



Research article

Indonesia medical students' knowledge, attitudes, and practices toward COVID-19



Jenny J.S. Sondakh^{a,*}, Widya Warastuti^b, Budi Susatia^a, Moh. Wildan^a, Bernadus Rudy Sunindya^a, Moch. Agus Krisno Budiyanto^c, Ahmad Fauzi^c

^a Politeknik Kesehatan Kementerian Kesehatan Malang, Indonesia

^b Politeknik Kesehatan Kementerian Kesehatan Palangka Raya, Indonesia

^c Universitas Muhammadiyah Malang, Indonesia

ARTICLE INFO

Keywords:

COVID-19
KAP survey
Medical students
Knowledge
Attitudes
Practices

ABSTRACT

Implementing health protocols and preventive measures are the only effective ways to suppress COVID-19 transmission before vaccines and antiviral drugs are developed. The implementation of health protocols and preventive measures are influenced by one's knowledge, attitudes, and practices (KAP) toward this pandemic. Medical students as candidates for healthcare workers and role models for the community should have a good KAP. This study intends 1) to explore the KAP of medical students in Indonesia toward COVID-19 and 2) to assess which demographic factors have a significant effect on their KAP scores. An online questionnaire consisting of 18 items of knowledge, six items of attitudes, and 12 items of practices were used as instruments in this study. After being distributed for two weeks in June 2020, 525 respondents whose data were worth analyzing were obtained. The respondents consisted of male and female students, from diploma to bachelor degree, and came from all four types of higher education institutions in Indonesia. The results, 48% of respondents had good knowledge, 81% had good attitudes, and 43.5% had good practices toward COVID-19. The location of students' residence has no significant effect on their KAP score. Gender has a significant effect on knowledge and practice scores. Age, institution type, and institution status have a significant effect on their three KAP domains. The KAP survey results can be used as a reflection of the importance of the curriculum that prepares medical students for the pandemic. Medical students are also expected to be able to actively participate in educating people around them on how to minimize the transmission of COVID-19 during the pandemic.

1. Introduction

Coronavirus 2019 (COVID-19) is an infectious disease caused by SARS-CoV-2 (El Zowalaty and Järhult, 2020; C. Li et al., 2020). It was first identified in Wuhan, China in December 2019 (Singhal, 2020; Wang et al., 2020; D. Wu et al., 2020). COVID-19 attacks the respiratory system with fever, tiredness, trouble breathing, cough, and temporary loss of smell and taste as common symptoms of this disease (T. Li et al., 2020; Singhal, 2020). In severe conditions, COVID-19 can cause pneumonia and damage to various body organs and thereby increasing the mortality risk (Lai et al., 2020). The high transmission rate, the incubation period that takes days, and the number of asymptomatic people infected caused the rapid spread of the virus (Dietz et al., 2020; Lai et al., 2020; F. Ye et al., 2020). Hence, it does not require a long time for this epidemic that starting from China to upgrade into a global pandemic that spreads across

continents. It was reported, until July 4, 2020, that more than 11 million cases from 188 countries had been officially published and caused more than 500,000 loss of life.

COVID-19 can be transmitted from humans to humans either through direct contact (Bulut and Kato, 2020) or through objects (Guo et al., 2020; D. X. Zhang, 2020). Transmission through direct contact can occur because SARS-CoV-2 can be transmitted via droplets produced by sneezing, coughing, or talking (D. Wu et al., 2020). The droplets can spread through the air and float in the air for up to 10 min (Morawska and Cao, 2020). When the droplets are inhaled by people nearby, they might be infected with COVID-19. Besides, the droplets can also fall onto the surface of various objects and last for several days on these objects (Razzini et al., 2020; G. Ye et al., 2020). When the object is touched, then the person rubs his eyes or touches his mouth, the virus can infect his body. Since vaccines or antiviral drugs have not yet been identified,

* Corresponding author.

E-mail address: jenny_jeltje@poltekkes-malang.ac.id (J.J.S. Sondakh).

<https://doi.org/10.1016/j.heliyon.2021.e08686>

Received 26 July 2020; Received in revised form 4 April 2021; Accepted 23 December 2021

2405-8440/© 2021 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

keeping the distance and staying at home are campaigned by WHO and governments in each country to reduce the transmission rate of COVID-19 (Chu et al., 2020; Kim, 2020; H. Wu et al., 2020).

In Indonesia, keeping a safe distance and implementing other preventive measures are health protocols emphasized by the central and regional governments (Soderborg and Muhtadi, 2020). The country that confirmed its first COVID-19 case in March 2020 prefers to implement a "new normal" policy by relying on the "awareness" of the community to implementing the discipline health protocol in their daily activities (Djalante et al., 2020). The problem arises that some people in Indonesia are indicated as not having enough knowledge related to COVID-19 (Fauzi et al., 2020). Public response on social media shows that many of them accuse the conspiracy behind COVID-19 more than they believe the scientific evidence and government recommendations. To make it worse, many people are not disciplined in implementing health protocols even though they believe in COVID-19 (Yanti et al., 2020). Whereas, the number of positive cases and fatalities due to COVID-19 is increasing day by day. It was reported that until July 2020, the number of cases has passed of more than 60,000 with more than 3000 deaths.

As the number of patients, the rate of misinformation, and the number of people with confusion increase, the existence of role models will have a significant impact on the community. One group that can be a role model in this pandemic are those coming from a healthcare background, both healthcare workers and medical students. Healthcare workers are indirectly responsible for providing knowledge, modeling daily routines, and preventing people from getting sick (Darch et al., 2017; Rachlis et al., 2016; Trause et al., 2014), especially during the pandemic period. On the other hand, medical students are often considered as healthcare workers who are still in the training period. The health education programs are expected to produce graduates with good knowledge, attitudes, and practices (KAP) during the pandemic. Thus, their educational process should set them up to behave and act in the pandemic. However, this kind of program only makes up a small portion of the overall curriculum. Therefore, KAP evaluation needs to be carried on medical students.

The KAP survey is an essential survey that needs to be carried out during a pandemic (Saefi et al., 2020b). KAP survey is a three-empirically supported construct used to understand healthcare workers' and medical students' behavior change (Chandler, 2018; Raina, 2013). KAP survey is also important because it can identify basic knowledge, misconceptions, beliefs, behavior, to the respondent's attitude towards disease (Andrade et al., 2020). Insights, habits, and perspectives of medical students in dealing with a pandemic can also be evaluated through this survey (Noreen et al., 2020). With a good KAP, medical students will have a positive impact in dealing with the pandemic. They can influence the health status and perceptions of their friends and family because they are considered a trusted source of health information (Gohel et al., 2021). Their attitudes and practices during the pandemic will be noticed by the surrounding community. In addition, in this era full of misinformation, health campaigns are also expected to optimize the involvement of medical students (Noreen et al., 2020). To meet these expectations, KAP students also need to be evaluated before campaigning for a good lifestyle. Therefore, in turn, students with good KAP can become agents of change in their families and communities (Ajilore et al., 2017).

The collapse of the health system has also become a serious problem in the midst of the COVID-19 pandemic. Many hospitals require additional health workers due to a large number of COVID-19 patients. The increasing number of health workers who are infected with COVID-19 also worsens the condition. Due to the increasingly overwhelmed hospitals, experts also recommend calling retired doctors to return to duty (Mahase, 2020). The pandemic has also turned health education upside down (Miller et al., 2020). The distance learning policy causes the quality and educational experience obtained by health students to be not optimal. Several health schools have also carried out the repatriation of students from hospitals due to the high risk of COVID-19 transmission (Stokes, 2020). Such condition also raises concerns in students regarding

the decline in their skills to the uncertainty of graduation time (Gallagher and Schleyer, 2020).

Although some medical schools prohibit student interaction with patients during the pandemic (Lincango-Naranjo et al., 2021), the involvement of students as a COVID-19 team is a solution to the unavailability of sufficient health workers (Stokes, 2020). This decision could also address health student education which was temporarily suspended due to the closure of educational institutions during the pandemic. However, health schools must also ensure the safety of their students (Gallagher and Schleyer, 2020). Without an adequate KAP, the involvement of students in the hospital will be an additional vector of virus transmission (Miller et al., 2020). Therefore, the KAP survey will ensure the readiness of students to take part in dealing with the COVID-19 pandemic.

