

Sociodemographic Disparities in COVID-19 Knowledge Among Malaysian School Students

Nurashma Juatan^{1*}, Vaidehi Ulaganathan², Nadia Hani Jahaya¹, Sheikh Shafizal Sheikh Ilman¹,
Baskaran Gunasekaran², Manimaran Krishan¹

¹Institute for Health Behavioural Research, National Institutes of Health, Ministry of Health, Selangor, Malaysia

²Faculty of Applied Sciences, UCSI University, Kuala Lumpur, Malaysia

Abstract: The world is experiencing a health crisis which has led to millions of infections and deaths worldwide, with substantial and multifaceted effects on school children worldwide. Understanding students' knowledge disparities of pandemics is crucial for better equipping them to contribute transmission prevention and foster a healthier and more informed generation. This cross-sectional study was conducted using an online survey, which involved participation from 24 government schools, covering both urban and rural settings across Malaysia. The study encompassed a comprehensive sample size of 3485 participants, comprising both primary and secondary school students. The overall knowledge of COVID-19 among students was high, with a total score of 87.1%. Statistically significant difference was observed in knowledge on COVID-19 characteristic among gender and education level ($p < 0.05$). Responses concerning knowledge on the symptoms also varied significantly by ethnicity, religion and localities ($p < 0.05$). Despite high overall knowledge, significant sociodemographic disparities exist among gender, ethnicity, religion, locality and education level. These results underscore the importance of tailored demographic-specific approaches in health education to enhance awareness among school students.

Keywords: COVID-19, disparities, knowledge, Malaysian, students.

1. Introduction

Infecting and killing millions worldwide, the coronavirus disease 2019 (COVID-19) pandemic was among the most significant global health crises in recent history [1]. The impact of the illness extended beyond the healthcare sector, disrupting economies, social structures, and educational systems. Students' educational and social environments were also negatively affected, prompting schools to introduce new health measures [2], leading to various challenges, including learning disruptions and reduced social interactions [3].

The COVID-19 pandemic has highlighted the vital role of public health knowledge and education in managing the spread of infectious diseases, particularly in the young demographic [4], [5]. Educating children about COVID-19 and implementing strategies to reduce infection risks to foster a pandemic-resilient society are the most practical solutions to the absence of vaccines for children [6]. Accordingly, assessing the disparity in school students' knowledge about pandemics is essential, given its significant influence on their ability to respond to the

challenges arising from pandemics and other public health threats [7], [8]. Furthermore, comprehending the mechanisms of pandemics can enhance students' resilience and capacity to respond effectively. Information on the virus, its transmission, and preventive measures can also contribute to adherence to health guidelines, the ability to recognise symptoms, and the willingness to actively participate in community efforts to mitigate its spread [9]-[11].

In light of these challenges, the pandemic has emphasized the vital role of public health knowledge and education in controlling the spread of infectious diseases, particularly among younger populations [6], [4]. In the absence of vaccines for children, the most practical solution lies in educating children about COVID-19 and implementing strategies to reduce the risk of infection, thereby fostering a pandemic-resilient society [6].

Understanding disparities in school students' knowledge about pandemics is crucial as it significantly influences their ability to respond to the challenges posed by pandemics and other public health threats [7], [8]. A clear understanding of how pandemics work can foster resilience and enhance their capacity to respond effectively. Furthermore, knowledge about the virus, its transmission, and preventive measures can shape their adherence to health guidelines, ability to recognize symptoms, and willingness to actively contribute to community efforts in mitigating its spread [9]-[11].

The ripple effect of health practice behaviours from school students on their families and communities can improve the leverage of health education beyond classrooms, broadening and improving public health responses [12]. Consequently, ensuring proper health education among children is paramount to fostering an informed and resilient society. Nevertheless, determining socio-demographic disparities is crucial for developing targeted educational strategies to ensure adequately informed and equipped students to protect themselves and their communities. Consequently, this study aimed to establish the differences in COVID-19 knowledge among school students. The predominant socio-demographic factors contributing to these variations were also highlighted, providing a foundation for more equitable health education initiatives.

*Corresponding author: nurashma@moh.gov.my

2. Methods

A. Research Design

The current study applied a cross-sectional design with a two-stage stratified sampling method, encompassing six primary states in the first stratum and urban and rural areas in the second stratum.

B. Participants and Sampling

The sample in the current study included primary students in grades 4 and 5, and secondary students in grades 1, 2, 4, and 6. The students were enrolled in 24 government daily schools in Malaysia. During the first phase of this study, six primary and six secondary schools were randomly chosen, proportional to school enrolment size. A random selection was also employed in the second phase, involving four to six classes from each school. All students in the selected classes were deemed eligible for participation. Students undergoing major examinations and without internet access were excluded during the data collection period.

C. Data Collection Instrument

The survey instrument employed in this study was adapted from Chen [13] and tailored to the Malaysian cultural context. The questionnaire was divided into demographic and knowledge sections. Four multiple-choice items were included in the demographic section, while the knowledge section encompassed four sub-domains: COVID-19 characteristics, transmission route, symptoms, and preventive measures. The items were followed by a Likert scale with three responses: “Yes”, “No”, and “Do not know”.

The face and content validity of the questionnaire employed in the present study were evaluated by subject matter experts from the Ministry of Education and the Ministry of Health. Several questions were also accompanied by visual elements to enhance the chances of identifying items accurately [14].

