Heliyon 6 (2020) e05799

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Do knowledge and attitudes matter for preventive behavioral practices toward the COVID-19? A cross-sectional online survey among the adult population in Bangladesh

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ARTICLE INFO

Keywords:
COVID-19
Bangladesh
Knowledge
Attitude
Preventive behavioral practice

ABSTRACT

The Government of Bangladesh has adopted several non-therapeutic measures to tackle the pandemic of SARS-CoV-2. However, the curve of COVID-19 positive cases has not significantly flattened yet, as the adoption of preventive measures by the general population is predominantly a behavioral phenomenon that is often influenced by people's knowledge and attitudes. This study aimed to assess the levels of knowledge, attitudes, and preventive behavioral practices toward COVID-19 and their interrelationships among the population of Bangladesh aged 18 years and above. This study adopted a web-based cross-sectional survey design and collected data from 1056 respondents using the online platform Google Form. We employed the independent sample t-test, one-way ANOVA, Pearson's product-moment correlation, and Spearman rank-order correlation to produce the bivariate level statistics. We also run multiple linear and logistic regression models to identify the factors affecting knowledge, attitudes, and preventive behavioral practices toward COVID-19. The respondents had an average knowledge score of 17.29 (Standard Deviation (SD) = 3.30). The average score for attitude scale toward COVID-19 was 13.6 (SD = 3.7). The respondents had excellent preventive behavioral practices toward COVID-19 (mean 7.7, SD = 0.72). However, this study found that knowledge and attitudes did not matter for preventive behavioral practices toward COVID-19. Instead, education appeared as a sole predictor for preventive behavioral practices toward COVID-19; that means preventive behavioral practices toward COVID-19 was lower among the less educated respondents. This study suggests increasing education as a long-term strategy and taking immediate action to increase knowledge and decrease negative attitudes toward COVID-19 through targeted health education initiatives as a short-term strategy.

1. Introduction

The Government of Bangladesh (GoB) has taken many non-therapeutic measures to tackle the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the cause of coronavirus disease 2019 (COVID-19) pandemic. These initiatives included: (1) setting up of the thermal scanner in all the land ports and airports, (2) sending all travelers to 14-day compulsory quarantine who entered into the country from the epicenters during the early period when the international flights were in operation (until 21 March 2020), (3) deploying the army to supervise the quarantine facilities, (4) postponing all mass gatherings including a ban on all political, social, cultural, and religious activities, (5) declaring a nationwide public holiday for all the non-essential organizations, businesses, and educational institutions, except for hospitals, pharmacies, groceries, and other unavoidable necessities, (6) upholding travel ban on water, rail, and air routes (though flights to and from China was in operation and the passengers coming from China were sent to 14-day compulsory quarantine), and (7) introducing social distancing protocol

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https://doi.org/10.1016/j.heliyon.2020.e05799
Received 28 September 2020; Received in revised form 17 November 2020; Accepted 17 December 2020

[1, 2]. However, implementing these non-therapeutic measures has become very relaxed since the beginning of June when everything except the educational institutions has been re-opened.

Despite the initiatives mentioned above of the GoB, the curve of COVID-19 positive cases has not significantly flattened yet. The GoB data shows that the average number of people tested positive per day was only 5.3 in the first month (8 March-7 April), which increased to 409 people per day in the second month (8 April-7 May), and 1720 people per day in the third month (8 May-7 June). The average number of people tested positive peaked in the fourth month (8 June-7 July), 3429 per day. The number then started to fall to 2705 people per day in the fifth month (8 July-7 August), 2415 people per day in the sixth month (8 August-7 September), and 1633 people per day in the seventh month (8–25 September). However, the declined number of people tested positive per day cannot be considered as reflecting the reality as our analysis of the GoB data shows that the correlation coefficient between the number of tests per day and the number of people tested positive per day is highly statistically significant ($r = .936$, $p = .000$). That means the number of people tested positive is dependent on the number of tests. It should be mentioned that the number of tests per day has also declined since the fourth month of the pandemic due to people's dwindling interest resulting from various aspects, such as social stigma, fear, long queue, and waiting time in sample collection, delay in providing test results, and introducing fees for tests [3]. It should be noted that Bangladesh is ranked 15th globally in terms of the total number of COVID-19 positive cases while 157th in terms of tests per million population (as on 25 September 2020) [4].

