

ORIGINAL ARTICLE

INDONESIAN UNIVERSITY STUDENTS' EFFORTS AND ATTITUDES TOWARDS COVID-19 PERSONAL SAFEGUARDS: A SURVEY BASED ON THE SWISS CHEESE MODEL

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ABSTRACT

A swiss cheese model-based survey was conducted to investigate the Indonesian students' efforts and attitude in following health protocols to minimize the spread of the COVID-19. The model was developed based on guidance related to student personal safeguards against COVID-19. The personal safeguards were distinguished into an individual (i.e., the use of face masks, physical distancing efforts, hand hygiene, immunity-boosting attempts, and vaccines) and shared (i.e., attitude towards COVID-19 and respiratory etiquette practices) layer of defenses. The survey was then administered to 232 Indonesian university students. The results indicated that the majority (>50%) were always wearing masks, wearing adequate masks, wearing fitted masks, and wearing masks properly. On the other hand, many participants (40-75%) reported not complying with the required hand hygiene standards, including washing hands in less than 20 seconds, and frequently touching the donned masks. Regarding immunity-boosting attempts, a third of the participants reported not exercising regularly. Also, about 10% of the participants were neutral or disagreed with staying at home when having close contacts or having the COVID-19 symptoms. Furthermore, some efforts and attitudes towards most safeguards were significantly different across the gender. In conclusion, most Indonesian student participants had adequate compliance regarding many safety measures regarding COVID-19 prevention, although several aspects such as hand hygiene and immunity-boosting attempts could still be improved.

Keywords: COVID-19, university student, safeguards, efforts, attitude

INTRODUCTION

The novel coronavirus disease (COVID-19) is the most recent infectious disease epidemic in the history of the human race². China reported the first case in late 2019, and by early 2020 it had spread to Indonesia and the rest of the world. To curb the spread of the virus, the Indonesian government implemented social restrictions³. To promote the success of social restrictions, colleges and universities were required to stop face-to-face learning and switch lessons to online⁴. However, institutions and students were faced with technological challenges, including disparities in internet access⁵ and low student engagement^{6,7}. Consequently, the government had to ease the restrictions and allow some programs to adopt blended learning⁸.

The SARS-CoV-2 transmission in an educational institution could be minimized through four approaches: personal, environmental, communication, and organizational interventions⁹. Personal interventions include factors that the individuals can undergo. Examples of personal interventions are face mask use, physical distancing efforts, and hand hygiene practice. Environmental

interventions in educational settings include but are not limited to classroom layout modifications and regular surface disinfection¹⁰. Organizational interventions that mostly implemented in educational settings, including but not limited to temperature and symptom screening. Providing education and training about virus transmission to the students are two examples of communication interventions.

Although the government had already eased the restrictions for educational institutions adopting blended instructions, limited studies explained the Indonesian college students' efforts and attitudes, particularly in maintaining personal safeguards or following the health protocols to minimize the spread of the virus. Such studies are crucial to help university management shape the correct countermeasures when normal or blended learning resumes. On the other hand, some studies in Indonesia were only conducted in a general population setting, such as healthcare¹¹ and traditional markets¹². Consequently, the general population setting results could not apply to college student groups due to the differences in age,

educational background, and socio-cultural interactions¹.

Some accident causation theories could help understand prevention strategies that could minimize any incidents, including preventing academia from contracting the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). As one of the accident causation theories, the swiss cheese model is fundamentally visual, making it easy to understand¹³. The swiss cheese model is founded on the premise that an accident or incident can be prevented by providing a multi-layer of defenses or safeguards¹⁴. Understanding that the spread of the virus is preventable by undergoing some safeguards such as proper handwashing, use of masks, and physical distancing, the swiss cheese model, should be fit to explain the COVID-19 prevention strategy.

This study aimed at filling the gap regarding limited studies to explain students' efforts and attitudes in following health protocols to minimize virus spread. The primary objective was to advocate the adoption of the swiss cheese model to prevent the spread of COVID-19 among college students. Furthermore, a follow-up survey based on the model was administered to the students to investigate the self-reported efforts and attitudes regarding COVID-19 prevention. Therefore, the university management should determine proper countermeasures to minimize the spread of the virus among academia when learning returns to normalcy or hybrid instructions are adopted.