D. Ethical Considerations and Administration

This study procured ethical approval from the Medical Research and Ethics Committee, the Ministry of Health, and the Educational Policy and Research Division, Ministry of Education. Permission for participation was also obtained from the State District Education Office.

The students in the present study were informed about the purpose of the study. The self-administered online questionnaire also included a virtual consent form. The students' consents were obtained before their responses were gathered. Designated teachers disseminated the survey link to the participating students. The data were collected via an online questionnaire from June 14th 2021 to June 24th 2021.

E. Data Analysis

In this study, the data procured were analysed with Statistical Package for the Social Sciences (SPSS) version 26. Frequencies and percentages represented categorical information, while mean scores, standard deviations, and frequency distributions denoted knowledge levels across domains. Subsequently, an independent t-test and Analysis of Variance (ANOVA) were

conducted to compare knowledge scores and determine significance according to p-values. Predictor analysis was also performed utilising univariate and multivariate regression to identify socio-demographic factors influencing knowledge, establishing crude, adjusted beta coefficients, and confidence intervals.

3. Results

A total of 3485 school students participated in the present study. Table 1 summarises the socio-demographic characteristics of the participants. According to the results, most participants were females (56.1%), Malay ethnicity (64.9%), and Muslim (73.8%). Most of the students (50.6%) were also enrolled in primary schools.

Table 1
Sociodemographic characteristic of study participants

Items	Number of participants	
	n	%
Gender		
Male	1530	43.9
Female	1955	56.1
Ethnicity		
Malay	2261	64.9
Chinese	335	9.6
Indian	200	5.7
Bumiputera Sabah	377	10.8
Bumiputera Sarawak	296	8.5
Others	15	0.4
Religion		
Muslim	2573	73.8
Buddhist	282	8.1
Hinduism	182	5.2
Christianity	439	12.6
Others	9	0.3
Education		
Primary	1765	50.6
Secondary	1720	49.4

A. Knowledge on the COVID-19 Pandemic

The knowledge that Malaysian school students have of COVID-19 is demonstrated in Table 2. Based on the data, a significant proportion of students stated familiarity with COVID-19 characteristics. Most students (98.6%) also possessed the knowledge that the disease is caused by a virus that can lead to respiratory tract infections (94.2%). Furthermore, an exceptional percentage of the participants (90.5%) indicated awareness of potential COVID-19 transmission in the absence of symptoms. Most students were also informed that particular demographics, such as the elderly or individuals with underlying health conditions or weakened immune systems, were at an increased risk of infection, potentially resulting in fatal outcomes (94.6%).

In terms of knowledge on the transmission route of the virus, the participants in the present study indicated awareness that the virus can be transmitted through respiratory droplets released during coughing or sneezing (95.8%), physical contact with surfaces contaminated by the virus (93.1%), and sharing food and drink with infected individuals (87.3%). Meanwhile, the most recognisable COVID-19 symptoms noted by the students were fever, cough, and shortness of breath (> 90.0%). Nevertheless, 61.2% of the students perceived a bloody nose as

indicative of an infection.

Table 2
Knowledge about COVID-19 among school students in Malaysia

Knowledge Items	Frequency (%)			
	Yes	No	Not sure	Correct
Domain 1: Characteristics of the COVID-19				
It is a disease caused by virus	3434 (98.6)	24 (0.7)	26 (0.7)	3434 (98.6)
It is a disease that can cause respiratory tract infections	3283 (94.2)	52 (1.5)	149 (4.3)	3283 (94.2)
A person usually shows signs of infection within 14 days after being infected	2920 (83.8)	211 (6.1)	353 (10.1)	2920 (83.8)
An individual can infect other individuals even they have no signs of the disease	3152 (90.5)	103 (3.0)	229 (6.6)	3152 (90.5)
The elderly, individuals with health problems or low immune system / antibodies have a higher risk of becoming infected and can cause death	3296 (94.6)	49 (1.4)	139 (4.0)	3296 (94.6)
Domain 2: Transmission route of the COVID-19				
Through respiratory droplets when coughing or sneezing by individuals with signs of infection	3338 (95.8)	43 (1.2)	103 (3.0)	3338 (95.8)
Touching surfaces or equipment that has been contaminated with the virus (examples: door knobs, elevator buttons, the handrail etc)	3243 (93.1)	93 (2.7)	148 (4.2)	3243 (93.1)
Share food and drink with individuals with signs of infection.	3042 (87.3)	221 (6.3)	221 (6.3)	3042 (87.3)
Domain 3: Symptoms of the COVID-19				
Fever	3386 (97.2)	32 (0.9)	66 (1.9)	3386 (97.2)
Cough	3385 (97.2)	39 (1.1)	60 (1.7)	3385 (97.2)
Bleeding nose	451 (12.9)	2131 (61.2)	902 (25.9)	2131 (61.2)
Shortness of breath	3366 (96.6)	43 (1.2)	75 (2.2)	3366 (96.6)
Domain 4: Prevention & control of the COVID-19				
Keep a distance of at least 1 meter from individuals with signs of infection	3436 (98.6)	18 (0.5)	30 (0.9)	3436 (98.6)
Wash hands with soap and water or hand sanitizers after touching the surface that has been touched by the public (examples: door knobs, elevator buttons, the handrail etc)	3448 (99.0)	20 (0.6)	16 (0.5)	3448 (99.0)
Wearing face mask	3460 (99.3)	17 (0.5)	7 (0.2)	3460 (99.3)
Get an influenza injection	2475 (71.0)	567 (16.3)	442 (12.7)	567 (16.3)
Avoid touching the eyes, nose and mouth regularly with unwashed hands	3348 (96.1)	61 (1.8)	75 (2.2)	3348 (96.1)
Wash hands with soap and water for about 20 seconds	3035 (87.1)	126 (3.6)	323 (9.3)	3035 (87.1)

According to the outcomes recorded in this study, 87.1% to 99.3% of the participants indicated awareness of the importance of implementing preventive behaviours, such as physical distancing, wearing face masks, and regularly washing hands, to prevent the spread of viral infections. Nonetheless, 16.3% of the students documented inaccurate knowledge about the

influenza vaccine as self-protection.