The less effectiveness of non-therapeutic measures to flatten the curve of the COVID-19 cases could be explained by the fact that individual behaviors, rather than governmental actions, are potentially crucial to control the spread of COVID-19 [4]. The adoption of preventive measures to shape pandemics is predominantly a behavioral issue that is often determined by knowledge and attitudes [5, 6, 7, 8, 9, 10]. Thus, assessing knowledge and attitudes about the SARS-CoV-2 and its influence on preventive behavioral practices toward COVID-19 is an essential task before designing any prevention program. The exploration of COVID-19 related knowledge and attitudes has become even more critical due to the growing surge of disinformation, misinformation, and malinformation [11, 12, 13, 14].

However, despite the importance of researching knowledge, attitudes, and preventive behavioral practices (KAP) toward COVID-19, very few studies [2, 15, 16] have been conducted in Bangladesh with a robust methodology and analytical framework. Most of the studies conducted in Bangladesh on KAP toward COVID-19 are of small sample size [17, 18, 19, 20], non-robust statistical analysis [17, 18], with a specific population group and geographic location [17, 18, 20, 21]. On top of that, these studies were conducted in the early periods of detecting the first COVID-19 case in Bangladesh when people were possibly less aware of the disease. In this context, the present study aimed to explore the levels of knowledge, attitudes, and preventive behavioral practices toward COVID-19 and examine their interrelationships among the adult population of Bangladesh, particularly the influence of knowledge and attitudes on the preventive behavioral practices toward COVID-19.

2. Materials and methods

2.1. Study design and population

This study used a web-based cross-sectional survey design. The criteria for selecting respondents of this research were to be an adult aged 18 years and above living in Bangladesh and could read and write and use the internet. There was no explicit exclusion criterion.

2.2. Sample size and sampling

The study protocol was prepared based on the guidelines for conducting the behavioral insights on COVID-19, developed by the WHO Regional Office for Europe [22]. The WHO [22] recommended having a sample size of 1000 adult population to obtain a high level of congruence between the distribution of the demographics in the sample and the adult population regarding their age, gender, and living area. The evidence shows that the precision of the estimates of surveys increases very slightly beyond this number [23]. The study followed a mix of convenience and snowballed sampling to reach this sample.

2.3. Study instrument

The structured questionnaire, developed by the WHO, was customized and finalized for the Bangladesh context. The tool was then translated into Bengali and pre-tested. It had four sections. The first three sections asked questions about outcome variables, and the last section asked questions about covariates. The study instrument can be found in the supplementary material (S1).

2.4. Outcome variables

Knowledge related to COVID-19 was assessed in three dimensions: (1) knowledge about symptoms of Coronavirus; (2) knowledge about treatment and vaccine of Coronavirus; and (3) knowledge about transmission and incubation period of Coronavirus. A total of 25 items were included in the questionnaire to assess the respondents' knowledge related to COVID-19. The response options of these items were 'yes,' 'no,' or 'not sure/do not know' except the item related to the incubation period of Coronavirus. The response option for the incubation period of Coronavirus was 'within 14 days,' after 14 days,' and 'not sure/do not know.' We assigned 1 point to a correct response and 0 points for an incorrect response. The reliability analysis of these 25 items was performed and found an acceptable level of standardized Cronbach Alpha ($\alpha = .716$). The total score of these 25 items ranged between 1 to 25, with a higher score indicating better knowledge about COVID-19. We also used Bloom's cut-off point to classify the overall knowledge level as good if the score was between 80 percent and 100 percent, moderate if the score was between 50 percent and 79 percent and poor if the score was less than 50 percent [24].

Attitude toward COVID-19 was assessed using eight Likert-type items. The response options for these items were 'strongly disagreed,' 'disagreed,' 'neither agreed nor disagreed,' 'agreed,' and 'strongly agreed.' The reliability of these eight items was acceptable with a standardized Cronbach Alpha ($\alpha = .694$). The total score of these eight items ranged between 8 to 33, with a higher score indicating a negative attitude toward COVID-19. Bloom's cut-off point was used to categorize the attitude as positive if the score was 80–100%, neutral if the score was 60–79%, and positive if the score was less than 60% [24].

Preventive behavioral practices toward COVID-19 was measured using eight items. The response options were 'yes,' 'no,' and 'do not know' and assigned 1 point if the response was 'yes' while assigned 0 points if the response was either 'no,' or 'do not know.' We conducted a reliability analysis of these eight items and found a weak level of standardized Cronbach Alpha ($\alpha = .586$). The total score of these eight items ranged between 0 to 8, with a higher score indicating a good preventive behavioral practice toward COVID-19. Like knowledge related to COVID-19, Bloom's cut-off point was used to categorize the respondent's preventive behavioral practices as good, moderate, and poor.

2.5. Covariates

The study instrument included the following covariates: age, gender, educational attainment, occupation, place of residence, geographical region, marital status, know someone as COVID-19 positive among the

respondent's immediate social environment, and respondent's COVID-19 status.

