledge regarding vaccinations as they must attend basic clinical courses such as microbiology and immunology where they develop a certain understanding of the mechanism of action and other possible complications of vaccines (9). 60.2% of our respondents had adequate knowledge towards COVID-19 immunisation which is close to the result of the study by Gao et al. (31) that showed medical students had a higher level of knowledge (65.3%) when compared to non-medical students (53.6%).

The proportion of good knowledge is significantly higher among clinical students compared to preclinical students. The result is similar to a study among medical students in Saudi Arabia which stated that clinical students have greater knowledge of the COVID-19 vaccine compared to preclinical students (32). This may be caused by clinical students having more exposure to COVID-19 cases in hospitals which allowed them to have a higher understanding and knowledge regarding the COVID-19 vaccines (32).

Other socio-demographic factors which include gender, university and history of COVID-19 infection had no significant association with the level of knowledge towards COVID-19 immunisation. These findings were supported by a lack of literature discussing their relationship with the level of knowledge towards COVID-19 immunisation. However, the absence of a significant association between university and level of knowledge may be explained by the standard of medical courses in these four public universities which are on par with each other. Therefore, the students from these universities have similar knowledge towards immunology subjects in general which can be demonstrated through their level of knowledge towards COVID-19 immunisation.

Factors associated with the level of attitude towards COVID-19 immunisation

Our study showed that there was no statistically significant association between all sociodemographic factors (age, gender, ethnicity, year of study, university, history of COVID-19 infection) and the level of attitude towards COVID-19 immunisation. Firstly, in terms of clinical and preclinical students, our study did not show any association towards the level of attitude toward COVID-19 vaccination. On the contrary, Habib et al. (30) indicate a substantially negative attitude towards the COVID-19 vaccine among preclinical students and more positive attitudes among clinical students. In support of our findings, Szmyd et al. (33) reported that the level of attitude towards COVID-19 immunisation shows a significant association with the academic years of medical students. This may be the fact that active educational strategies, such as case-based learning or hands-on clinical experience, are more successful in fostering favourable attitudes toward the COVID-19 vaccine in medical students during their clinical years than passive educational strategies, such as lectures during their preclinical years (33).

Factors associated with the level of practice towards COVID-19

As for practice, the 100% success rate of vaccination and vaccine acceptance among medical students can be explained by a few factors. Firstly, according to the Standard Operating Procedure (SOP) listed by the Ministry of Education, students who will return to the campus by October 2021 will need to be fully vaccinated (34). To support this, about 66% of public university students have been vaccinated by 14th September 2021 (35, 36). There is also an initiative launched by the Ministry of Education which aims for a 100% vaccination rate among students in the Institute for Higher Education (IPT) by the end of October 2021 (36). Since our survey was distributed around the timeframe of April 2022, we believe this can be the contributing factor to the 100% vaccination rate. Furthermore, getting vaccinated is also a requirement proposed by every university, especially for returning students who will be having physical classes in the labs and other forms of physical learning such as medical studies. In our study, all of the respondents were either fully vaccinated (16.2%) or had received the booster dose (83.8%). These findings are supported by a previous study on the acceptability of a COVID-19 booster dose among osteopathic medical students which the majority of their respondents have accepted the booster dose (70.2%) (37). Medical students are more likely to be updated on the pandemic, available vaccines and emerging variants in medical school, hence, they are more aware of the waning response of the first two doses of the COVID-19 vaccines and the increasing rate of the COVID-19 virus transmission. Thus, their respondents who were medical students have a higher understanding regarding the requirement of booster doses to achieve a higher level of protection against the COVID-19 infection.

Pelan Pemulihan Institut Pendidikan Tinggi (PEMULIH IPT) which was followed by UPM is an example that requires all students to be vaccinated before resuming physical classes on campus (38). Moreover, according to the Special Committee on COVID-19 Vaccine Supply (JKJAV), adults aged 18 and above which include medical students are listed in the third phase of Malaysia's National COVID-19 vaccination programme which commences from May 2021 to February 2022 (19, 20, 34). Thus, this information

further explains the findings of our study. Our study also reported that there was a significant correlation between years of study (preclinical vs clinical), age and ethnicity towards COVID-19 immunisation. However, there was no association between sociodemographic factors, history of COVID-19 infection and level of attitude and practice towards COVID-19 immunisation.