B. Mean COVID-19 Pandemic Knowledge Scores

The mean scores, total, and sub-domain knowledge levels about COVID-19 among school children in Malaysia are summarised in Table 3. The data were determined with 18 items, which offered two responses: 1, representing true, and 0, denoting false. In this study, all correct answers were coded as 1 point, whereas incorrect and unsure answers were coded as zero.

Table 3
Mean score and level of total knowledge and subdomains among students

Domain	Mean $\pm$ SD	Frequency (%)		
		Low	Moderate	High
Characteristics of the COVID-19	0.92 $\pm$ 0.14	70 (2.0)	192 (5.5)	3223 (92.5)
Transmission route of the COVID-19	0.92 $\pm$ 0.18	151 (4.3)	506 (14.5)	2828 (81.1)
Symptoms of the COVID-19	0.88 $\pm$ 0.15	125 (3.6)	1382 (39.7)	1978 (56.8)
Prevention & control of the COVID-19	0.83 $\pm$ 0.10	73 (2.1)	390 (11.2)	3022 (86.7)
Total knowledge score	0.89 $\pm$ 0.09	54 (1.5)	396 (11.4)	3035 (87.1)

The composite score obtained in the current study ranged between 0 and 18. The data were categorised according to Bloom's cut-off point, where less than 60% indicated low, 60% to 80% represented moderate, and 80% to 100% denoted exceptional knowledge levels. Overall, the total mean score of knowledge regarding COVID-19 was 0.89 $\pm$ 0.09 (see Table 3).

Approximately 87.1% of the students participating in this study possessed notable COVID-19 knowledge, whereas a minimum of 1.5% were poorly informed. The results also indicated that familiarity with COVID-19 characteristics had the highest mean score, which was Mean (M) = 0.92 and Standard Deviation (SD) = 0.14, followed by knowledge of transmission route COVID-19 virus (M = 0.92, SD = 0.18), symptoms (M = 0.88, SD = 0.15), and COVID-19 prevention and management (M = 0.83, SD = 0.10). Furthermore, a substantial COVID-19 knowledge prevalence was observed, at 92.5%, particularly on characteristics of the disease. A minimum of 56.8% of the participants also had significant information on COVID-19 symptoms.

C. Score Distribution and Variations in COVID-19 Knowledge Across Socio-Demographic Attributes

Table 4 lists the distribution and differences of the total score concerning COVID-19 knowledge and its dimensions across socio-demographic characteristics. No statistically significant differences were recorded for total, transmission route, and prevention and management awareness across varying socio-demographics. Nevertheless, knowledge regarding the characteristics and symptoms of COVID-19 indicated disparity.

According to the findings, gender and education level were associated with elevated information on COVID-19 attributes. Male participants (0.93 $\pm$ 0.14) demonstrated higher COVID-19 attribute awareness than their female counterparts (0.92 $\pm$ 0.15), recording $t = 2.443$ and $p = 0.015$. Primary school

Table 4
Distribution and differences in total knowledge score and its dimensions on COVID-19 across socio demographic characteristics