2.6. Data collection

The data for this study were collected from 10 to 16 May 2020. The country was partially lockdown during this period, and the government declared a general holiday. It was not possible to conduct face-to-face interviews for data collection during this period as the population movement was restricted. Thus, the data was collected through the online survey portal, Google Forms using Bengali as a language. A link of the form was created and sent to the prospective participants by e-mail, WhatsApp, ResearchGate, LinkedIn, and Facebook. The researchers used their personal, professional, and social network to send the link of the Google Form. All the participants to whom the survey link was sent were requested to share the link in their network to reach more people. The research team members circulated the survey link in their respective professional networks through the snowball process. As recommended by WHO [22], the online data collection portal was active for seven days. A total of 1059 respondents submitted their responses during these seven days. However, three respondents did not provide consent to participate in this survey, and thus, they did not provide any data; therefore, the response rate of the study was 99.7%. The final sample size of this study was 1056. The data is now available in the Mendeley open research data repository [25].

2.7. Statistical analysis

Based on the previous literature, this study hypothesized that attitudes are a product of knowledge and both knowledge and attitudes are the determinants of preventive behavioral practices related to COVID-19 after controlling the effects of covariates. However, the sample we have drawn for this study to test these hypotheses was not representative of the overall population of Bangladesh in terms of age, gender, place of residence, education, marital status, and occupation as we followed a mix of convenience and snowballed sampling to reach the sample size. Thus, at the beginning of data analysis, this study used a weight adjustment technique for the variables age, gender, marital status, and place of residence using the following the formula [26]:

$$w_i = \frac{p_i}{s_i}$$

Here, w_i is the weight adjusted factor, p_i is the relative proportion of population characteristics (according to Census 2011), and s_i is the proportion of sample characteristics. We used age, gender, marital status, and place of residence to calculate weight for the sample of this study. For example, the sample proportion of urban married men of age 18–24 years was 0.323 and the population proportion was 0.201. Using the above formula, we got the weight of 0.621 for urban married men of age 18–24 years characteristics. Similarly, we calculated weights for other characteristics: (1) women, urban, and married samples; (2) men, urban, and unmarried samples; (3) women, urban, and unmarried samples; (4) men, rural, and married samples; (5) women, rural, and married samples; (6) men, rural, and unmarried samples; (7) women, rural, and unmarried samples. These weights were then multiplied with the respective samples.

The weighted sample was then used for statistical analysis. This study used descriptive statistics (percentage, mean, standard deviation), the independent sample t-test (if the variables had two categories), one-way ANOVA (if the variables had more than two categories), Spearman rank-order (if the variables were ordinal), and Pearson's product-moment correlation (if the variables were interval level) were calculated to produce bivariable level statistics. We also conducted the multiple linear regression model after checking the assumptions and multicollinearity for knowledge and attitudes toward COVID-19 and multiple logistic regression for preventive practices toward COVID-19. A backward stepwise elimination process was followed for multiple regression models. The data for this study were analyzed using the Statistical Product and Service Solutions (SPSS) software, version 26.

2.8. Ethical approval

This research was approved by the Bangladesh Medical Research Council (BMRC) (Registration Number: 302 1 1 05 2020). Participation in this research was voluntary, and there was no incentive for the respondents. Information about this survey, including the objectives, was provided in the Bengali language at the beginning of the survey. The respondents' voluntary and informed consent was sought by using a question 'do you agree to participate in this study after reading the information about this research?' which had a binary response option. The respondents who consented to participate voluntarily in the survey then needed to click to the 'Continue' option, and only then they were directed to complete the Google Forms. The respondents could not participate in this study if their answers to this consent question were 'no.'

3. Results

3.1. Sample characteristics

Table 1 presents both weighted and unweighted sample characteristics of the study population. The mean age of the weighted sample was 35.75 years, with the standard deviation (SD) of 12.18. The highest percent (22.7%) of the respondents was from the age group of 31–39 years. More than 50 percent of the respondents (56.4%) had post-graduate (Masters) level education, and another 24.8 percent of respondents had undergraduate level education. About 39 percent of the respondents were from the middle region (Dhaka, Mymensingh, and Barisal division) of the country, while two-thirds (67%) of the respondents were living in rural areas. Two-thirds (67.7%) of the respondents were married. Nearly one-third (36.4%) of the respondents knew someone as COVID-19 positive in their immediate social environment. However, none of the respondents was COVID-19 positive though 2.3 percent felt that they might be carrying the Coronavirus infection but did not test.