Our results are in contrast with a study by Wong et al. (24) which was conducted in a private university in Malaysia. The findings revealed that 25% were COVID-19 vaccine hesitant/refusal whereas our study reported a 100% success rate of vaccination and vaccine acceptance. However, there are several differences between the previous study and our current study as stated as the limitation in the study by Wong et al. A few factors such as the timeframe of study and vaccination exposure should also be considered. For example, the previous study was conducted in March 2021 when most classes were conducted online and the requirement for vaccination was not as important as it is in the year 2022. Moreover, during the early introduction to the COVID-19 vaccine, the presence of negative stereotypes and conspiracy theories may have also influenced participants' acceptance of the vaccine. Furthermore, the earlier study was conducted at a local private medical school and therefore it may affect the feasibility of generalisability. The sociodemographic distribution variation includes the majority of respondents who were of Chinese ethnicity (53.2%) and from clinical years (64.1%). As opposed to our current study which had the majority of respondents were Malay ethnicity (70.3%) and almost similar distribution of preclinical (50.4%) and clinical years (49.6%). Furthermore, the questionnaires used between both studies were different and the time point of the survey was different, which was important because information and awareness are not much extensive earlier on as compared to the present study. Initiatives from the government were also not as evident as they were soon after. In addition, Wong et al. (24) only included medical students from one private university whereas our study population included medical students from four public universities from different regions in Peninsular Malaysia. Our current study is able to show a higher representation of medical students in Malaysia. Thus, the vast difference between both the studies conditioned them differently and is not designed to make a justified comparison. However, further studies should be conducted to assess the level of practice towards COVID-19 immunisation in these two groups.

Association between knowledge and attitude; attitude and practice; and knowledge and practice towards COVID-19 immunisation

There was also no association between the level of knowledge with a level of practice; the level of knowledge with a level of attitude; and the level of attitude with the level of practice towards COVID-19 immunisation. Since all 427 respondents have a good practice, we were not able to measure the association between the level of attitude and level of practice towards COVID-19 immunisation. In contrast, a study reported that the majority who were vaccine-hesitant or refused COVID-19 vaccination had poor knowledge and attitude (5). Conversely, the majority who accepted the COVID-19 vaccination portrayed good knowledge and showed a positive attitude (5). This situation can further support the importance of educational programmes in spreading useful vaccination knowledge and attitude to achieve the maximum rate of vaccine acceptance which can then lead to herd immunity.

Conclusion

In conclusion, almost two-thirds of medical students had good knowledge and a positive attitude and all participants were vaccinated in these four public medical schools in Malaysia. Clinical students had a higher proportion of good knowledge as compared to preclinical students towards COVID-19 immunisation. Sociodemographic factors of age group; 21 to 24 years old and 25 to 29 years old and Indians ethnicity had a higher probability of having good knowledge but none with the level of attitude and practice towards COVID-19 immunisation.

Study strength

According to our knowledge, our study is one of the few that investigate the level of knowledge, attitude, and practice of the COVID-19 immunisation section among medical students in four public universities in Malaysia. Most of the studies that were published are on COVID-19 infection in general instead of COVID-19 immunisation specifically. Furthermore, by investigating the level of knowledge, attitude and practice of COVID-19 immunisation among medical students, our study is able to estimate the awareness and readiness of medical students who are going to be future healthcare providers to advocate for vaccination programs in Malaysia.

Clinical implications

Our study reported that the level of knowledge towards COVID-19 immunisation among medical students was adequate in the four public universities in Malaysia. However, preclinical students had poorer knowledge towards COVID-19 immunisation as compared to clinical students. Thus, universities should consider having more educational talks or programs on COVID-19 immunisation for preclinical students so that they can have the same level of knowledge towards COVID-19 immunisation as the clinical students.

Limitations

This study was subjected to several limitations. This study was a cross-sectional survey that measured the association of level of knowledge, attitude and practices towards COVID-19 immunisation among medical students in four public universities. Therefore, the results obtained from this study represent the association of the level of knowledge, in medical students towards COVID-19

immunisation. Moreover, the result could be affected by non-response bias as students tend to disregard the research surveys conducted through email or social media from their university as well as other universities. Furthermore, this study also faced response bias whereas the students who answered the survey may be caused by their desirability. In addition, there was a lack of sociodemographic characteristics that were assessed which will hinder a significant result. In terms of our methodology, the sampling may become biased because most of them should receive their vaccines before they can attend face-to-face learning sessions at the university. This is a prominent limitation of the study that should be considered before the questionnaire is designed for medical students since it is a requirement for them to take their vaccines before returning to the campus.

Recommendations

The results obtained were affected by several limitations, and there are some possible ways to overcome these limitations in future work. To represent all medical students in Malaysia, a wider target population can be proposed. For example, by including all public universities that offer medical courses including those in Sabah and Sarawak. The sample population should also include non-medical students for better findings especially to assess the association for the level of practice towards COVID-19 immunisation. The study should also assess the association between the level of knowledge, attitude, and practice towards COVID-19 immunisation amongst medical students and their households. In addition, further studies need to be explored more to support the outcome of the research.

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Competing interests

The authors claim to have no conflicts of interest.

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