Items	Total knowledge		Knowledge on characteristics		Knowledge on transmission route		Knowledge on symptoms		Knowledge of prevention and control	
	Mean $\pm$ SD	t/ F (p-value)	Mean $\pm$ SD	t/ F (p-value)	Mean $\pm$ SD	t/ F (p-value)	Mean $\pm$ SD	t/ F (p-value)	Mean $\pm$ SD	t/ F (p-value)
Gender										
Male	0.89 $\pm$ 0.09	1.291	0.93 $\pm$ 0.14	2.443	0.93 $\pm$ 0.17	1.396	0.88 $\pm$ 0.15	-0.845	0.83 $\pm$ 0.10	0.127
Female	0.89 $\pm$ 0.10	(0.197)	0.92 $\pm$ 0.15	(0.015)*	0.92 $\pm$ 0.19	(0.163)	0.88 $\pm$ 0.15	(0.398)	0.83 $\pm$ 0.10	(0.899)
Ethnicity										
Malay	0.89 $\pm$ 0.09		0.92 $\pm$ 0.14		0.92 $\pm$ 0.18		0.89 $\pm$ 0.15		0.82 $\pm$ 0.11	
Chinese	0.88 $\pm$ 0.10	0.879	0.93 $\pm$ 0.14	0.767	0.93 $\pm$ 0.17	0.976	0.83 $\pm$ 0.17	11.798	0.82 $\pm$ 0.09	2.062
Indian	0.89 $\pm$ 0.10	(0.482)	0.94 $\pm$ 0.15	(0.574)	0.90 $\pm$ 0.21	(0.431)	0.87 $\pm$ 0.16	(0.000)*	0.85 $\pm$ 0.09	(0.067)
Bumiputera Sabah	0.89 $\pm$ 0.09		0.92 $\pm$ 0.14		0.92 $\pm$ 0.18		0.88 $\pm$ 0.15		0.83 $\pm$ 0.10	
Bumiputera Sarawak	0.89 $\pm$ 0.10		0.92 $\pm$ 0.15		0.93 $\pm$ 0.18		0.87 $\pm$ 0.16		0.86 $\pm$ 0.11	
Others	0.89 $\pm$ 0.10		0.91 $\pm$ 0.13		0.91 $\pm$ 0.27		0.88 $\pm$ 0.13		0.83 $\pm$ 0.06	
Religion										
Muslim	0.89 $\pm$ 0.09		0.92 $\pm$ 0.14		0.92 $\pm$ 0.18		0.89 $\pm$ 0.14		0.83 $\pm$ 0.10	
Buddhist	0.88 $\pm$ 0.10	1.900	0.93 $\pm$ 0.14	1.535	0.93 $\pm$ 0.17	2.035	0.82 $\pm$ 0.17	15.078	0.82 $\pm$ 0.08	0.739
Hinduism	0.88 $\pm$ 0.13	(0.108)	0.92 $\pm$ 0.18	(0.189)	0.89 $\pm$ 0.23	(0.087)	0.87 $\pm$ 0.16	(0.000)*	0.84 $\pm$ 0.11	(0.565)
Christianity	0.88 $\pm$ 0.10		0.91 $\pm$ 0.15		0.93 $\pm$ 0.18		0.87 $\pm$ 0.17		0.83 $\pm$ 0.11	
Others	0.91 $\pm$ 0.05		0.96 $\pm$ 0.09		0.96 $\pm$ 0.11		0.89 $\pm$ 0.13		0.81 $\pm$ 0.06	
Locality										
Kedah	0.88 $\pm$ 0.11		0.92 $\pm$ 0.15		0.92 $\pm$ 0.19		0.87 $\pm$ 0.16		0.82 $\pm$ 0.11	
Selangor	0.89 $\pm$ 0.09	2.201	0.92 $\pm$ 0.15	1.956	0.92 $\pm$ 0.17	0.495	0.89 $\pm$ 0.13	8.467	0.82 $\pm$ 0.11	0.951
Johor	0.89 $\pm$ 0.09	(0.052)	0.94 $\pm$ 0.13	(0.082)	0.91 $\pm$ 0.19	(0.780)	0.88 $\pm$ 0.14	(0.000)*	0.83 $\pm$ 0.10	(0.447)
Kelantan	0.90 $\pm$ 0.08		0.92 $\pm$ 0.13		0.93 $\pm$ 0.17		0.91 $\pm$ 0.14		0.83 $\pm$ 0.10	
Sabah	0.88 $\pm$ 0.10		0.92 $\pm$ 0.15		0.92 $\pm$ 0.17		0.87 $\pm$ 0.16		0.83 $\pm$ 0.10	
Sarawak	0.88 $\pm$ 0.10		0.92 $\pm$ 0.15		0.92 $\pm$ 0.19		0.86 $\pm$ 0.16		0.83 $\pm$ 0.10	
Education level										
Primary	0.89 $\pm$ 0.10	1.967	0.94 $\pm$ 0.14	15.468	0.92 $\pm$ 0.19	0.197	0.88 $\pm$ 0.15	1.747	0.83 $\pm$ 0.10	2.619
Secondary	0.88 $\pm$ 0.09	(0.140)	0.91 $\pm$ 0.14	(0.000)*	0.92 $\pm$ 0.17	(0.821)	0.88 $\pm$ 0.15	(0.175)	0.82 $\pm$ 0.11	(0.073)

students (0.94 $\pm$ 0.14) also exhibited superior knowledge of the disease than the secondary school students (0.91 $\pm$ 0.14), with $t = 15.468$ and $p = 0.000$.

Ethnicity, religion, and locality data revealed associations with COVID-19 symptoms. For instance, Malay students (0.89 $\pm$ 0.15; $t = 11.798$, $p = 0.000$) recorded exceptionally elevated information on the illness than other ethnic groups. Similarly, Muslim participants (0.89 $\pm$ 0.14 and 0.89 $\pm$ 0.13; $t = 15.078$, $p = 0.000$) exhibited a higher level of knowledge than Buddhist, Hindu, and Christian students. In terms of localities, Kelantanese participants (0.91 $\pm$ 0.14; $t = 8.467$, $p = 0.000$) recorded increased awareness compared to other localities.

D. Predictors of COVID-19 Knowledge Across Varying Socio-Demography

Table 5 demonstrates the knowledge of COVID-19 predictors across socio-demographic factors. The results highlighted substantial associations in specific domains. For instance, gender was significantly correlated with COVID-19 knowledge (adjusted- $\beta = 0.035$, 95% CI 0.000, 0.020), indicating a minor but statistically notable variation in awareness levels. Nevertheless, parallel correlations between gender and other knowledge domains were not observed.

Ethnicity exhibited a significantly negative association with COVID-19 prevention and control knowledge (adjusted- $\beta = -0.075$, 95% CI -0.028, -0.004), suggesting disparities between students of different ethnicities. Conversely, religion was notably linked to total COVID-19 knowledge (adjusted- $\beta = 0.060$, 95% CI 0.001, 0.025) and familiarity with its symptoms (adjusted- $\beta = 0.081$, 95% CI 0.009, 0.047). Consequently, religion might influence awareness and

symptom recognition.