3.2. Knowledge, attitudes, and preventive behavioral practices toward COVID-19

Table 2 shows the findings of knowledge related to COVID-19. It shows that more than 90 percent of respondents knew some aspects of the most common, less common, and severe symptoms of COVID-19 correctly. About 93 percent of respondents correctly knew that Coronavirus could be asymptomatic. Another 93 percent of respondents correctly knew that there is no vaccine for Coronavirus. The respondents had good knowledge of most of the items related to the transmission and incubation period of the virus. However, the respondents were relatively less knowledgeable on the following aspects: 73.5 percent of respondents reported that the novel Coronavirus could be transmitted by animals to humans only, 57.5 percent of respondents reported that Coronavirus could not be transmitted through sexual intimacy, and 36.4 percent of respondents mentioned that Coronavirus could not remain alive for more than four hours. We used Bloom's cut-off point to assess the overall knowledge level and found that 25.8 percent of the respondents had good knowledge, 67.2 percent of respondents had moderate knowledge, and 7.0 percent of respondents had poor knowledge. The average knowledge score was 17.29 (SD = 3.30, range: 1–25).

Table 3 shows the findings of attitudes toward COVID-19. The findings show that 22.6 percent of respondents agreed and strongly agreed to the statement that COVID-19 is a punishment from the creator, followed by COVID-19 is a human-made disease (15.2%), and people could be safe

Table 1. Sample characteristics of the respondents.

Background Characteristics	Unweighted sample		Weighted sample	
	n = 1056	%	n = 1056	%
Age (in years)				
18-24	341	32.3	212	20.1
25-30	275	26.0	208	19.7
31-39	184	17.4	240	22.7
40-49	178	16.9	195	18.5
50 years and above	78	7.4	201	19.1
Mean (SD)	31.6 (10.56)		35.75 (12.18)	
Gender				
Men	688	65.2	529	50.1
Women	368	34.8	527	49.9
Educational attainment				
Up to higher secondary	82	7.8	68	6.6
Undergraduate	352	33.3	259	24.8
Post-graduate (Masters)	532	50.4	587	56.4
Post-graduate (MPhil/PhD)	90	8.5	127	12.2
Occupation				
Government and private sector job	181	17.1	178	17.1
Professional*	211	20.0	242	23.2
NGO worker	173	16.4	232	22.2
Students and unemployed	407	38.5	283	27.2
Others**	84	8.0	106	10.2
Region of Bangladesh				
The eastern part (Sylhet and Chattogram division)	126	11.9	281	26.6
The middle part (Dhaka, Barisal, and Mymensingh division)	775	73.4	409	38.7
The western part (Khulna, Rangpur, and Rajshahi division)	155	14.7	366	34.7
Place of residence				
Rural	180	17.0	708	67.0
Urban (other than city corporation)	170	16.1	137	13.0
City corporation	706	66.9	211	20.0
Marital status				
Married	505	47.8	715	67.7
Unmarried	551	52.2	342	32.4
Know someone as COVID-19 positive within the immediate social environment				
No	710	67.2	672	63.6
Yes	346	32.8	384	36.4
Own COVID-19 status				
Negative	1033	97.8	1032	97.7
Felt but not tested for	23	2.2	24	2.3

* Professional category included teacher, engineer, lawyer, doctor, nurse, paramedics, and pharmacist.
** The Others category included business, agriculture, housewife, and others.

if they prayed to Allah/God/Creator regularly (10.0%). Bloom's cut-off shows that overall, 93.0 percent of respondents had positive attitudes toward COVID-19, followed by neutral attitudes (6.9%) and negative attitudes (0.1%).

The respondents of this study had excellent preventive behavioral practices toward COVID-19. Table 4 shows that more than 90 percent of the respondents practiced all the preventive behavioral measures used in this study to prevent COVID-19. Bloom's cut-off shows that 94.3 percent of respondents had good preventive behavioral practices toward COVID-19. The average score in preventive behavioral practices toward COVID-19 was 7.7 (SD = 0.72, range: 0–8).

3.3. Predictors of knowledge, attitudes, and preventive behavioral practices toward COVID-19

Table 5 shows that the average knowledge score was statistically significantly ($p < 0.05$) varied by respondents' age, gender, educational attainment, occupation, geographical region, place of residence, marital status, and knowing someone as COVID-19 positive within the respondents' immediate social environment. The average score of attitudes toward COVID-19 was statistically significantly varied by the educational attainment, occupation, geographical region, place of residence, know someone as COVID-19 positive within the respondents' immediate social environment. Besides, knowledge about COVID-19 was also statistically significantly correlated with attitudes toward COVID-19 ($r = -.009$; $p = .001$) (Table 6). The average score of preventive behavioral practices toward COVID-19 was statistically significantly varied by age, gender, educational attainment, occupation, and marital status (Table 5). It shows that knowledge related to COVID-19 and attitude toward COVID-19 were not statistically significantly correlated with preventive behavioral practices.