MATERIALS AND METHODS

Participants

Participants were recruited from the population of Indonesians attending universities, colleges, or any post-secondary institutions in Indonesia. Recruitment flyers were distributed via social media, e.g., Facebook and WhatsApp. The participants should plan to attend at least one course in the Spring Semester 2020/2021 to be included in the study. An electronic consent was obtained before the participation of the study. Participant characteristics are presented in Table 1. More than half of the participants were female. Most participants (64%) were less than 20 years old and took engineering programs. Furthermore, more than 50% of the participants were undergraduate students. At least 70% of the participants were from universities or colleges placed in urban areas of Indonesia, such as Jakarta and Yogyakarta. At the same time, about half of them stayed in their hometowns in rural areas of Indonesia while having

online learning caused by the pandemic.

Study design and the swiss-cheese model-based survey

A cross-sectional survey based on the swiss-cheese model was performed to understand the students' efforts and attitudes in maintaining the personal safeguards for protecting themselves against Covid-19. In developing the swiss-cheese model, potential safeguards that could protect students from contracting COVID-19, as well as latent failures associated with each measure, were also explored. Reviews on existing guidance were crucial in identifying the safeguards and the latent failures. The primary guidance utilized to develop the model were Centers for Disease Control and Prevention¹⁵ and The UK Department for Education¹⁶ guidance for reopening campuses. Moreover, several state-level guidance, such as New York State¹⁷ and California State guidance^{9,18}, helped advance the comprehensiveness of the model.

Inquiries were developed based on the latent failures of the swiss-cheese model to determine the self-reported efforts and attitudes regarding the safeguards against coronavirus. Most questions were tailored towards establishing how frequently participants had undergone latent failures associated with each safeguard. The five-level Likert scale used to measure the frequency included never, seldom, sometimes, often, and always. The survey was administered in Bahasa Indonesia, the official language using an online survey platform (Google Form) between the end of December 2020 to January 2021. Before the survey administration, a pilot study was conducted involving five Indonesian students with various levels: sophomore, junior, senior, and two master students. Minor adjustments such as sentence clarity were performed to accommodate the pilot study results. The study was approved by the Research and Community Service Committee of the authors' institution.

Data analysis

The frequency and percentage for each survey inquiry were calculated. Median values were also calculated to measure the responses' central tendency¹⁹. Furthermore, comparisons of self-reported efforts and attitudes across different participant characteristics, including gender, age group, academic degree, programs, university location, and place of residence, were conducted by performing Wilcoxon signed-rank, Kruskal-Wallis, and Chi-squared tests. RStudio was utilized to do the statistical calculations.

Table 1: Participant characteristics

Variable	Categories	Frequency (n = 232)	Relative frequency (%)
Gender	Female	129	56%
	Male	98	42%
	Not reported	5	2%
Age (years)	<20	148	64%
	21-25	50	22%
	26-30	11	5%
	>30	19	8%
	Not reported	4	2%
Programs	Humanities and Social Sciences	88	38%
	Agriculture, Engineering, Mathematics, Medicine, and Natural Sciences	141	61%
	Not reported	3	1%
Academic degree and Class standing	Undergraduate		
	First-year	67	29%
	Second-year	60	26%
	Third-year	31	13%
	Fourth-year	17	7%
	>Fourth year	8	3%
	Master/doctoral		
	First-year	18	8%
	Second-year	17	7%
	Third-year	3	1%
	Fourth-year	1	<1%
	>Fourth year	2	1%
	Not reported	8	3%
Place of residence	Rural	116	50%
	Urban	96	41%
	Not reported	20	9%
Locations of the university or college	Rural	56	24%
	Urban	165	71%
	Not reported	11	5%

RESULTS

The model divided the personal safeguards against COVID-19 into two: safeguards associated with individual and shared responsibility. The individual safeguards against COVID-19 included the use of face masks, hand hygiene, maintaining physical distancing, immunity-boosting attempts, and influenza vaccination. Notably, the respiratory practices of other students have a major impact in

keeping coronavirus at bay. Therefore, the safeguards were associated with shared responsibility. An illustration of the swiss cheese model to accommodate the safeguards can be seen in Figure 1. Furthermore, the latent failures associated with each identified safeguard are presented in Table 2.