Due to the importance of the KAP overview during this current pandemic, various researchers in various countries conducted KAP surveys with a variety of subjects. However, to date, until July 5, 2020, search engine results through Google informed that only 22 KAP surveys had been published in international journals. Of the surveys, only three publications involved medical students as research subjects (Alzoubi et al., 2020; Hamza et al., 2020; Maheshwari et al., 2020). KAP survey toward COVID-19 had also been conducted twice in Indonesia. However, one survey involved non-medical undergraduate students (Saefi et al., 2020a), while another survey only limited their scope in social distancing topic (Yanti et al., 2020). Thus, this study aimed 1) to evaluate the knowledge, attitudes, and practices of Indonesian medical students towards COVID-19 and 2) to analyze the influence of respondents' demographics on their KAP scores. The results of this study will be fruitful as a useful guide for designing the curriculum in various health majors.

2. Method

2.1. Research design and participant

This survey was intended to draw the initial responses of medical students' to COVID-19 in the first three months of this pandemic hit Indonesia. Therefore, a quick survey with a target number of 500 respondents was targeted to be finished in two weeks (3–17 June 2020). The target respondents were medical students who come from institutions around East Java, Indonesia. As this is a knowledge and perception assessment quick survey, the target population size in this study was 10,000. Therefore, based on the Krejcie and Morgan table, the sample size with a 95% confidence level and 5% margin of error is 370 respondents.

During the data collection period, COVID-19 outbreaks have raided all provinces in Indonesia. Several higher education institutions have instructed students not to return to their hometowns even though these institutions have implemented online learning during the pandemic. Thus, it was not possible to carry out direct survey sampling in the institution. Therefore, this study applied an online survey for data collection. The instruments were then copied into Google Form. The survey link was then distributed to health lecturers in East Java via WhatsApp. Furthermore, the lecturers conveyed the survey link to their students. Respondents were not limited to one type of higher education institution; they came from all four types of institutions in Indonesia (colleges, polytechnics, universities, and academies). The criteria for respondents were diploma or bachelor degrees medical students (not students from a master or doctoral degree). Respondents in this survey were confirmed to be Indonesian citizens, in good health condition, aged 15 years and over, and were willing to participate in this study. The inclusion criteria for respondents were medical students, Indonesian citizens, aged 15 years and over, and were willing to participate in this study. The exclusion criteria for respondents were students from a master or doctoral degree, not a medical student, already dropped out, non-student status, and does not provide complete demographic information.

2.2. Instruments and data collection procedures

The instrument used in this survey was the SKAPCOV-19 questionnaire developed by Saefi et al. (2020). The instrument consists of four parts: (1) demographic profile of respondents consisting of a residence, gender, age, length of study at a higher education institution, level of education, type of tertiary institutions, and institution status; (2) 18 items on knowledge of respondent's on the etiology, symptoms, risk groups, transmission, and prevention of COVID-19; (3) 6 items on attitudes toward the respondent's information receiving and social interaction related to COVID-19 pandemic; and (4) 12 item items on practices that measure respondents' behavior in implementing health protocols during the pandemic. Each item in the knowledge domain asks respondents to determine the truth of the information written on the questionnaire by choosing one of three choices, namely (1) yes, (2) no, and (3) do not know. As for items in the attitude domain, respondents were asked to determine the level of agreement of each statement written on the questionnaire by choosing one of three choices, namely (1) agree, (2) not sure, and (3) disagree. In the items in the practice domain, respondents are asked to choose what describes their habits during the pandemic by choosing one of three choices, namely (1) always, (2) sometimes, and (3) never.

The results of the instrument analysis informed that all items in SKAPCOV-19 had a CVI > 0.80 so that all items were declared essential in measuring KAP. The result of factor analysis also states that all items have a significant value of λ ($p < 0.05$). The item reliability for the three domains was very good (Real RMSE of 0.97 for the attitudes, 0.98 for the knowledge, and 0.99 for the practice domains.) and with a separation index value > 0.20. The results of the rating scale diagnostic also state that the choice of response in each item does not confuse respondents. The Andriect threshold and logit value of the response categories increases monotonically and moves according to the expected directors. The instruments also has acceptable infit and outfit MNSQ fit statistics.

2.3. Data processing and analysis

Survey data were downloaded in .csv format and checked by the authors before being analyzed. Microsoft Excel and SPSS software were employed for data analysis. Demographic data were analyzed using frequency and percentage. The percentage of each option in each KAP item was calculated. The KAP data was converted to a binary of the accuracy of answering items in the knowledge domain, the positive responses in the attitude domain, and the discipline of implementing positive habits in the practice domain was labeled with a score of 1. On the other hand, inaccuracy in answering items in the knowledge domain, the negative responses in the attitude domain, and the indiscipline of implementing positive habits in the practice domain were labeled with a score of 0. When the respondent chose the "don't know" option in the knowledge domain, then the responses were grouped as incorrect answers since it indicated that the respondent did not known the information asked. Likewise, when the respondent chooses the "not sure" response in the attitude domain, this response will be given a score of 0. This scoring has been adjusted to the scoring procedure that was informed by the research team that developed this SKAPCOV-19 instrument (Saefi et al., 2020a).

Knowledge, attitudes, and practice scores were calculated by summing up the scores of all items and converted to a score of 0–100. The scores of these three aspects were categorized into "good" and "poor" based on the Bloom cut-off point. The respondent's score was categorized as "good" if the respondent can answer at least 80% of the items correctly, while if it does not reach 80% it would be categorized as "poor". The percentage of respondents categorized as "good" and "poor" in each KAP domain was presented in the form of a pie graph. Furthermore, one-way ANOVA was used to determine the differences in mean scores based on demographic characteristics. The significance level used in this study was 0.05.

2.4. Ethical approval

Ethical approval was obtained from the Politeknik Kesehatan Kemenkes Malang. Respondents' participation was entirely consensual and anonymous. Participants must confirm their willingness to participate voluntarily before completing the KAP survey. Respondents were informed that they could withdraw from this study by not completing the KAP questionnaire.

3. Results

3.1. Respondent's characteristics

There were 545 diploma and undergraduate students filled out KAP questionnaires. Of all the responses collected, 525 participants fulfilled the study's criteria were obtained. More than 50% of respondents were from urban areas, the majority of them were female, and 58.7% of respondents were over 20 years. Most respondents were third-year medical students, while the least was fifth-year students. 68.6% of respondents were diploma students, while the remaining 31.4% were undergraduate students. Based on the institution, 69.7% of respondents were polytechnic students and the majority of their institutions were public institutions (74.1%). In more detail, the respondents' demographic information is presented in Table 1.

3.2. Knowledge toward COVID-19

The mean accuracy of medical students' answers in the knowledge domain was 80.14 (SD 9.98). The range score of the knowledge domain was 22.2–100. Of the 525 respondents, only 48% were categorized as good, while the remaining 52% were categorized as poor (Figure 1). Of the 18 items, the fourth item was the highest incorrect answer rate. The item asks about those who are at risk of severe conditions when infected

Table 1. Demographics of medical students involved in this study (n = 525).