The independent variables were entered into the backward stepwise multiple regression models after checking the assumptions and multicollinearity. The weighted sample was used to run the regression models.

Table 2. Knowledge related to COVID-19 (weighted sample, n = 1056).

Knowledge related to COVID-19	n (%)	
	Correct knowledge	Incorrect knowledge
Knowledge about symptoms of COVID-19		
Most common symptoms		
Fever	1024 (96.9)	32 (3.1)
Dry cough	1011 (95.7)	45 (4.3)
Fatigue (tiredness)	727 (68.9)	329 (31.1)
Less common symptoms		
Muscle or body aches and pains	745 (70.6)	311 (29.4)
Nasal congestion	727 (68.8)	329 (31.2)
Sore throat	1009 (95.5)	47 (4.5)
Diarrhea	785 (74.3)	271 (25.7)
Conjunctivitis	165 (15.6)	891 (84.4)
Headaches	661 (62.6)	395 (37.4)
Loss of taste or smell	638 (60.4)	418 (39.6)
A rash on the skin, or discoloration of fingers or toes	300 (28.4)	756 (71.6)
Severe symptoms		
Shortness of breath	1028 (97.3)	28 (2.7)
Chest pain or pressure	585 (55.4)	471 (44.6)
Loss of speech or movement	67 (6.3)	989 (93.7)
The novel Coronavirus can be asymptomatic	984 (93.2)	72 (6.8)
Knowledge about treatment and vaccine of Coronavirus		
There is no drug to treat the novel Coronavirus	775 (73.4)	281 (26.6)
There is no vaccine for the novel Coronavirus	982 (93.0)	74 (7.0)
Knowledge about transmission and incubation period of Coronavirus		
The novel Coronavirus can be transmitted by animals to humans only	280 (26.5)	776 (73.5)
The novel Coronavirus is transmissible via droplets through coughing, sneezing, or intimate contact	1033 (97.9)	23 (2.1)
The novel Coronavirus can remain alive for more than four hours	671 (63.6)	385 (36.4)
The novel Coronavirus can transmit during sexual intimacy	449 (42.5)	607 (57.5)
The novel Coronavirus can transmit through papers and cartoons used in packing groceries/foods/packets that we order online	817 (77.4)	239 (22.6)
A Coronavirus infected person can be recovered from COVID-19	1014 (96.1)	42 (3.9)
A recovered person be infected with Coronavirus again	854 (80.9)	202 (19.1)
What is the incubation period of the novel Coronavirus?	926 (87.7)	130 (12.3)
Bloom's cut-off point for the knowledge level	**Poor**	**Moderate**	**Good**
Knowledge related to COVID-19 (%)	7.0	67.2	25.8
Average score for knowledge related to COVID-19 = 17.29 (SD = 3.30, range: 1–25)			

Table 3. Attitude toward COVID-19 (weighted sample, n = 1056).

Statements	n (%)		
	Strongly disagree and disagree	Neutral	Agree and strongly agree
COVID-19 is a human-made disease	447 (42.4)	448 (42.4)	161 (15.2)
Positive with the Novel Coronavirus means death is definite	1016 (96.2)	32 (3.0)	8 (0.8)
COVID-19 is a punishment from the creator	515 (48.7)	303 (28.7)	239 (22.6)
COVID-19 does not attack Muslim people	1033 (97.8)	18 (1.7)	5 (0.5)
Non-Muslims are more prone to be infected by this virus	953 (90.2)	57 (5.4)	47 (4.5)
There is nothing called Coronavirus; it is just a bad air	1027 (97.2)	21 (2.0)	8 (0.8)
We can stay safe if we pray to Allah/God/Creator regularly	770 (73.0)	180 (17.0)	106 (10.0)
Coronavirus is created by Media	989 (93.6)	58 (4.5)	19 (1.8)
Bloom's cut-off point for attitude toward COVID-19	**Positive**	**Neutral**	**Negative**
Attitude toward COVID-19 (%)	93.0	6.9	0.1
Average score for attitude toward COVID-19 = 13.6 (SD = 3.7, range: 8–33)			

Age was dropped from the regression models due to multicollinearity with education ($r = .646$, $p < 0.001$) and marital status ($r = -.658$, $p < 0.001$) (Table 6). Both knowledge and attitudes scores fulfilled the linearity and normality criteria, but the preventive behavioral practice score was curvilinear and negatively skewed. The multiple linear regression analysis for knowledge and attitudes scores and multiple logistic regression analysis for preventive behavioral practice were used. The outlier cases were dropped from the models. Thus, the sample size is smaller in two models than the original size. Table 7 shows the final (reduced) models of stepwise regression.