According to the results, complete knowledge (adjusted- $\beta = 0.037$, 95% CI 0.001, 0.019) and symptoms recognition of COVID-19 (adjusted- $\beta = 0.058$, 95% CI 0.010, 0.039) were considerably influenced by locality, suggesting that geographical location contributes to awareness, particularly on symptom recognition. Education level was also a crucial predictor of COVID-19 knowledge, recording significant associations with symptom familiarity (adjusted- $\beta = 0.089$, 95% CI 0.016, 0.035) and prevention and management (adjusted- $\beta = 0.034$, 95% CI 0.000, 0.014), underscoring the importance of educational attainment in shaping an individual's understanding of a disease and its preventive measures. Conclusively, the outcomes emphasised the exceptional influence of socio-demographic factors on various COVID-19 knowledge dimensions. Furthermore, education level, locality, religion, ethnicity, and gender were predominant predictors across the varying knowledge domains.

4. Discussion

Adhering to public health measures is essential in minimising the spread of COVID-19 and safeguarding public health due to its notable transmissibility. An individual's response to health threats, including COVID-19, is directly affected by their knowledge, fundamentally shaping protective behaviours. Well-informed populations have an increased likelihood of adopting preventive measures to reduce transmission risks, particularly during early outbreak onset. Consequently, comprehending school students' knowledge about COVID-19 is essential. The awareness reflects the ability to recognise

Table 5
Predictors of knowledge about COVID-19 across socio demographic characteristics

Items	Univariate analysis			Multivariate analysis				
	Crude β	95%CI	p-value	B	S.E.	Adjusted- β	95% CI	p-value
Total Knowledge								
Gender	0.022	-0.002, 0.010	0.203	0.004	0.003	0.020	-0.003, 0.010	0.240
Ethnicity	0.021	-0.002, 0.011	0.218	-0.008	0.006	-0.038	-0.019, 0.003	0.178
Religion	0.042	0.002, 0.016	0.014*	0.013	0.006	0.060	0.001, 0.025	0.031*
Locality	0.040	0.002, 0.019	0.019*	0.010	0.005	0.037	0.001, 0.019	0.036*
Education level	0.031	0.000, 0.012	0.068	0.005	0.003	0.025	-0.002, 0.011	0.153
Knowledge on characteristics								
Gender	0.041	0.002, 0.021	0.016	0.010	0.005	0.035	0.000, 0.020	0.041*
Ethnicity	-0.003	-0.011, 0.009	0.858	-0.006	0.009	-0.019	-0.023, 0.011	0.507
Religion	0.014	-0.006, 0.015	0.406	0.007	0.009	0.022	-0.011, 0.025	0.433
Locality	-0.004	-0.015, 0.012	0.806	-0.001	0.007	-0.002	-0.015, 0.013	0.893
Education level	0.093	0.017, 0.036	0.000	0.026	0.005	0.089	0.016, 0.035	0.000*
Knowledge on transmission route								
Gender	0.023	-0.004, 0.021	0.168	0.009	0.006	0.025	-0.003, 0.021	0.142
Ethnicity	-0.016	-0.018, 0.007	0.358	-0.013	0.011	-0.035	-0.034, 0.008	0.220
Religion	-0.007	-0.017, 0.011	0.669	0.006	0.012	0.016	-0.016, 0.029	0.576
Locality	0.013	-0.010, 0.023	0.442	0.010	0.009	0.020	-0.007, 0.028	0.258
Education level	-0.008	-0.015, 0.009	0.649	-0.004	0.006	-0.011	-0.016, 0.008	0.516
Knowledge on symptoms								
Gender	-0.014	-0.014, 0.006	0.398	-0.004	0.005	-0.014	-0.014, 0.006	0.422
Ethnicity	0.097	0.020, 0.041	0.000	0.005	0.009	0.015	-0.013, 0.022	0.600
Religion	0.104	0.024, 0.047	0.000	0.028	0.010	0.081	0.009, 0.047	0.004*
Locality	0.083	0.021, 0.049	0.000	0.025	0.007	0.058	0.010, 0.039	0.001*
Education level	-0.029	-0.019, 0.001	0.088	-0.010	0.005	-0.033	-0.020, 0.000	0.052
Knowledge of prevention and control								
Gender	0.002	-0.006, 0.007	0.899	0.000	0.004	0.001	-0.007, 0.007	0.959
Ethnicity	-0.034	-0.015, 0.000	0.044	-0.016	0.006	-0.075	-0.028, -0.004	0.009*
Religion	-0.007	-0.010, 0.006	0.664	0.010	0.007	0.045	-0.002, 0.023	0.113
Locality	0.007	-0.008, 0.011	0.689	0.005	0.005	0.019	-0.005, 0.015	0.292
Education level	0.039	0.001, 0.015	0.022	0.007	0.004	0.034	0.000, 0.014	0.048*

symptoms, transmission routes, and preventive measures.

In the context of this study, most participants demonstrated notable awareness, indicating exceptional knowledge of the characteristics and key dissemination of the COVID-19 virus. The students were also well-informed on COVID-19 preventive strategies. Previous studies have also noted the relatively significant public awareness about the disease and symptoms during the early stages of the outbreak [15], [16]. Furthermore, the substantial knowledge observed in this study aligned with expectations, considering the extensive media coverage and health campaigns on this illness [17].

The global urgency during the onset of the COVID-19 pandemic ensured widespread critical information dissemination to curb the spread of infection in public areas [18]. The strategy might have contributed to generating great awareness among school students. Nonetheless, a report noted the limited knowledge of university students despite their education level [19]. The respondents also documented misconceptions about protection measures and the infection risks for vulnerable populations. The university students' considerable dependence on social media and the Internet as their primary information sources might have contributed to the false knowledge [20]. Nevertheless, several studies revealed a better COVID-19 awareness among university students [21], [22], [20].