Variable	Freq (n)	%
Place of current residence		
City	198	37.7
Rural	327	62.3
Gender		
Male	18	3.4
Female	507	96.6
Age		
≤20	217	41.3
>20	308	58.7
Spent year in higher education		
1 year	78	14.9
2 year	48	9.1
3 year	157	29.9
4 year	124	23.6
5 year	44	8.4
>5 year	74	14.1
Educational stage		
Diploma	360	68.6
Bachelor	165	31.4
Higher Education Institution		
Colleges	125	23.8
Polytechnic	366	69.7
University	22	4.2
Academy	12	2.3
Institutional status		
Public	389	74.1
Private	136	25.9

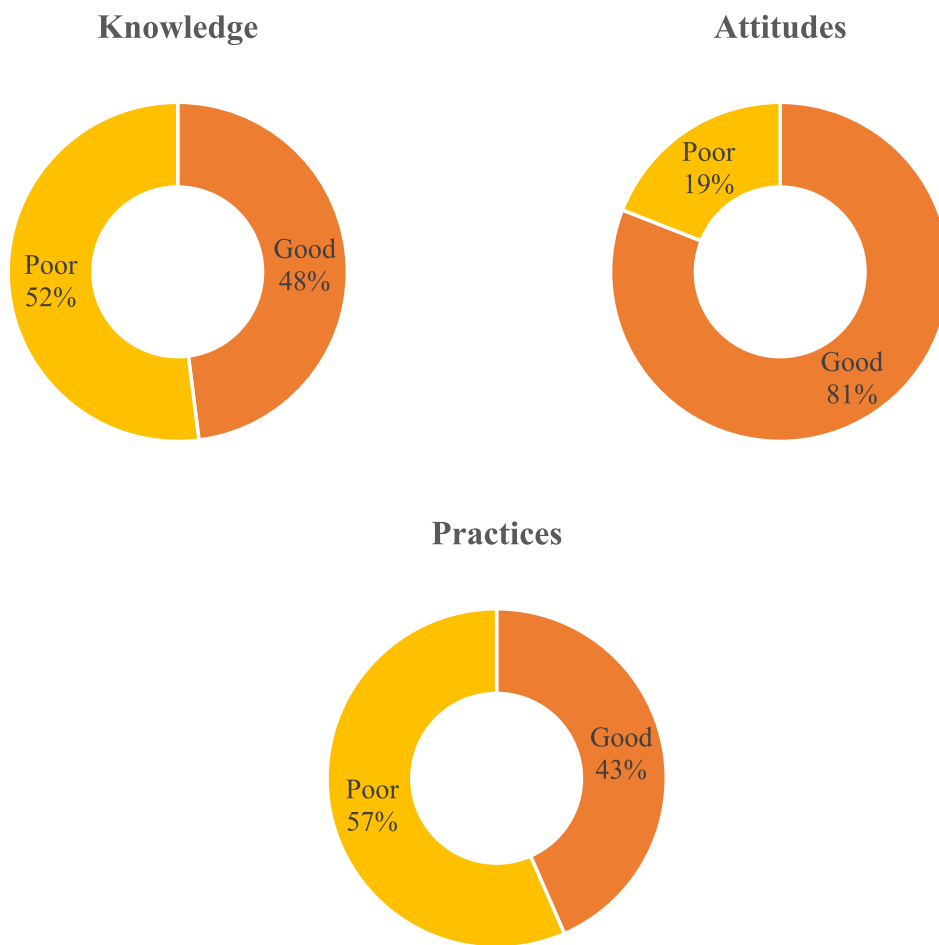


Figure 1. Profile of medical students' KAP score.

with COVID-19. On the other hand, item 12 was the item that gets most responses “do not know”. The item asks relates to COVID-19’s penetration through a cloth mask. Furthermore, nine items had a correct answer

Table 2. Profile of medical students’ knowledge toward COVID-19.

Item	Do not know		Incorrect		Correct	
	Freq (n)	%	Freq (n)	%	Freq (n)	%
K1	4	0.8	13	2.5	508	96.8
K2	6	1.1	12	2.3	507	96.6
K3	8	1.5	5	1.0	512	97.5
K4	21	4.0	438	83.4	66	12.6
K5	22	4.2	19	3.6	484	92.2
K6	8	1.5	31	5.9	486	92.6
K7	25	4.8	267	50.9	233	44.4
K8	27	5.1	62	11.8	436	83.0
K9	14	2.7	40	7.6	471	89.7
K10	36	6.9	55	10.5	434	82.7
K11	43	8.2	70	13.3	412	78.5
K12	67	12.8	232	44.2	226	43.0
K13	28	5.3	216	41.1	281	53.5
K14	14	2.7	10	1.9	501	95.4
K15	3	0.6	11	2.1	511	97.3
K16	0	0	13	2.5	512	97.3
K17	7	1.3	47	9.0	471	89.7
K18	1	0.2	2	0.4	522	99.4

rate of more than 90%. These items ask about the causes, symptoms, and preventive measures for the transmission of this disease (Table 2).

3.3. Attitude toward COVID-19

The score for the attitude domain was 68.25 (SD = 11.4) ranging from 0 to 100. There were 81% of medical students in the “good” category, while the remaining 19% were categorized as “poor” (Figure 1). Of the six items, the second item had the lowest percentage of positive responses of 52.8%. This item related to the students’ feelings after listening to information related to COVID-19. Many of them become agitated after hearing such information. On the contrary, the sixth item had the highest positive response of 98.3%. These items are the statement related to the responsibility of COVID patients in performing self-isolation to minimize the COVID-19 transmission rate. The fourth item of the statement whether all people infected with COVID-19 are those who have violated government calls are items with the highest “not sure” (Table 3).

Table 3. Profile of medical students’ attitudes toward COVID-19.

Item	Disagree		Not sure		Agree	
	Freq (n)	%	Freq (n)	%	Freq (n)	%
A1	3	0.6	43	8.2	479	91.2
A2	277	52.8	196	37.3	52	9.9
A3	3	0.6	9	1.7	513	97.7
A4	139	26.5	287	54.7	99	18.9
A5	8	1.5	26	5.0	491	93.5
A6	2	0.4	7	1.3	516	98.3

3.4. Practices toward COVID-19

The mean score of the practice domain was 79.98 (SD = 16.35) ranging from 8.33 to 100. Only 43.5% of respondents were categorized as good while the rest 56.5% was categorized as poor. 8.8% of 525 medical students had never taken any vitamin to boost their immune. Using masks, doing physical distancing, washing hands regularly, cleaning the house more routinely, and washing hands with soap are habits by more than 94% of medical students. However, only 35.2% of students exercise and 45.5% of students consume vitamins regularly (Table 4).

Table 4. Profile of medical students' practices toward COVID-19.

Item	Never		Occasionally		Always	
	Freq (n)	%	Freq (n)	%	Freq (n)	%
P1	0	0.0	8	1.5	517	98.5
P2	0	0.0	27	5.1	498	94.9
P3	6	1.1	60	11.4	459	87.4
P4	0	0.0	13	2.5	512	97.5
P5	11	2.1	100	19.0	414	78.9
P6	10	1.9	168	32.0	347	66.1
P7	1	0.2	92	17.5	432	82.3
P8	2	0.4	93	17.7	430	81.9
P9	26	5.0	314	59.8	185	35.2
P10	46	8.8	240	45.7	239	45.5
P11	0	0.0	30	5.7	495	94.3
P12	0	0.0	14	2.7	511	97.3

3.5. Factors influencing KAP

The results of the ANOVA reported that gender, age, level of education, institution type, and institution status had a significant effect on student knowledge (Table 5). Female students have significantly higher knowledge than male students. Students whose ages are over 20 have scores that are significantly higher than students less than 20 years. Undergraduate student knowledge was also higher than diploma students. Students from public institutions have higher knowledge scores from private institutions. In addition, it was revealed that college students have significantly lower knowledge than students of polytechnic, universities, and academies.

In the attitudes domain, significant differences were found in the age, level of education, type of institution, and status of the institution (Table 5). Students aged more than 20 years old, undergraduate students, and students from public institutions have better scores than the comparison group. In addition, significant differences were also found in the length of students studying in tertiary institutions in which students who have studied for five years have a significantly higher attitude than those who have studied for two years, three years, or more than five years.

Significant differences in the practice domain were found in the gender, age, length of study, type of institution, and status of the institution. Female students have better habits than male students. Students aged more than 20 have better habits than students less than that age. Students from public institutions have significantly better practices than private students. Students who study at the academy have significantly higher practices than college and university students but are not significantly different from polytechnic students.

Table 5. Differences in KAP scores of medical students in each demographic character.