Table 7 shows that women had higher knowledge than men ($\beta = 0.092$; $p = 0.003$). The respondents who had graduate-level ($\beta = 0.259$; p

Table 4. Preventive behavioral practices toward COVID-19 (weighted sample, n = 1056).

Ways to prevent COVID-19	n (%)	
	No	Yes
Washed hands for 20 s	8 (0.7)	1048 (99.3)
Used disinfectants to clean hands when soap and water was not available for washing hands	22 (2.1)	1034 (97.8)
Maintained at least 1- meter distance from others while at outside	59 (5.6)	997 (94.4)
Avoided crowded places	9 (0.8)	1047 (99.2)
Avoided touching eyes, nose, and mouth with hands	70 (6.6)	986 (93.4)
Covered mouth and nose with the bent elbow or tissue or handkerchief while coughing or sneezing	23 (2.2)	1033 (97.8)
Used mask to cover mouth and nose	5 (0.5)	1051 (99.5)
Stayed at home	25 (2.3)	1031 (97.7)
Bloom's cut-off point for practices toward COVID-19	**Poor**	**Moderate**	**Good**
Practices toward COVID-19 (%)	0.6	5.1	94.3
Average score for practices toward COVID-19 = 7.7 (SD = 0.72, range: 0–8)			

Table 5. Differentials of knowledge, attitudes, and preventive behavioral practices toward COVID-19 (weighted sample, n = 1056).

Variables	Knowledge score			Attitudes score			Preventive behavioral practices score		
	Mean	SD	*P*	Mean	SD	*P*	Mean	SD	*P*
Age (in years)			<0.001			0.159			<0.001
18-24	16.0	3.12		14.0	3.45		7.6	0.83	
25-30	17.3	3.00		13.6	3.69		7.8	0.58	
31-39	17.7	3.37		13.5	3.65		7.6	0.83	
40-49	17.5	3.32		13.4	3.67		7.9	0.35	
50 years and above	18.1	3.26		13.1	4.32		7.8	0.80	
Gender			0.008			0.292			0.023
Men	17.0	3.31		13.7	3.78		7.8	0.61	
Women	17.6	3.26		13.4	3.73		7.7	0.82	
Educational attainment			<0.001			<0.001			<0.001
Up to higher secondary	15.7	4.80		14.9	4.59		7.3	1.49	
Undergraduate	16.4	3.23		13.9	3.31		7.7	0.71	
Post-graduate (Masters)	17.7	2.93		13.4	3.81		7.7	0.62	
Post-graduate (MPhil/PhD)	17.8	3.43		12.7	3.65		7.9	0.32	
Occupation			<0.001			<0.001			<0.001
Government and private sector job	17.3	2.99		14.5	3.67		7.7	0.62	
Professional	18.2	3.04		13.3	3.70		7.8	0.59	
NGO worker	17.6	2.90		12.4	3.94		7.8	0.44	
Students and unemployed	16.4	3.21		13.8	3.39		7.6	0.80	
Others	16.8	4.52		14.6	3.89		7.5	1.18	
Region of Bangladesh			0.001			<0.001			0.706
The eastern part	16.8	3.68		14.7	3.87		7.8	0.52	
The middle part	17.5	3.24		13.2	3.69		7.7	0.75	
The western part	16.4	3.12		14.6	3.75		7.7	0.69	
Place of residence			<0.001			<0.001			0.922
Rural	15.6	4.30		15.5	4.24		7.7	0.71	
Urban (other than city corporation)	17.4	2.85		13.7	3.71		7.7	0.74	
City corporation	17.5	3.12		13.2	3.59		7.7	0.71	
Marital status			<0.001			0.815			0.013
Married	17.7	3.16		13.5	3.86		7.8	0.68	
Unmarried	16.7	3.39		13.6	3.60		7.6	0.77	
Know someone as COVID-19 positive within the immediate social environment			<0.001			<0.001			0.596
No	17.0	3.50		13.9	3.86		7.7	0.68	
Yes	17.8	2.84		13.0	3.50		7.7	0.77	
Own COVID-19 status			0.006			0.214			0.224
Negative	17.3	3.15		13.6	3.72		7.7	0.72	
Felt but not tested for	15.5	6.89		12.6	5.12		7.9	0.43	

Table 6. Correlation between outcomes and selected independent variables (weighted sample).