Disparities in knowledge across the socio-demographic groups evaluated in the present study were observed despite the overall significant knowledge score. Differences in COVID-19 characteristics awareness were observed when comparing genders and education levels. Although minor, gender was a statistically significant predictor of knowledge of COVID-19

attributes. Conversely, no significant correlations were documented in other knowledge domains.

Reports on gender differences in COVID-19 health-related awareness revealed conflicting findings. Several studies indicated elevated knowledge levels among males, while others recorded superior familiarity in females. The male school students in this study demonstrated a slightly higher COVID-19 knowledge level than their female counterparts. Similar findings were documented in a few studies in Kedah [23]. Nevertheless, the variation was not statistically notable. Two studies in India involving adolescents and young adults also recorded a similar difference, specifically in awareness of COVID-19 primary symptoms rather than its characteristics [24], [25].

Adult and young adult females had more information on COVID-19 and engaged in preventive behaviours than males, as they were generally more aware of health risks [26], [27], [28]. The slight knowledge disparity among the male students might be attributable to differences in information-seeking behaviours and access to health information [27]. Consequently, improved social interactions and access to information sources can enhance exposure to health knowledge [29]. How available health information is acquired and utilised is also influenced by men's processing rapidity and implementation capabilities, which differ from women [30].

Education is critical in shaping knowledge, enabling effective comprehension and interpretation of information [31], [32], [33]. The results documented in the present study indicated that education level was a substantial knowledge predictor. The parameter was also correlated to awareness of COVID-19 characteristics and prevention and regulation

measures.

The primary school students in the current study exhibited significantly greater knowledge of COVID-19 than their secondary school counterparts. Although direct comparative studies between these specific age groups are limited, knowledge level variations might arise from how students acquire information. A study conducted in Yemen established that grade 1 secondary school students were more aware of COVID-19 than grade 3 students. This finding was due to the elevated motivation of younger students to learn, as opposed to the increased academic pressure faced by senior students, diminishing their time to keep up with health information [34]. A similar trend was revealed in another study involving Malaysian university students [35].

Although educational exposure influences an individual's knowledge, other factors mediate awareness improvement, including educational attainment. An enhanced understanding of health information and preventive behaviours was correlated to a higher level of education [36]. This data indirectly indicated that age is also vital in affecting knowledge. Awareness increases with age due to the accumulation of life experiences, exposure to different situations, and learning accumulated over time [23].

Parameters, such as ethnicity, locality and religion, are crucial in shaping COVID-19 symptom knowledge. Based on the findings in the current study, Malay students had more information on COVID-19 than students from other ethnic groups. Although recording minor variations, Malay students were also able to recognise COVID-19 symptoms better than students of other ethnicities.

According to regression analysis, ethnicity resulted in differences in COVID-19 prevention and management knowledge among the participants in this study. This disparity might be linked to language accessibility. Most health information is available in Malay, the primary spoken language in Malaysia. Consequently, other minorities, who might be relying on other languages, had less direct access to pandemic-related information, potentially affecting their comprehension of the disease [37]. The phenomenon could also hinder comprehending disease symptoms and preventive measures, leading to health awareness and decision-making gaps [38].

In this study, geography was a notable predictor of total knowledge and symptom awareness. The students in Kelantan demonstrated a slightly higher knowledge level than those in other regions. The results implied that factors other than urbanisation, such as community engagement and localised awareness activities, could contribute to the trend [39]. Consequently, future research should consider assessing geographical effects in developing health knowledge across states.

Ethnicity and religion are frequently associated as they influence cultural identity, social structures, and access to information, affecting how groups view and respond to health-related concerns, including COVID-19 [37]. A study conducted in Malaysia found that the observed disparity in COVID-19 knowledge among students of different religions was largely attributable to variations in their primary sources of health

information. In this study, Muslim participants exhibited slightly elevated knowledge of disease symptoms compared to students of Buddhism, Hinduism, and Christian religious backgrounds. Similar findings were documented in Bangladesh. Nonetheless, a comparative analysis between different religious groups was unavailable [40]. Conclusively, religious beliefs can influence COVID-19 knowledge and perceptions, influencing the understanding and responses of different groups to disease outbreaks. Muslims have stronger faith-based coping mechanisms and greater reliance on divine will, potentially contributing to variations in health awareness and behaviours [37].

Ethnicity and religion are frequently associated as they influence cultural identity, social structures, and access to information, affecting how groups view and respond to health-related concerns, including COVID-19 [37]. In this study, Muslim participants exhibited slightly elevated knowledge of disease symptoms compared to students of Buddhism, Hinduism, and Christian religious backgrounds. Similar findings were documented in Bangladesh. Nonetheless, a comparative analysis between different religious groups was unavailable [40]. Conclusively, religious beliefs can influence COVID-19 knowledge and perceptions, influencing the understanding and responses of different groups to disease outbreaks. Muslims have stronger faith-based coping mechanisms and greater reliance on divine will, potentially contributing to variations in health awareness and behaviours [37].

5. Conclusion

The Malaysian school students who participated in the present study possessed substantial awareness of COVID-19. The findings indicated the effectiveness of public health campaigns and information dissemination. Nonetheless, socio-demographic factors, such as gender, ethnicity, religion, locality, and education level, affect knowledge levels, requiring consideration when developing public health strategies. The results also underscored the importance of addressing knowledge gaps through targeted education programs, encouraging community engagement, and promoting inclusive health communication. Improving these initiatives can enhance future public health responses and provide equal access to health information, leading to increased health literacy across all populations.