Variables	Freq (n)	Knowledge score		Attitude score		Practice score	
		Mean (SD)	F	Mean (SD)	F	Mean (SD)	F
Place of current residence							
City	198	80.42 (9.914)	0.246	67.76 (11.643)	0.594	80.89 (16.031)	0.98
Rural	327	79.97 (10.037)		68.55 (11.26)		7.43 (16.547)	
Gender							
Male	18	75.00 (12.676)	4.973*	68.52 (26.127)	0.01	68.98 (26.167)	8.558**
Female	507	80.32 (9.841)		68.25 (10.568)		80.37 (15.796)	
Age							
≤20	217	77.98 (10.364)	17.785**	66.82 (11.339)	5.903*	76.34 (17.042)	18.951**
>20	308	81.66 (9.432)		69.26 (11.356)		82.55 (15.369)	
Spent year in higher education							
1 year	78	79.56 (9.153)	1.497	69.66 (13.089)	2.323*	75.43 (16.876)	2.399*
2 year	48	80.67 (7.426)		66.67 (9.096)		80.38 (12.805)	
3 year	157	79.30 (11.575)		67.20 (10.910)		81.37 (14.863)	
4 year	124	81.41 (8.706)		68.95 (10.906)		82.59 (15.618)	
5 year	44	82.45 (8.635)		72.35 (13.895)		78.97 (20.997)	
>5 year	74	78.68 (11.112)		66.44 (10.502)		77.82 (18.104)	
Educational stage							
Diploma	360	79.55 (10.292)	3.956*	67.36 (10.787)	7.106**	80.48 (15.667)	1.079
Bachelor	165	81.414 (9.175)		70.20 (12.454)		78.89 (17.762)	
Higher Education Institution							
Colleges	125	75.11 (12.534)	15.096**	65.47 (11.236)	5.270**	74.13 (16.526)	12.629**
Polytechnic	366	81.79 (8.436)		69.54 (10.547)		82.51 (14.601)	
University	22	80.56 (9.660)		64.39 (21.390)		68.94 (27.839)	
Academy	12	81.48 (7.615)		65.28 (4.811)		84.03 (15.674)	
Institutional status							
Public	389	81.71 (8.502)	39.762**	69.37 (11.122)	14.653**	81.83 (15.575)	19.900**
Private	136	75.65 (12.322)		65.07 (11.632)		74.69 (17.404)	

* p-value < 0.05, ** p-value < 0.01.

4. Discussion

This study shows that more than 50% of medical students have “poor” knowledge related to COVID-19. The finding is not in line with research in Egypt which reported that 72.5% of pharmacy students had a good knowledge of COVID-19 (Hamza et al., 2020). This difference could be due to the study in Egypt only involved final year medical students from the pharmacist study program, while this present study involved students from several institution types, study programs, and academic levels. The first-year students, diploma students, and students from other programs also influence the final percentage of the data obtained in this present study. The percentage obtained in this study is lower than the KAP survey involving healthcare workers in China (M. Zhang et al., 2020), Vietnam (Giao et al., 2020) and Pakistan (Saqlain et al., 2020) that more than 88% of respondents are categorized into having good knowledge. However, the percentage obtained in this study is higher than the KAP survey toward COVID involving patients in the hospital in Ethiopia (Akalu et al., 2020). The higher percentage of healthcare workers because they have been directly involved in medics for a long time. On the other hand, studies involving medical students in India (Maheshwari et al., 2020) and Jordan (Alzoubi et al., 2020) do not present the percentage of the respondents having good knowledge of COVID-19.

Based on the findings in this study, almost all medical students (94%) understood that isolation and treatment of people infected with COVID-19 is an effective way to suppress the spread of the disease. The finding is in line with the results of researches on medical students in India (Maheshwari et al., 2020) and Egypt (Hamza et al., 2020). KAP surveys conducted involving communities in other countries also report similar findings, such as in Malaysia (Azlan et al., 2020) and Saudi Arabia (Al-Hanawi et al., 2020). These findings indicate that communities ranging from healthcare workers, medical students, to the public acknowledge the importance of medical treatment and isolation on COVID-19 patients. In addition, this current study and previous studies in various countries confirm that the majority of respondents already know that COVID-19 can be prevented by not going to the crowd or traveling across the city.

The analysis results showed that more than 95% of medical students know the main symptoms of COVID-19. This percentage is higher than research involving medical students in India (Maheshwari et al., 2020) and Egypt (Hamza et al., 2020). The percentage is also higher than Giao's research involving healthcare workers (72.8%). Public knowledge of the main symptoms of COVID-19 is reported in Saudi Arabia (Al-Hanawi et al., 2020), Malaysia (Azlan et al., 2020), and Pakistan (Hayat et al., 2020). The difference in data collection period may be a factor contributing to the percentage difference, considering that COVID-19 is still a new disease that is often difficult to distinguish from the common cold.

On the one hand, knowledge regarding who is at risk of the severe condition and who can be infected with COVID-19 are still quite low. More than 50% of respondents do not know that severe conditions due to COVID-19 can not only occur in the elderly and those with weak immune systems. This knowledge is important since it can increase medical student's awareness of the risks of COVID-19. With the misleading thought, they will underestimate this disease. Based on previous report, young people can also get critical conditions after being infected with COVID-19 (Lawton, 2020). In addition, although the immune system looks good, everyone is potentially being infected by this disease.

Further, 81% of students have a good attitude even though the mean score of 525 students is only 68.25. This percentage is higher than the survey conducted on medical students in Jordan (Alzoubi et al., 2020) but lower than the healthcare workers in Vietnam (Giao et al., 2020). It is worth noting that the items asked in the attitudes domain vary from one study to another. Furthermore, more than 90% of medical students have positive attitudes regarding the importance of updating information related to COVID-19 (the first and second items), no need to give a negative stigma (the fifth item), and appreciate people willing to self-isolate (sixth item). Unfortunately, nearly one-fifth of respondents

thought that all COVID-19 patients were people who had violated government calls, and nearly one-tenth of those felt anxious after hearing the updated information about COVID-19.

In the practice domain, more than half of the respondents have scored in the “poor” category. This study also revealed that no more than half of the respondents regularly do some and take vitamins. Other KAP surveys did not involve this item, but a survey conducted in Jordan asked respondents whether they consumed ginger, honey, and garlic during the pandemic (Alzoubi et al., 2020). That study also reported that no more than half of the students consumed garlic and only 51% of students consumed ginger with honey. In line with that finding, research involving higher education students in Indonesia also revealed that less than 30% of Indonesian students routinely exercised during the pandemic (Saefi et al., 2020a). These findings indicate that healthy lifestyle habits through meal patterns and sports are still low since these two practices are more rarely applied to other practices, such as washing hands and wearing masks. Taking vitamins, supplements, or herbal sometimes requires money or time, and effort to find them. Even though exercise and vitamins can boost the immune system (Min et al., 2018; Pekmezci, 2011; Woods et al., 2020). With strong immune system, the body can deal the virus more optimally (Vabret et al., 2020; Woods et al., 2020).

Furthermore, wearing a mask is a practice that always done by almost all medical students (98.5%). The percentage of medical students wearing masks is higher than students in Jordan (64.7%) (Alzoubi et al., 2020), and pharmacy students in Egypt (48.5%) (Hamza et al., 2020). The mask is also still rarely worn by the public in Malaysia (Azlan et al., 2020). The higher use of masks by medical students in Indonesia is due to several possibilities. First, the Indonesian government calls on people to wear masks every day (Sari et al., 2020). Second, despite the scarcity of masks, it was soon overcome by the government of Indonesia. Third, the use of masks is related to community norms and the norm of using masks differs from one country to another. In some countries, the use of masks is commonplace, but this habit is still considered taboo in other countries (Burgess and Horii, 2012; Soderborg and Muhtadi, 2020).

In addition to wearing masks, washing hands with soap is another practice carried out by more than 95% of medical students. This finding is in line with the KAP survey involving medical students in Jordan (Alzoubi et al., 2020). The public in various countries also has high discipline related to this practice (Azlan et al., 2020; Hayat et al., 2020; Rahman and Sathi, 2020). Washing hands using soap is personal hygiene that can be the key to suppressing COVID-19 transmission (Hemida and Ba Abdullallah, 2020; Pradhan et al., 2020) in addition to minimizing contact. The hand is the most vulnerable part of the body to carry the virus since it often touches various objects. As has been reported, SARS-CoV-2 can survive in various objects for days (Kampf et al., 2020; Günter Kampf, 2020). By washing hands with soap, the virus in the hands will be pulled apart as the lipid layer in the body of the virus is destroyed by soap.