Variables	1	2	3	4	5	6
1. Age[b]	-					
2. Education[a]	.646 (<0.001)	-				
3. Marital status[a]	-.658 (<0.001)	-.443 (<0.001)	-			
4. Knowledge related to COVID-19[b]	.175 (<0.001)	.201 (<0.001)	-.156 (<0.001)	-		
5. Attitudes toward COVID-19[b]	-.080 (.010)	-.134 (<0.001)	.007 (.815)	-.099 (<0.001)	-	
6. Preventive behavioral practices to prevent COVID-19[b]	.070 (.023)	.180 (<0.001)	-.077 (.013)	.044 (.155)	-.010 (.736)	-

Note: P-value in the parenthesis; a = Spearman Rank-order Correlation; b = Pearson Correlation.

< 0.001) and MPhil/PhD level education (β = 0.161; p < 0.001) had significantly higher knowledge than the reference category (up to higher secondary). The respondents living in urban (β = 0.142; p < 0.001) and city corporation (β = 0.157; p < 0.001) areas had more knowledge than respondents living in rural areas. The unmarried respondents had less knowledge (β = -0.060; p = 0.049) than married respondents, while respondents who knew someone as COVID-19 positive within the immediate social environment had more knowledge (β = -0.070; p = 0.020) than those who did not know. The overall model used to predict COVID-19 related knowledge was statistically significant ($F_{(8, 1035)} = 9.277$; $P < 0.001$), and the included variables explained nine percent of the total model.

Table 7 also shows that the attitudes score toward COVID-19 was significantly lower among those respondents who had graduate-level (β = -0.135; p = 0.043) and MPhil/PhD level education (β = -0.142; p = 0.007) compared to those who had up to the higher secondary level of education. The respondents who were employed in the government and private sector (β = 0.186; p < 0.001), professional (β = 0.101; p = 0.010), and others category (β = 0.119; p = 0.001) had more negative attitudes toward COVID-19 than NGO workers. The respondents living in urban (β = -0.157; p < 0.001) and city corporation (β = -0.235; p < 0.001) areas had less negative attitudes than the respondents living in the rural area. Besides, the respondents who know someone as COVID-19 positive within the immediate social environment (β = -0.074; p = 0.016) had less negative attitudes toward COVD-19. The overall model used to predict negative attitudes toward COVID-19 was statistically significant ($F_{(10, 1030)} = 11.744$; $P < 0.001$), and it explained 11.7 percent of the total model.

Table 7. Predictors of knowledge, attitudes, and preventive behavioral practices toward COVID-19 (Weighted sample).

Variables	Knowledge				Attitudes				Preventive behavioral practices**			
	B	*SE B*	β	P	*B*	*SE B*	β	P	*B*	*SE B*	β	P
Gender												
Women	0.604	0.203	0.092	0.003								
Men (RC)												
Educational attainment												
Up to higher secondary (RC)												
Undergraduate	0.675	0.432	0.089	0.119	-0.678	0.499	-0.078	0.175	0.415	0.108	0.142	<0.001
Post-graduate (Masters)	1.717	0.420	0.259	<0.001	-1.021	0.504	-0.135	0.043	0.421	0.108	0.191	<0.001
MPhil/PhD	1.623	0.499	0.161	0.001	-1.628	0.601	-0.142	0.007	1.672	0.137	0.288	<0.001
Occupation												
Government and private sector job					1.853	0.363	0.186	<0.001				
Professional					0.896	0.349	0.101	0.010				
Students and unemployed					0.374	0.395	0.044	0.344				
Others					1.482	0.450	0.119	0.001				
NGO worker (RC)												
Place of residence												
Urban (other than city corporation)	1.286	0.389	0.142	0.001	-1.623	0.444	-0.157	<0.001				
City corporation	1.161	0.332	0.157	0.001	-1.985	0.375	-0.235	<0.001				
Rural (RC)												
Marital status												
Unmarried	-0.402	0.236	-0.060	0.049								
Married (RC)												
Know someone as COVID-19 positive within the immediate social environment												
Yes	0.480	0.207	0.070	0.020	-0.574	0.237	-0.074	0.016				
No (RC)												
Constant	14.404	0.658		<0.001	15.632	0.632		<0.001	2.145	0.651		0.003
Model Summary												
n	1044*				1039*				1056			
R	.313				.357							
R^2/Nagelkerke R^2	.098				.127				.033			
Adjusted R^2	.090				.117							

Note. *Sample size reduced as outliers were dropped from the analysis; **Logit model was used; the unstandardized beta = B; the standard error for the unstandardized beta = SE B; the standardized beta = β; the probability value = p; Reference category = RC.