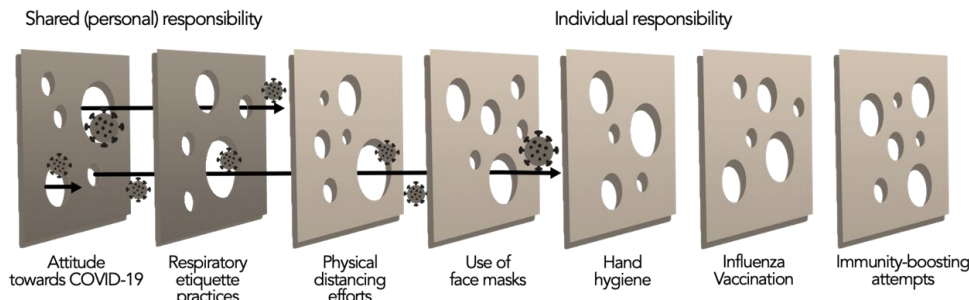


Figure 1: Proposed Swiss cheese model of the personal safeguards against COVID-19 among university students

Table 2: Potential weaknesses associated with student safeguards against COVID-19

Safeguards against COVID-19	Latent failures	Abbreviations	References	
Use of face masks	Students do not put on masks when staying in the public space, using public transportation, or having in-person interaction.	No masks	(15,16,18)	
	Students use masks that do not comply with the COVID-19 prevention regulations.	Non-comply masks	(9)	
	Students use loose/unfit masks.	Loose masks	(9)	
	Students do not put on the masks properly, e.g., putting the masks under the nose or the chin.	Improper mask donning	Authors' observation	
Hand hygiene activities	Students touch their donned masks.	Touch the donned masks.	(15)	
	Students do not undergo washing hands before having meals, after touching masks, after sneezing/coughing, or after traveling.	No handwashing	(18)	
	Students wash their hands without soap or hand sanitizer.	Without soap	(15,18)	
	Students wash their hands too quickly (less than 20 s).	Too quick handwashing	(15,18)	
Physical distancing efforts	Students do not adequately clean their hands with good handwashing practice.	Non-adequate handwashing	(18)	
	Students touch parts of the face without having handwashing first.	Touching face without handwashing	Authors' observation	
	Students use shared laboratories, art, recreational equipment, computers, or books.	Shared equipment	(15,18)	
	Students use shared bathrooms or shower facilities.	Shared bathroom	(18)	
	Students do not perform regularly scheduled cleaning and disinfection of frequently touched areas.	Regular cleaning	(15,16,18)	
	Students have meals at buffet-style restaurants.	Buffet meals	(18)	
	Students do not maintain a safe distance when staying in public spaces.	Safety distance	(15-18)	
	Students attend social gatherings and events.	Social gatherings	(15-18)	
	Students have dine-in indoor meals.	Dine-in indoor meals	(15,18)	
	Students have meals in restaurants with inadequate ventilation.	Inadequate ventilation restaurant	(15)	
Respiratory etiquette practices	Students receive uninvited visitors to their residences.	Uninvited visitors	(15,17)	
	Students use public transportation or ride-sharing platforms.	Public transport	(15)	
	Students do not cover the nose and mouth with elbows/tissues/ masks when sneezing or coughing.	Covering the nose and mouth	(15,18)	
	Immunity-boosting attempts	Students do safe exercise.	Exercise	(20)
		Students have healthy meals.	Healthy meals	(21)
		Students have enough sleep.	Enough sleep	(22)
Students take adequate vitamins or immune booster supplements.	Vitamins	(23)		
Students do stress-relieving activities.	Stress-relieving activities	(24)		
Attitudes towards COVID-19	Students do not smoke.	Not smoking	(25)	
	Students do not stay at home when having COVID-19 symptoms.	Stay at home	(15,18)	
	Students who had close contacts do not stay at home.	Close contact	(15,18)	
Influenza vaccination status	Students did not get flu shots during the last year.	Flu shots	(18)	

Table 3 shows participants' responses regarding their self-reported efforts and attitude toward personal safeguards against COVID-19. The majority (>50%) of participants reported that they were never or seldom not putting on masks, wearing unacceptable masks, loose masks, or not wearing masks properly. Furthermore, most participants reported performing good physical distancing practices, including never or seldom not maintaining safety distance, not attending social gatherings, and not having dine-in services.