The commitment of all components of society in implementing health protocols is an important step in preventing the spread of COVID-19 before the vaccine is identified. Some neglected habits shown by medical students in Indonesia indicate the need to make Indonesians aware of the importance of healthy lifestyle habits during this pandemic. Optimizing the COVID-19 educational program is expected to increase public knowledge about the risks and prevention of this disease. The increase in knowledge will increase their positive attitudes and practice. This statement is supported by previous studies reporting a significant correlation between these domains (Rahman and Sathi, 2020; Saefi et al., 2020a; Saqlain et al., 2020). Thus, knowledge is important for a better practice toward COVID-19.

As for the demographic factors, place of current residence does not cause a significant difference in student KAP scores. The ease of access to information is the potential reason why this finding was obtained. Even in the pandemic era, students in cities and villages can access information and news anytime and anywhere. In today's digital era, information

related to COVID-19 is not only accessible from television but also social media. As part of the 21st Century generation, they can easily access information from social media. Not surprisingly, the survey results in several previous studies informed that social media is a source of information related to COVID-19 for the majority of students (Fauzi et al., 2020; Olaimat et al., 2020). However, students must be critical in receiving information because of the large number of misinformation (Cinelli et al., 2020; Cox, 2021) and conspiracy theories about COVID-19 circulating on social media (Goreis and Kothgassner, 2020; Stephens, 2020). Misinformation to hoaxes related to health has also been reported to affect their attitudes and practices in maintaining health in this current pandemic (Allington et al., 2020; Bierwiazzonek et al., 2020).

In the gender variable, female students have significantly higher knowledge and practice scores than male students. This finding is in line with other studies that have examined the effect of gender on student KAP scores against other diseases, such as KAP toward cardiovascular disease (Shen et al., 2017). This finding is also consistent with other studies examining the influence of gender on students' health knowledge (Suen et al., 2019) and practice (Gabhainn, 2000). Other studies have reported that there are differences in the performance between male and female students (Nnamani and Oyibe, 2016; Parajuli and Thapa, 2017). Female students have a good internal locus of control and learning motivation (Dabbagh and Khajehpour, 2011) and they can get better knowledge and practice scores. Gender also plays a role in the level of interest and knowledge acquisition (Evans et al., 2002). Furthermore, knowledge correlates with practice (Rahman and Sathi, 2020; Saefi et al., 2020a; Saqlain et al., 2020). Therefore, the analysis results of this study also show that the practice of females was significantly higher than male students.

Significant differences in the scores of the three KAP domains were found in age and type of institution. Students in the age group over 20 years have higher KAP scores than those under 20 years of age. Research in Ethiopia also reports that gender is a significant factor in KAP toward COVID-19 score (Wake, 2020). The KAP study toward hepatitis conducted in Pakistan also reported similar findings (Khan et al., 2010). This report is in line with other studies that have examined the effect of age on student competency levels (Momanyi et al., 2015). Older students usually will gain more knowledge to experience. The reason is, the majority of them took longer to acquire knowledge than the younger students. Therefore, their knowledge will also be broader than that of younger students. On the other hand, the difference in KAP scores on the type of institution is an interesting finding. The difference in curricula and student characteristics among the four types of institutions may be the reason for this finding.

Significant differences in KAP scores were also found in the institutional status variable. This finding is in line with various other study that have examined the influence of institutions' status on student competence in Indonesia (Hendajany, 2016). Public and private higher education in Indonesia is reported to have differences in various aspects of quality and regulation (Welch, 2007) which will be related to student input and output. The difference in KAP scores between students in public and private institutions can be caused by differences in student input from the two institutions types. In Indonesia, students with high initial competencies prefer to enter public institutions rather than private ones. The difference in student input will also affect the average competency performance of the educational institution (Newhouse and Beegle, 2005). Public institutions in Indonesia also often have more educational facilities. This condition can affect the optimal empowerment of their students' quality (Zainuddin and Subri, 2017) as well as the interest of high achieving students to apply to the institution. Furthermore, differences in the students' quality are also related to differences in learning motivation, curiosity, attitudes, and awareness. This condition can affect the differences in their KAP levels.

Apart from the suboptimal habits exhibited by medical students and various factors that influence the KAP scores of these students, students in higher education institutions are expected to be the role models who

indirectly guide the community. Unfortunately, it was only 66% of medical students who routinely involved the community-based education. This study also revealed that despite obtaining a health education curriculum, many lacked knowledge with suboptimal practices. This finding is corroborated by previous publication reporting that educational curricula in medical colleges have too small a portion in teaching students to act in the pandemic (Scott et al., 2010).

Several recommendations regarding curriculum reformulation and lecture form need to be submitted in response to the findings of this study. The health education curriculum must empower students' knowledge and behavior on how to protect themselves from disease during pandemics. Health education institutions also periodically hold training on prevention, self-protection, and efforts to break the chain of infection during the pandemic (Carney et al., 2011; O'Byrne, 2020). KAP evaluation also needs to be carried out continuously because scheduled evaluations can be used to determine program quality (Andrade et al., 2020). The development of curriculum content that facilitates additional training of students in nursing, telemedicine, and social education tasks is also recommended (Lincango-Naranjo et al., 2021). After obtaining sufficient competence, increasing the involvement of medical students in community service also needs to be improved so that they are accustomed to being involved in the community. This recommendation must be realized in Indonesian health education so that medical students can play an optimal role once pandemic occurs again in the future.

It is difficult to predict the upcoming Epidemic or pandemic, so students must also be trained to implement what they get from the education they receive in various unexpected conditions. The implementation of several innovative learnings that can empower critical thinking skills can improve these competencies, such as problem-based learning (Yuan et al., 2008) and project-based learning (Cortázar et al., 2021). Webinars and guest lectures also need to be held continuously to discuss various new diseases and other diseases that could potentially be the next pandemic. Simulation and role-playing learning methods also need to be designed to prepare students to face these diseases.

In addition, to provide a more optimal quality of learning if the next pandemic also limits face-to-face learning, it is necessary to increase the competence of faculty members in facilitating distance learning. The provision of a learning management system also plays an important role in the quality of online learning (Yunus, 2021). Training activities to improve lecturers' skills in designing online or blended learning by applying several previously recommended learning models and methods are also urgent to do. Even though the COVID-19 pandemic is over and face-to-face can be done as usual, online learning still needs to be carried out with a certain portion to habituate and increase lecturer competence in managing distance learning.

Concerning the infodemic phenomenon in the current digital era, health education also needs to prepare students who are not easily influenced by hoaxes to disseminate fake news. Improving information literacy and digital literacy of medical students is an important step to achieve this goal (Guess et al., 2020; Jones-Jang et al., 2019; Osborne, 2018). Genetic literacy also needs to be pursued because genetics application in the current pandemic era plays an important role in identifying new viruses and diagnosing patients. Their understanding of the genetic aspect will be useful in countering conspiracy theories that may also appear in the next pandemic (Fauzi et al., 2021). Students are also accustomed to using their social media to conduct health campaigns with valid information.

Until now, COVID-19 cases in Indonesia are still high. The vast territory of Indonesia also causes differences in emergency status in each city and each province. In this regard, an increase in the number of respondents and the involvement of respondents from various regions needs to be carried out in the next KAP survey to analyze the association level of the pandemic status of each region on the student KAP scores. Differences in campus accreditation levels also need to be positioned as independent variables to determine the effect of campus accreditation on student readiness to be involved in dealing with COVID-19 in their

respective regions. In addition, measuring information literacy, digital literacy, genetic literacy, or measuring student acceptance rates related to conspiracy theories about COVID-19 is also needed so that a regression analysis that aims to identify significant predictors of student KAP levels can be carried out. Finally, the KAP for lecturers also needs to be evaluated because lecturers are one of the most trusted sources of information for medical students. The results of these studies are expected to contribute to the health education sector in taking steps to optimize student KAPs.

5. Conclusion

This study concludes that there are still many medical students who do not have good knowledge of COVID-19. In addition, despite the majority of students have positive attitudes, more than half of them are lack discipline in implementing preventive measures, especially about taking vitamins and exercise. The majority of students have routinely implemented wearing masks and hygienic lifestyles. The students have not optimally played a role in educating people around them regarding COVID-19 preventive measures. Furthermore, the results of ANOVA test concluded that the location where students live has no significant effect on their KAP score. Gender differences provide significant differences in the domain of knowledge and practice. On the other hand, age, institution type, and institution status have a significant effect on all domains.