The document starts here. Copy and paste the content in the paragraphs.

References

- [1] World Health Organization (WHO), "WHO coronavirus dashboard," World Health Organization, 2020. [Online]. Available: <https://data.who.int/dashboards/covid19/cases>.
- [2] World Health Organization (WHO), "Considerations for school-related public health measures in the context of COVID-19," World Health Organization, Geneva, 2020. [Online]. Available: <https://www.who.int/publications/i/item/considerations-for-school-related-public-health-measures-in-the-context-of-covid-19>.

- [3] United Nations Children's Fund (UNICEF), "The impact of COVID-19 on education: Children's learning and wellbeing," UNICEF Indonesia, Jakarta, 2021. [Online]. Available: <https://www.unicef.org/indonesia/media/15231/file/Issue%20Brief%20-%20The%20Impact%20of%20the%20COVID-19%20Pandemic%20on%20Children's%20Learning%20in%20Indonesia.pdf>.
- [4] G. J. Soma, "Communicating to children about the COVID-19 pandemic," *South Sudan Med. J.*, vol. 13, no. 2, pp. 60-63, 2020.
- [5] World Health Organization (WHO), "What we know about young people and COVID-19," World Health Organization, Geneva, 2020. [Online]. Available: https://www.who.int/docs/default-source/coronaviruse/risk-comms-updates/update35.pdf?sfvrsn=81ddaea_4.
- [6] D. Allen, J. G. Allen, H. Jenkins, and M. Levinson, "Schools and the path to zero: Strategies for pandemic resilience in the face of high community spread," Center for Global Development, Washington, DC, 2021. [Online]. Available: https://globalepidemics.org/wpcontent/uploads/2021/01/SchoolsandthePathtoZero_wFAQ.pdf.
- [7] M. K. Roberts, D. M. Ehde, T. E. Herring, and K. N. Alschuler, "Public health adherence and information-seeking for people with chronic conditions during the early phase of the COVID-19 pandemic," *PM&R*, vol. 13, no. 11, pp. 1249-1260, Nov. 2021.
- [8] X. Wang et al., "Enhancing the effectiveness of infectious disease health education for children and adolescents in China: a national multicenter school-based trial," *BMC Public Health*, vol. 23, no. 1, p. 1161, 2023.
- [9] N. Bartek, J. L. Peck, D. Garzon, and S. VanCleve, "Addressing the clinical impact of COVID-19 on pediatric mental health," *J. Pediatr. Health Care*, vol. 35, no. 4, pp. 377-386, Jul.-Aug. 2021.
- [10] Centers for Disease Control and Prevention, "Information for pediatric healthcare providers," U.S. Department of Health and Human Services, Atlanta, GA, 2024. [Online]. Available: <https://www.cdc.gov/covid/hcp/clinical-care/for-pediatric-hcp.html>.
- [11] A. Martin-Storey et al., "Conduct problems and adherence to COVID-19 guidelines: a developmental psychopathology-informed approach," *Res. Child Adolescent Psychopathol.*, vol. 49, no. 8, pp. 1055-1067, Aug. 2021.
- [12] F. Santos et al., "School-based family-oriented health interventions to promote physical activity in children and adolescents: a systematic review," *Amer. J. Health Promotion*, vol. 37, no. 2, pp. 243-262, Feb. 2023.
- [13] X. Chen et al., "Hand hygiene, mask-wearing behaviors and its associated factors during the COVID-19 epidemic: A cross-sectional study among primary school students in Wuhan, China," *Int. J. Environ. Res. Public Health*, vol. 17, no. 8, p. 2893, Apr. 2020.
- [14] M. Mackiewicz and J. Cieciuch, "Pictorial personality traits questionnaire for children (PPTQ-C)—A new measure of children's personality traits," *Front. Psychol.*, vol. 7, p. 498, Apr. 2016.
- [15] Y. Liu et al., "A snapshot of public knowledge of novel coronavirus disease 2019: a web-based national survey," *BMC Public Health*, vol. 21, pp. 1-10, 2021.
- [16] I. M. Puspitasari, L. Yusuf, R. K. Sinuraya, R. Abdulah, and H. Koyama, "Knowledge, attitude, and practice during the COVID-19 pandemic: a review," *J. Multidisciplinary Healthcare*, pp. 727-733, 2020.
- [17] A. U. Rehman et al., "Role of the media in health-related awareness campaigns on perception of COVID-19: a pre-post study in the general population of Pakistan," *Front. Public Health*, vol. 9, p. 779090, 2021.
- [18] J. Prasad Singh, A. Sewda, and D. G. Shiv, "Assessing the knowledge, attitude and practices of students regarding the COVID-19 pandemic," *J. Health Manage.*, vol. 22, no. 2, pp. 281-290, Jun. 2020.
- [19] A. Chesser, A. Drassen Ham, and N. Keene Woods, "Assessment of COVID-19 knowledge among university students: implications for future risk communication strategies," *Health Educ. Behavior*, vol. 47, no. 4, pp. 540-543, Aug. 2020.
- [20] R. Sirat, M. S. Sahrai, B. A. Rahimi, A. Asady, and A. W. Wasiq, "Knowledge, attitudes and practices of university students toward COVID-19 in Southern region, Afghanistan: a cross-sectional study," *BMC Med. Educ.*, vol. 23, no. 1, p. 171, 2023.