Regarding hand hygiene, many participants (46%) reported washing their hands hastily in less than 20 seconds. More than 75% of the participants reported frequently touching the donned masks, while more than 40% of the participants never cleaned nor did

they disinfect their personal items. Furthermore, most participants (53%) reported having practiced recommended respiratory etiquettes, such as covering the mouth with elbows, tissue, or masks when sneezing and coughing.

Among several safeguards associated with immunity-boosting attempts, exercising has the lowest median, in which 32% reported had either never or seldom performed the activities. Furthermore, the survey revealed that at least 10% of participants were either neutral or disagreed with staying at home when having COVID-19 symptoms or having close contact with COVID-19 patients. Moreover, almost all participants (97%) reported not having influenza vaccination.

Table 3: Self-reported efforts regarding face mask use, physical distancing efforts, hand hygiene, respiratory etiquette practices, immunity-boosting attempts, attitude towards COVID-19, and influenza vaccine status (n=232)

Latent failures	Never (1)	Seldom (2)	Sometimes (3)	Often (4)	Always (5)	Not reported*	Median
Use of face masks							
No masks	173 (75%)	43 (19%)	11 (5%)	2 (1%)	2 (1%)	1 (<1%)	1
Non-comply masks	117 (50%)	60 (26%)	34 (15%)	10 (4%)	10 (4%)	1 (<1%)	1
Loose masks	113 (49%)	66 (28%)	41 (18%)	11 (5%)	1 (<1%)	0 (0%)	2
Improper mask donning	47 (20%)	79 (34%)	79 (34%)	21 (9%)	6 (3%)	0 (0%)	2
Touch the donned masks	15 (6%)	57 (25%)	97 (42%)	50 (22%)	13 (6%)	0 (0%)	3
Hand hygiene activities							
No handwashing	139 (60%)	59 (25%)	25 (11%)	6 (3%)	1 (0%)	2 (1%)	1
Without soap	91 (39%)	76 (33%)	44 (19%)	17 (7%)	4 (2%)	0 (0%)	2
Too quick handwashing	32 (14%)	70 (30%)	83 (36%)	39 (17%)	7 (3%)	1 (<1%)	3
Non-adequate handwashing	98 (42%)	65 (28%)	47 (20%)	12 (5%)	7 (3%)	3 (1%)	2
Touching face without handwashing	47 (20%)	79 (34%)	83 (36%)	18 (8%)	5 (2%)	0 (0%)	2
Shared equipment	99 (43%)	80 (34%)	34 (15%)	16 (7%)	3 (1%)	0 (0%)	2
Shared bathroom	138 (59%)	57 (25%)	34 (15%)	1 (0%)	2 (1%)	0 (0%)	1
Regular cleaning	59 (25%)	69 (30%)	58 (25%)	34 (15%)	12 (5%)	0 (0%)	2
Buffet meals	136 (59%)	60 (26%)	24 (10%)	5 (2%)	7 (3%)	0 (0%)	1
Physical distancing efforts							
Safety distance	40 (17%)	90 (39%)	67 (29%)	25 (11%)	10 (4%)	0 (0%)	2
Social gatherings	44 (19%)	104 (45%)	61 (26%)	15 (6%)	8 (3%)	0 (0%)	2
Dine-in indoor meals	52 (22%)	90 (39%)	57 (25%)	28 (12%)	3 (1%)	2 (1%)	2
Inadequate ventilation restaurant	122 (53%)	65 (28%)	36 (16%)	8 (3%)	1 (<1%)	0 (0%)	1
Uninvited visitors	120 (52%)	73 (31%)	29 (13%)	6 (3%)	4 (2%)	0 (0%)	1
Public transport	147 (63%)	59 (25%)	16 (7%)	5 (2%)	5 (2%)	0 (0%)	1
Respiratory etiquette practices							
Covering the nose and mouth	124 (53%)	71 (31%)	26 (11%)	5 (2%)	6 (3%)	0 (0%)	1
Immunity-boosting attempts	Never (1)	Seldom (2)	Sometimes (3)	Often (4)	Always (5)		
Exercise	10 (4%)	65 (28%)	87 (38%)	49 (21%)	21 (9%)	0 (0%)	3
Healthy meals	1 (0%)	7 (3%)	50 (22%)	116 (50%)	58 (25%)	0 (0%)	4
Enough sleep	4 (2%)	44 (19%)	70 (30%)	74 (32%)	40 (17%)	0 (0%)	3
Vitamins	8 (3%)	51 (22%)	71 (31%)	72 (31%)	30 (13%)	0 (0%)	3
Stress-relieving activities	2 (1%)	20 (9%)	71 (31%)	87 (38%)	52 (22%)	0 (0%)	4
Not smoking	59 (25%)	12 (5%)	8 (3%)	19 (8%)	134 (58%)	0 (0%)	5
Attitude towards COVID-19	Strongly agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly disagree (5)		
Staying at home	148 (64%)	60 (26%)	17 (7%)	7 (3%)	0 (0%)	0 (0%)	1
Close contact	139 (60%)	65 (28%)	21 (9%)	7 (3%)	0 (0%)	0 (0%)	1
Vaccine	Yes	No					
Getting flu vaccines.	7 (3%)	225 (97%)				0 (0%)	NA