The current pandemic provides important lesson for medical colleges to design a curriculum that prepares students to contribute positively when a pandemic happens. This pandemic is a slap for all parties that many people lose their trust in science. Therefore, the government should design an educational curriculum that instills scientific attitudes since elementary school.

Declarations

Author contribution statement

Jenny J. S. Sondakh: Conceived and designed the experiments; Performed the experiments.

Widya Warastuti: Performed the experiments; Wrote the paper.

Budi Susatia: Performed the experiments; Wrote the paper.

Moh. Wildan: Performed the experiments; Wrote the paper.

Bernadus Rudy Sunindya: Performed the experiments; Wrote the paper.

Moch. Agus Krisno Budiyo: Conceived and designed the experiments.

Ahmad Fauzi: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

The author expresses his sincere gratitude and appreciation to the lecturers in various medical schools who have helped distribute the research questionnaire to their students.

References

- Ajilore, K., Atakiti, I., Onyenakeya, K., 2017. College students' knowledge, attitudes and adherence to public service announcements on Ebola in Nigeria: suggestions for improving future Ebola prevention education programmes. *Health Educ. J.* 76 (6), 648–660.
- Akalu, Y., Ayelign, B., Molla, M.D., 2020. Knowledge, attitude and practice towards COVID-19 among chronic disease patients at Addis Zemen Hospital, Northwest Ethiopia. *Infect. Drug Resist.* 13, 1949–1960. https://www.dovepress.com/front-end/cr_data/cache/pdf/download_1593705541_5efe04456c1da/idr-258736-knowledge-attitude-and-practice-towards-covid-19-among-chron.pdf.
- Al-Hanawi, M.K., Angawi, K., Alshareef, N., Qattan, A.M.N., Helmy, H.Z., Abudawood, Y., Alqurashi, M., Kattan, W.M., Kadasah, N.A., Chirwa, G.C., Alsharqi, O., 2020. Knowledge, attitude and practice toward COVID-19 among the public in the Kingdom of Saudi Arabia: a cross-sectional study. *Front. Public Health* 8 (May), 1–10.
- Allington, D., Duffy, B., Wessely, S., Dhavan, N., Rubin, J., 2020. Health-protective behaviour, social media usage, and conspiracy belief during the COVID-19 public health emergency. *Psychol. Med.*
- Alzoubi, H., Alnawaiseh, N., Al-Mnayyis, A., Abu-Lubad, M., Aqel, A., Al-Shagahin, H., 2020. Covid-19 - knowledge, attitude and practice among medical and non-medical university students in Jordan. *J. Pure Appl. Microbiol.* 14 (1), 17–24.
- Andrade, C., Menon, V., Ameen, S., Kumar Praharaj, S., 2020. Designing and conducting knowledge, attitude, and practice surveys in psychiatry: practical guidance. *Indian J. Psychol. Med.* 42 (5), 478–481.
- Azlan, A.A., Hamzah, M.R., Sern, T.J., Ayub, S.H., Mohamad, E., 2020. Public knowledge, attitudes and practices towards COVID-19: a cross-sectional study in Malaysia. *PLoS One* 15 (5), 1–15.
- Bierwaczzonek, K., Kunst, J.R., Pich, O., 2020. Belief in COVID-19 conspiracy theories reduces social distancing over time. *Appl. Psychol.: Health Well-Being* 12 (4), 1270–1285.
- Bulut, C., Kato, Y., 2020. Epidemiology of COVID-19. *Turk. J. Med. Sci.* 50 (SI-1), 563–570.
- Burgess, A., Horii, M., 2012. Risk, ritual and health responsabilisation: Japan's 'safety blanket' of surgical face mask-wearing. *Sociol. Health Illness* 34 (8), 1184–1198.
- Carney, J.K., Schilling, L.M., Frank, S.H., Biddinger, P.D., Bertsch, T.F., Grace, C.J., Finkelstein, J.A., 2011. Planning and incorporating public health preparedness into the medical curriculum. *Am. J. Prev. Med.* 41 (4 SUPPL. 3), S193–S199.
- Chandler, C.I.R., 2018. Knowledge, attitudes, and practice surveys. In: *The International Encyclopedia of Anthropology*. John Wiley & Sons, Ltd, pp. 1–2.
- Chu, D.K., Akl, E.A., Duda, S., Solo, K., Yaacoub, S., Schünemann, H.J., Chu, D.K., Akl, E.A., El-harakeh, A., Bognanni, A., Lotfi, T., Loeb, M., Hajizadeh, A., Bak, A., Izcovich, A., Cuellar-Garcia, C.A., Chen, C., Harris, D.J., Borowiack, E., Schünemann, H.J., 2020. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *Lancet* 395 (10242), 1973–1987.
- Cinelli, M., Quattrociochi, W., Galeazzi, A., Valensise, C.M., Brugnoti, E., Schmidt, A.L., Zola, P., Zollo, F., Scala, A., 2020. The COVID-19 social media infodemic. *Sci. Rep.* 10 (1), 1–10.
- Cortázar, C., Nussbaum, M., Harcha, J., Alvares, D., López, F., Goñi, J., Cabezas, V., 2021. Promoting critical thinking in an online, project-based course. *Comput. Hum. Behav.* 119, 106705.
- Cox, S.R., 2021. COVID-19 era of misinformation: when your family does not trust you, will your patients? *J. Am. Pharmaceut. Assoc.* 61 (1), 33.
- Dabbagh, S., Khajehpour, M., 2011. Gender differences in factors affecting academic performance of high school students. *Procedia - Soc. Behav. Sci.* 15, 1040–1045.
- Darch, J., Baillie, L., Gillison, F., 2017. Nurses as role models in health promotion: a concept analysis. *Br. J. Nurs.* 26 (17), 982–988.
- Dietz, L., Horve, P.F., Coil, D.A., Fretz, M., Eisen, J.A., Van Den Wymelenberg, K., 2020. 2019 novel coronavirus (COVID-19) pandemic: built environment considerations to reduce transmission. *mSystems* 5 (2).
- Djalante, R., Lassa, J., Setiamarga, D., Sudjatma, A., Indrawan, M., Haryanto, B., Mahfud, C., Sinapoy, M.S., Djalante, S., Rafliana, I., Gunawan, L.A., Surtiari, G.A.K., Warsilah, H., 2020. Review and analysis of current responses to COVID-19 in Indonesia: period of January to March 2020. *Prog. Disa. Sci.* 6, 100091.
- El Zowalaty, M.E., Järhult, J.D., 2020. From SARS to COVID-19: a previously unknown SARS-related coronavirus (SARS-CoV-2) of pandemic potential infecting humans – call for a One Health approach. *One Health* 9, 100124.
- Evans, E.M., Schweingruber, H., Stevenson, H.W., 2002. Gender differences in interest and knowledge acquisition: the United States, Taiwan, and Japan. *Sex. Roles* 47 (3/4), 153–167.
- Fauzi, A., Husamah, H., Miharja, F.J., Fatmawati, D., Permana, T.I., Hudha, A.M., 2020. Exploring-covid-19-literacy-level-among-biology-teacher-candidates. *Eurasia J. Math. Sci. Technol. Educ.* 16 (7), em1864.
- Fauzi, A., Saeifi, M., Kristiana, E., Adi, W.C., Lestariani, N., 2021. Factor and Rasch analysis on COVID-19 genetics literacy assessment instrument. *Eurasia J. Math. Sci. Technol. Educ.* 17 (11), em2032.
- Gabhainn, S.N., 2000. School health education and gender: an interactive effect? *Health Educ. Res.* 15 (5), 591–602.