- [21] N. A. Canti, N. M. Zain, and H. Embong, "Knowledge on Coronavirus disease (COVID-19) and practice of COVID-19 prevention among students in the health campus," *Int. J. Care Scholars*, vol. 5, no. 2, pp. 75-86, 2022.
- [22] K. Maleelai and P. Juntavaree, "A Cross-Sectional Study on Diploma Students' Knowledge, Attitudes, and Preventive Behavior about COVID-19 in Northeastern Thailand," *Int. J. Public Health Res.*, vol. 14, no. 1, pp. 1865-1875, 2024.
- [23] C. Ganaprakasam, S. Humayra, K. Ganasegaran, E. Kuppusamy, and B. Karikalan, "Knowledge, attitude, and practice regarding COVID-19 among primary school students in Kedah, Malaysia: a cross-sectional study," *Malaysian J. Public Health Med.*, vol. 21, no. 3, pp. 49-59, 2021.
- [24] J. Pinchoff et al., "Gender specific differences in COVID-19 knowledge, behavior and health effects among adolescents and young adults in Uttar Pradesh and Bihar, India," *PLoS ONE*, vol. 15, no. 12, p. e0244053, Dec. 2020.
- [25] A. Stephen et al., "Gender differences in COVID-19 knowledge, risk perception, and public stigma among the general community: Findings from a nationwide cross-sectional study in India," *Int. J. Disaster Risk Reduction*, vol. 93, p. 103776, Jul. 2023.
- [26] M. MS. Anaam and S. Alsahali, "Gender differences in knowledge, attitudes, and practices toward COVID-19 in Saudi Arabia: a cross-sectional study," *Diseases*, vol. 11, no. 2, p. 63, Apr. 2023.
- [27] I. Kamenidou, A. Stavrianea, S. Mamalis, and I. Mylona, "Knowledge assessment of covid-19 symptoms: Gender differences and communication routes for the generation z cohort," *Int. J. Environ. Res. Public Health*, vol. 17, no. 19, p. 6964, Oct. 2020.
- [28] M. S. Sultana, A. H. Khan, M. R. Islam, S. Hossain, M. T. Hasan, and M. T. Sikder, "Gender differences in knowledge, attitudes and preparedness to respond to COVID-19 among adults in Bangladesh: A cross-sectional study," *Population Med.*, vol. 4, Jan. 2022.
- [29] L. C. Ivers and D. A. Walton, "COVID-19: global health equity in pandemic response," *Amer. J. Tropical Med. Hygiene*, vol. 102, no. 6, p. 1149, Apr. 2020.
- [30] L. Ma, H. Liu, Z. Tao, N. Jiang, W. Wang, and X. Jiang, "Knowledge, Beliefs/Attitudes, and practices of rural residents in the prevention and control of COVID-19: an online questionnaire survey," *Amer. J. Tropical Med. Hygiene*, vol. 103, no. 6, p. 2357, Oct. 2020.
- [31] T. Bayati, A. Dehghan, F. Bonyadi, and L. Bazrafkan, "Investigating the effect of education on health literacy and its relation to health-promoting behaviors in health center," *J. Educ. Health Promotion*, vol. 7, no. 1, p. 127, 2018.
- [32] V. Raghupathi and W. Raghupathi, "The influence of education on health: an empirical assessment of OECD countries for the period 1995–2015," *Arch. Public Health*, vol. 78, pp. 1-8, 2020.
- [33] R. Shahid et al., "Impact of low health literacy on patients' health outcomes: a multicenter cohort study," *BMC Health Services Res.*, vol. 22, no. 1, p. 1148, 2022.
- [34] A. H. Al-Shahethi et al., "Knowledge, attitudes, and practices of secondary school students towards COVID-19 in Sana'a City, Yemen: A cross-sectional study," *J. Public Health Res.*, vol. 13, no. 1, 2024.
- [35] M. F. Sazali et al., "Knowledge, attitude and practice on COVID-19 among students during the early phase of pandemic in a university in Borneo, Malaysia," *J. Public Health Res.*, vol. 10, no. 3, 2021.
- [36] CL. Wong et al., "Knowledge, attitudes and practices towards COVID-19 amongst ethnic minorities in Hong Kong," *Int. J. Environ. Res. Public Health*, vol. 17, no. 21, p. 7878, Nov. 2020.
- [37] R. S. Ting, Y. Y. Aw Yong, M. M. Tan, and C. K. Yap, "Cultural responses to COVID-19 pandemic: Religions, illness perception, and perceived stress," *Front. Psychol.*, vol. 12, p. 634863, 2021.
- [38] A. Aravindhan et al., "Knowledge, attitudes and practices towards COVID-19 among multiethnic elderly Asian residents in Singapore: a mixed-methods study," *Singapore Med. J.*, vol. 64, no. 11, pp. 657-666, Nov. 2023.
- [39] W. M. Mohammad, "Community engagement through a community-based medical curriculum in a North-Eastern state in Malaysia," *Int. e-J. Community Industry Engagement (IeJCIE)*, vol. 1, no. 2, 2014.
- [40] M. S. Hossain, R. Banik, I. Hosen, M. Z. Islam, and L. R. Kundu, "Assessment of knowledge, attitudes and practices towards COVID-19 among rural adolescents in Thakurgaon district, Bangladesh: An interview-based study," *BMJ Open*, vol. 13, no. 7, p. e073382, Jul. 2023.