* Not reported means that participants preferred not to answer the particular inquiries.

Table 4 shows the self-reported efforts and attitude comparison test results across different participant characteristics. As indicated in the table, this study revealed significant differences among the participants on mask usages, physical distancing efforts, hand hygiene activities, respiratory etiquette practices, immunity-boosting attempts, and attitude towards COVID-19.

The participants' efforts and attitudes appear significantly different across gender. Different

efforts across gender were observed in all aspects regarding mask use. Furthermore, at least half of the efforts in each latent failure of other safeguards differed significantly between female and male participants. As indicated by the p-values, only a few significant differences were observed in self-reported efforts and attitudes across age groups, academic degrees, and programs. However, significant differences were observed in the attitude towards COVID-19 across the university of locations.

Table 4: P-values indicating comparisons of self-reported efforts and attitude regarding personal safeguards against COVID-19 across different participant characteristics

Latent failures	Gender [†]	Age group [‡]	Academic Degree [‡]	Programs [‡]	Univ location [‡]	Place of residence [‡]
Use of face masks						
No masks	<0.001**	0.441	0.068	0.745	0.041*	0.200
Non-comply masks	<0.001**	0.842	0.622	0.333	0.450	0.304
Loose masks	<0.001**	0.784	0.309	0.262	0.699	0.319
Improper mask donning	<0.001**	0.597	0.529	0.328	0.330	0.083
Touch the donned masks	<0.001**	0.550	0.217	0.572	0.345	0.230
Physical distancing efforts						
Safety distance	0.022*	0.825	0.575	0.672	0.661	0.816
Social gatherings	0.018*	0.187	0.066	0.798	0.115	0.639
Dine-in indoor meals	0.398	0.217	0.041*	0.995	0.803	0.905
Inadequate ventilation restaurant	<0.001**	0.724	0.319	0.600	0.559	0.223
Uninvited visitors	0.108	0.618	0.580	0.800	0.674	0.076
Public transport	0.730	<0.001**	0.034*	0.063	0.461	0.041*
Hand hygiene						
No handwashing	0.294	0.536	0.721	0.3	0.136	0.968
Without soap	<0.001**	0.548	0.966	0.338	0.925	0.827
Too quick handwashing	0.026*	0.791	0.224	0.478	0.401	0.103
Non-adequate handwashing	0.057	0.675	0.345	0.689	0.943	0.791
Touching face without handwashing	0.163	0.798	0.189	0.370	0.867	0.031*
Shared equipment	<0.001**	0.160	0.007*	0.095	0.614	0.194
Shared bathroom	0.015*	0.040*	0.015*	0.321	0.118	0.600
Regular cleaning	0.073	0.699	0.367	0.345	0.633	0.455
Buffet meals	0.019*	0.117	0.301	0.950	0.138	0.523
Respiratory etiquette practices						
Covering the nose and mouth	0.003*	0.988	0.581	0.971	0.210	0.333
Immunity-boosting attempts						
Exercise	0.668	0.805	0.274	0.204	0.486	0.959
Healthy meals	0.07	0.650	0.151	0.909	0.250	0.392
Enough sleep	0.032*	0.719	0.113	0.415	0.741	0.862
Vitamins	0.156	0.393	0.201	0.96	0.987	0.899
Stress-relieving activities	0.668	0.704	0.140	0.084	0.753	0.756
Not smoking	0.085	0.060	0.283	0.207	<0.001**	0.047*
Attitude towards COVID-19						
Staying at home	0.059	0.118	0.223	0.1	0.002*	0.355
Close contact	0.004*	0.122	0.043*	0.613	<0.001**	0.956
Vaccine						
Getting flu vaccines [§]	0.467	0.684	0.770	0.783	0.012*	0.120