- Gallagher, T.H., Schleyer, A.M., 2020. "We signed up for this!" — student and trainee responses to the COVID-19 pandemic. *N. Engl. J. Med.* 382 (25), e96.
- Giao, H., Le An, P., Thi Ngoc Han, N., Van Khanh, T., Kim Ngan, V., Van Tam, V., 2020. Knowledge and attitude toward COVID-19 among healthcare workers at district 2 hospital, Ho Chi Minh city. *Asian Pac. J. Trop. Med.* 13 (March), 6–11.
- Gohel, K.H., Patel, P.B., Shah, P.M., Patel, J.R., Pandit, N., Raut, A., 2021. Knowledge and perceptions about COVID-19 among the medical and allied health science students in India: an online cross-sectional survey. *Clin. Epidemiol. Glob. Health* 9, 104–109.
- Goreis, A., Kothgassner, O.D., 2020. Social media as vehicle for conspiracy beliefs on COVID-19. *Digit. Psychol.* 1 (2), 36–39.
- Guess, A.M., Lerner, M., Lyons, B., Montgomery, J.M., Nyhan, B., Reifler, J., Sircar, N., 2020. A digital media literacy intervention increases discernment between mainstream and false news in the United States and India. *Proc. Natl. Acad. Sci. Unit. States Am.* 117 (27), 15536–15545.
- Guo, Z.-D., Wang, Z.-Y., Zhang, S.-F., Li, X., Li, L., Li, C., Cui, Y., Fu, R.-B., Dong, Y.-Z., Chi, X.-Y., Zhang, M.-Y., Liu, K., Cao, C., Liu, B., Zhang, K., Gao, Y.-W., Lu, B., Chen, W., 2020. Aerosol and surface distribution of severe acute respiratory syndrome coronavirus 2 in Hospital Wards, Wuhan, China, 2020. *Emerg. Infect. Dis.* 26 (7), 1583–1591.
- Hamza, M.S., Badary, O.A., Elmazar, M.M., 2020. Cross-sectional study on awareness and knowledge of COVID-19 among senior pharmacy students. *J. Commun. Health* 1–8, 0123456789.
- Hayat, K., Rosenthal, M., Xu, S., Arshed, M., Li, P., Zhai, P., Desalegn, G.K., Fang, Y., 2020. View of Pakistani residents toward coronavirus disease (COVID-19) during a rapid outbreak: a rapid online survey. *Int. J. Environ. Res. Publ. Health* 17 (10), 1–10.
- Hemida, M.G., Ba Abdualah, M.M., 2020. The SARS-CoV-2 outbreak from a one health perspective. *One Health* 100127.
- Hendajany, N., 2016. The effectiveness of public vs private schools in Indonesia. *J. Indones. Appl. Econ.* 6 (1), 66–89.
- Jones-Jang, S.M., Mortensen, T., Liu, J., 2019. Does media literacy help identification of fake news? information literacy helps, but other literacies don't. *Am. Behav. Sci.* 000276421986940.
- Kampf, G., Todt, D., Pfaender, S., Steinmann, E., 2020. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J. Hosp. Infect.* 104 (3), 246–251.
- Kampf, G., 2020. Potential role of inanimate surfaces for the spread of coronaviruses and their inactivation with disinfectant agents. *Infect. Prevent. Prac.* 2 (2), 100044.
- Khan, N., Ahmed, S.M., Khalid, M.M., Siddiqui, S.H., Merchant, A.A., 2010. Effect of gender and age on the knowledge, attitude and practice regarding hepatitis B and C and vaccination status of hepatitis B among medical students of Karachi, Pakistan. *J. Pak. Med. Assoc.* 60 (6), 450–455.
- Kim, E.A., 2020. Social distancing and public health guidelines at workplaces in Korea: responses to COVID-19. *Safe. Health Work.*
- Lai, C.-C., Liu, Y.H., Wang, C.-Y., Wang, Y.-H., Hsueh, S.-C., Yen, M.-Y., Ko, W.-C., Hsueh, P.-R., 2020. Asymptomatic carrier state, acute respiratory disease, and pneumonia due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): facts and myths. *J. Microbiol. Immunol. Infect.* S1684118220300402.
- Lawton, G., 2020. Infectious without symptoms. *New Sci.* 245 (3275), 10–11.
- Li, C., Yang, Y., Ren, L., 2020. Genetic evolution analysis of 2019 novel coronavirus and coronavirus from other species. *Infect. Genet. Evol.* 82 (March), 1–3.
- Li, T., Lu, H., Zhang, W., 2020. Clinical observation and management of COVID-19 patients. *Emerg. Microb. Infect.* 9 (1), 687–690.
- Lincango-Naranjo, E., Espinoza-Suarez, N., Solis-Pazmino, P., Vinuesa-Moreano, P., Rodriguez-Villafuerte, S., Lincango-Naranjo, J., Barberis-Barcia, G., Ruiz-Sosa, C., Rojas-Velasco, G., Gravholt, D., Golembiewski, E., Soto-Becerra, P., Khan, M., Ortiz-Prado, E., 2021. Paradigms about the COVID-19 pandemic: knowledge, attitudes and practices from medical students. *BMC Med. Educ.* 21 (1), 128.
- Mahase, E., 2020. Covid-19: UK could delay non-urgent care and call doctors back from leave and retirement. *BMJ* m854.
- Maheshwari, S., Gupta, P., Sinha, R., Rawat, P., 2020. Knowledge, attitude, and practice towards coronavirus disease 2019 (COVID-19) among medical students: a cross-sectional study. *J. Acute Dis.* 9 (3), 100–104.
- Miller, D.G., Pierson, L., Doernberg, S., 2020. The role of medical students during the COVID-19 pandemic. *Ann. Intern. Med.* 173 (2), 145–146.
- Min, Y.N., Niu, Z.Y., Sun, T.T., Wang, Z.P., Jiao, P.X., Zi, B.B., Chen, P.P., Tian, D.L., Liu, F.Z., 2018. Vitamin E and vitamin C supplementation improves antioxidant status and immune function in oxidative-stressed breeder roosters by up-regulating expression of GSH-Px gene. *Poultry Sci.* 97 (4), 1238–1244.
- Momanyi, J.M., Too, J., Simiyu, C., 2015. Effect of students' age on academic motivation and academic performance among high school students in Kenya. *Asian J. Educ. E-Learn.* 3 (5), 2321–2454.
- Morawska, L., Cao, J., 2020. Airborne transmission of SARS-CoV-2: the world should face the reality. *Environ. Int.* 139, 105730.
- Newhouse, D.L., Beegle, K., 2005. The effect of school type on academic achievement: evidence from Indonesia. *SSRN Electron. J.*
- Nnamani, S.C., Oyibe, O.A., 2016. Gender and academic achievement of secondary school students in social studies in Abakaliki Urban of Ebonyi State. *Brit. J. Educ.* 4 (8), 72–83. <http://www.eajournals.org/wp-content/uploads/Gender-and-Academic-Achievement-of-Secondary-School-Students.pdf>.
- Noreen, K., Rubab, Z., Umar, M., Rehman, R., Baig, M., Baig, F., 2020. Knowledge, attitudes, and practices against the growing threat of COVID-19 among medical students of Pakistan. *PLoS One* 15 (12), e0243696.
- O'Byrne, L., 2020. Medical students and COVID-19: the need for pandemic preparedness. *J. Med. Ethics Medethics*-2020-106353.
- Olaimat, A.N., Aolyamat, I., Shahbaz, H.M., Holley, R.A., 2020. Knowledge and information sources about COVID-19 among university students in Jordan: a cross-sectional study. *Front. Publ. Health* 8.
- Osborne, C.L., 2018. Programming to promote information literacy in the era of fake news. *Int. J. Leg. Inf.* 46 (2), 101–109.
- Parajuli, M., Thapa, A., 2017. Gender differences in the academic performance of students. *J. Develop. Soc. Eng.* 3 (1), 39–47.
- Pekmezci, D., 2011. Vitamin E and immunity. In: Litwack, G. (Ed.), *Vitamins & Hormones*. Academic Press, pp. 179–215.
- Pradhan, D., Biswasroy, P., Kumar Naik, P., Ghosh, G., Rath, G., 2020. A review of current interventions for COVID-19 prevention. *Arch. Med. Res.* 51 (5), 363–374.
- Rachlis, B., Naanyu, V., Wachira, J., Genberg, B., Koeh, B., Kamene, R., Akinyi, J., Braitstein, P., 2016. Community perceptions of Community Health Workers (CHWs) and their roles in management for HIV, tuberculosis and hypertension in Western Kenya. *PLoS One* 11 (2), e0149412.
- Rahman, A., Sathi, N.J., 2020. Knowledge, attitude, and preventive practices toward COVID-19 among Bangladeshi internet users. *Electr. J. Gen. Med.* 17 (5).
- Raina, S., 2013. Assessment of knowledge, attitude, and practice in health care delivery. *N. Am. J. Med. Sci.* 5 (3), 249.
- Razzini, K., Castrica, M., Menchetti, L., Maggi, L., Negroni, L., Orfeo, N.V., Pizzoccheri, A., Stocco, M., Muttini, S., Balzaretta, C.M., 2020. SARS-CoV-2 RNA detection in the air and on surfaces in the COVID-19 ward of a hospital in Milan, Italy. *Sci. Total Environ.* 742, 140540.
- Saeifi, M., Fauzi, A., Kristiana, E., Adi, W.C., Muchson, M., Setiawan, M.E., Islami, N.N., Ningrum, D.E.A.F., Ikhsan, M.A., Ramadhani, M., 2020a. Survey data of COVID-19-related knowledge, attitude, and practices among Indonesian undergraduate students. *Data Brief* 31, 105855.
- Saeifi, M., Fauzi, A., Kristiana, E., Adi, W.C., Muchson, M., Setiawan, M.E., Islami, N.N., Ningrum, D.E.A.F., Ikhsan, M.A., Ramadhani, M., 2020b. Validating of Knowledge, Attitudes, and Practices questionnaire for prevention of COVID-19 infections among undergraduate students: a RASCH and factor analysis. *Eurasia J. Math. Sci. Technol. Educ.* 16 (12), em1926.
- Saqin, M., Munir, M.M., Rehman, S.U., Gulzar, A., Naz, S., Ahmed, Z., Tahir, A.H., Mashhood, M., 2020. Knowledge, attitude, practice and perceived barriers among healthcare workers regarding COVID-19: a cross-sectional survey from Pakistan. *J. Hosp. Infect.* 105 (3), 419–423.
- Sari, D.K., Amelia, R., Dharmajaya, R., Sari, L.M., Fitri, N.K., 2020. Positive correlation between general public knowledge and attitudes regarding COVID-19 outbreak 1 month after first cases reported in Indonesia. *J. Commun. Health*, 0123456789.
- Scott, L.A., Carson, D.S., Greenwell, I.B., 2010. Disaster 101: a novel approach to disaster medicine training for health professionals. *J. Emerg. Med.* 39 (2), 220–226. In this issue.
- Shen, T., Teo, T.Y., Yap, J.J., Yeo, K.K., 2017. Gender differences in knowledge, attitudes and practices towards cardiovascular disease and its treatment among Asian patients. *Ann. Acad. Med. Singapore* 46 (1), 20–28.
- Singhal, T., 2020. A review of coronavirus disease-2019 (COVID-19). *Indian J. Pediatr.* 87 (4), 281–286.
- Soderborg, S., Muhtadi, B., 2020. Policy, partisanship, and pay: diverging COVID-19 responses in Indonesia. *SSRN Electron. J.*
- Stephens, M., 2020. A geospatial infodemic: mapping Twitter conspiracy theories of COVID-19. *Dial. Human Geograph.* 10 (2), 276–281.
- Stokes, D.C., 2020. Senior medical students in the COVID-19 response: an opportunity to be proactive. *Acad. Emerg. Med.* 27 (4), 343–345.
- Suen, L.K.P., So, Z.Y.Y., Yeung, S.K.W., Lo, K.Y.K., Lam, S.C., 2019. Epidemiological investigation on hand hygiene knowledge and behaviour: a cross-sectional study on gender disparity. *BMC Publ. Health* 19 (1), 401.
- Trause, D., Peterson, S., Doty, N., Liguori, A., Holmes, K., Kanzleiter, L., Mehta, K., 2014. The diverse roles of community health workers: cues for technology innovations. *Procedia Eng.* 78, 208–217.
- Vabret, N., Britton, G.J., Gruber, C., Hegde, S., Kim, J., Kuksin, M., Levantovsky, R., Malle, L., Moreira, A., Park, M.D., Pia, L., Risson, E., Saffern, M., Salomé, B., Esai Selvan, M., Spindler, M.P., Tan, J., van der Heide, V., Gregory, J.K., Laserson, U., 2020. Immunology of COVID-19: current state of the science. *Immunity* 52 (6), 910–941.
- Wake, A.D., 2020. Knowledge, attitude, practice, and associated factors regarding the novel Coronavirus Disease 2019 (COVID-19) pandemic. *Infect. Drug Resist.* 13, 3817–3832.
- Wang, H., Wang, Z., Dong, Y., Chang, R., Xu, C., Yu, X., Zhang, S., Tsamlag, L., Shang, M., Huang, J., Wang, Y., Xu, G., Shen, T., Zhang, X., Cai, Y., 2020. Phase-adjusted estimation of the number of coronavirus disease 2019 cases in Wuhan, China. *Cell Discov.* 6 (1), 4–11.
- Welch, A.R., 2007. Blurred vision?: public and private higher education in Indonesia. *High Educ.* 54 (5), 665–687.
- Woods, J., Hutchinson, N.T., Powers, S.K., Roberts, W.O., Gomez-Cabrera, M.C., Radak, Z., Berkes, I., Boros, A., Boldogh, I., Leeuwenburgh, C., Coelho-Júnior, H.J., Marzetti, E., Cheng, Y., Liu, J., Durstine, J.L., Sun, J., Ji, L.L., 2020. The COVID-19 pandemic and physical activity. *Sport Med. Health Sci.*
- Wu, D., Wu, T., Liu, Q., Yang, Z., 2020. The SARS-CoV-2 outbreak: what we know. *Int. J. Infect. Dis.* 94, 44–48.
- Wu, H., Huang, J., Zhang, C.J.P., He, Z., Ming, W.-K., 2020. Facemask shortage and the novel coronavirus disease (COVID-19) outbreak: reflections on public health measures. *EclinicalMedicine* 21, 100329.
- Yanti, B., Wahyudi, E., Wahiduddin, W., Novika, R.G.H., Arina, Y.M.D., Martani, N.S., Nawan, N., 2020. Community knowledge, attitudes, and behavior towards social