* Significant at p<.05; ** Significant at p<.001

[†] Wilcoxon signed-rank test results; [‡] Kruskal-Wallis test results; [§] Chi-squared test results

DISCUSSION

The swiss cheese model proposed in the study included seven layers of protection consisting of individual and shared-personal safeguards against COVID-19. Although suggested to be an effective control measure toward eradicating the disease^{26,28}, COVID-19 vaccination was not included in the model. The exclusion was prompted by the references utilized during the model development drawn from a time when no vaccine for COVID-19 had been developed.

The proposed model indicates that hand hygiene safeguard has the most latent failures. However, this model could not tell how a particular safeguard will likely protect the students because each failure has a different probability and severity. These two quantitative measures could not be described solely based on the swiss cheese model. As a result, additional techniques such as fault tree analysis¹³ and analytic hierarchy process²⁹ were incorporated to provide more comprehensive information on the quantification of the latent failures.

This study revealed that most Indonesian post-secondary level students had adequate compliance regarding many safety measures for COVID-19 prevention. These results could be associated with the timing of the data collection, where Indonesians had just finished with the Delta variant³⁰. The Delta variant was the strain causing the highest deaths in many countries³¹. Understanding that the variant was very deadly could drive the high compliance of following the safety measures. Therefore, different levels of compliance could be observed when the covid case was low, or the variants became less deadly.

Although most participants reported at least seldom washed their hands without soap or hand sanitizer, a high percentage said confirmed to have washed hands in less than 20 seconds. However, the students who complied with these safeguards were still higher than the general population³². To fully sensitize students on the importance of handwashing, university administrators could continue with handwashing education intervention programs. This includes visual education³³, peer-reminder program³⁴, or introducing more engineering controls such as installing timers on the handwashing stations.

More than 25% of the students were either never or seldom performed regular exercises to boost their immunity. Ranasinghe et al. (20) reported that having regular exercise during the pandemic could physically and psychologically benefit the body. Exercising improves the persons' innate immunity that affords protection from viral infections. It also

reduces adverse effects of isolation such as stress, anxiety, and sedentarism, which may affect someone's immunity. Therefore, online exercise programs³⁵ could be introduced to students as an alternative of workout programs while staying at home.

About 10% of the participants were neutral or disagreed with staying at home when having COVID-19 symptoms or coming into close contact with COVID-19 patients. Singh et al.³⁶ also indicated similar findings where a high percentage of college students were unwilling to stay in quarantine when a family member was discovered having COVID-19 symptoms. Although most college students had good knowledge about COVID-19 prevention³⁷, only a fraction was worried about contracting the virus³⁸. Furthermore, this study revealed that student attitude towards self-isolation was associated with their university location, which is in line with the findings of Yue et al.³⁹. Therefore, university administrators should introduce programs to ensure that every student has similar knowledge about the virus spreading before allowing them back.

This study revealed that the Indonesian student efforts and attitudes regarding personal safeguards against COVID-19 were remarkably different across gender. This result was in line with the finding from such studies on the general population, where women perceived to take seriously caution against COVID- than men^{40,41}.

CONCLUSION

The swiss cheese model could describe Indonesian post-secondary students' personal safeguards against COVID-19. The model distinguished the safeguards based on the type of responsibility: individual and shared. Individual safeguards included the use of face mask, physical distancing efforts, hand hygiene activities, immunity-boosting attempts, and vaccines. The shared responsibility safeguards included attitude towards COVID-19 and respiratory etiquette practices. The model was further utilized as the basis of the survey development to measure students' self-effort and attitudes associated with personal safeguards against COVID-19. Although the compliance of the students regarding some safety measures for minimizing the transmission of the virus was adequate, the survey indicated that some students are still less compliant with observing the protocols. These included frequently touching the donned masks, washing the hands in less than 20 seconds, lacking frequent exercises, having a negative attitude towards self-isolation, and not taking the flu shots. There were disparities reported across the gender regarding maintaining the safeguards.

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Conflict of interest

The authors have no conflicts of interest to declare.

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