- distancing policy as prevention transmission of COVID-19 in Indonesia. *J. Administr. Kesehatan. Indonesia* 8 (1), 4–14.
- Ye, F., Xu, S., Rong, Z., Xu, R., Liu, X., Deng, P., Liu, H., Xu, X., 2020. Delivery of infection from asymptomatic carriers of COVID-19 in a familial cluster. *Int. J. Infect. Dis.* 94, 133–138.
- Ye, G., Lin, H., Chen, S., Wang, S., Zeng, Z., Wang, W., Zhang, S., Rebmann, T., Li, Y., Pan, Z., Yang, Z., Wang, Y., Wang, F., Qian, Z., Wang, X., 2020. Environmental contamination of SARS-CoV-2 in healthcare premises. *J. Infect.*
- Yuan, H., Kunaviktikul, W., Klunklin, A., Williams, B.A., 2008. Improvement of nursing students' critical thinking skills through problem-based learning in the People's Republic of China: a quasi-experimental study. *Nurs. Health Sci.* 10 (1), 70–76.
- Yunus, H., 2021. Online learning management system (OLMS) in Indonesian higher education: investigating benefits and obstacles. *PJEIS: Parahikma J. Educ. Integr. Sci.* 1 (1), 1–8. <https://journal.parahikma.ac.id/pjeis/article/view/42>.
- Zainuddin, H. A. bin, Subri, F. binti, 2017. The school facilities towards the improvement of students' academic achievement: case study-secondary schools in Klang. *J. Mod. Educ. Rev.* 7 (9), 647–653.
- Zhang, D.X., 2020. SARS-CoV-2: air/aerosols and surfaces in laboratory and clinical settings. *J. Hosp. Infect.* 105 (3), 577–579.
- Zhang, M., Zhou, M., Tang, F., Wang, Y., Nie, H., Zhang, L., You, G., 2020. Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. *J. Hosp. Infect.* 105 (2), 183–187.