On the contrary, none but the education was statistically significantly predicting the preventive behavioral practices toward COVID-19. It shows that the respondents who had undergraduate ($\beta = 0.142$; $p < 0.001$), masters level education ($\beta = 0.191$; $p < 0.001$), and MPhil/PhD level education ($\beta = 0.288$; $p < 0.001$) had more preventive behavioral practices toward COVID-19 than those who had up to higher secondary level education. Similar to bivariable analysis, the multiple logistic regression analysis shows that knowledge related to COVID-19 and attitudes toward COVID-19 did not predict preventive behavioral practices significantly. The overall model used to predict preventive behavioral practices toward COVID-19 was statistically significant ($X^2_{(9)} = 30.63$; $P < 0.001$), but it explained only 3.3 percent of the total model. We also analyzed the multiple regression model using the unweighted sample to see the effect of selection bias, which has been adjusted through the weightage of the sample. However, the findings remained almost identical.

4. Discussion

This study aimed to examine the levels of knowledge, attitudes, and preventive behavioral practices toward COVID-19 and how knowledge and attitudes influence preventive behavioral practices. We hypothesized that attitudes are a product of knowledge, and both knowledge and attitudes are the determinants of preventive behavioral practices related to COVID-19 after controlling the effects of covariates.

More than two-thirds (67.2%) of the participants of this study had moderate knowledge about COVID-19 with a mean knowledge score of 17.29 (SD = 3.70). This knowledge level can be considered relatively low, considering the respondent's high level of education. The findings show that women had more knowledge than men after controlling the effects of other independent variables. This finding is supported by other studies [18, 27] though many studies had a vice-versa result [2, 5, 15, 19, 27, 28]. In this study, the participants aged 50 years and above had a higher knowledge score at the bivariable level, similar to other studies [5, 7, 15, 19, 27, 28, 29, 30, 31]. However, we dropped the age variable from the multiple regression analysis due to its multicollinearity with education and marital status. We found education as a significant predictor of knowledge score after controlling the effect of other covariates, and respondents with MPhil/PhD degrees had more knowledge than any other educational category. Education has appeared as a significant predictor of knowledge in many studies [2, 5, 15, 19, 30] as education creates the opportunity to access information related to COVID-19 as well as it helps to assess that information rationally in the time of infodemic.

The study found that the respondents living in urban or city corporation areas had more knowledge than the respondents living in rural areas, which was found by other studies as well [2, 19, 30, 31]. The urban respondents have more knowledge as they have more access to COVID-19 related information through mass media, social media, and other sources. The unmarried respondents had less knowledge than married respondents. This finding is supported by Al-Hanawi et al. [5], though two Bangladeshi studies [15, 19] have concluded that unmarried had more knowledge than married respondents. In our study, unmarried respondents were relatively less educated and had a much lower average age than the married respondents. Both age and education of the respondents predicted their knowledge of COVID-19. Thus, married respondents being more educated and older had higher knowledge after controlling the effects of other variables. Finally, respondents had more knowledge if they knew someone as COVID-19 positive within their immediate social environment, which perhaps gave them the opportunity and motivated to learn more about COVID-19.

Most of the respondents in this study had positive attitudes toward COVID-19. The respondents who had more knowledge of COVID-19 had less negative attitudes toward COVID-19, which is the findings of other studies [2, 5, 21, 32]. This finding thus supported the hypothesis that more knowledge is associated with less negative attitudes toward COVID-19. Likewise, respondents with an MPhil/PhD level education had less negative attitudes toward COVID-19 than those respondents who had up to higher secondary, undergraduate, and post-graduate (Masters) level education. Rahman and Sathi [14] also supports this finding. The respondents working in the NGO sector had less negative attitudes toward COVID-19 than other occupational categories. Occupational variation as a predictor of attitudes toward COVID-19 had also been found in other studies [5, 29, 32]. The respondents living in rural areas were relatively less educated, less exposed to modernity, and less exposed to COVID-19 related information than respondents living in urban areas. Thus, the respondents living in rural areas had more negative attitudes toward COVID-19, supported by another study [18]. On the other hand, respondents had less negative attitudes toward COVID-19 if they knew someone as COVID-19 positive within their immediate social environment. That means personal contact with a COVID-19 positive person had developed positive attitudes toward COVID-19; similar findings exist in the context of HIV, where it has been observed that personal contact with HIV-positive persons is associated with reduced HIV-related stigma [33].

The respondents of this study had a very high level of preventive behavioral practices related to COVID-19 though they had a moderate level of knowledge related to COVID-19. The average score in preventive behavioral practices toward COVID-19 was 7.7 (SD = 0.72). This study could not prove our central hypothesis through multivariable analysis that the knowledge and attitudes toward COVID-19 determine the preventive behavioral practices. Based on previous studies on COVID-19 and non-COVID-19 [5–8,34–36], we hypothesized that knowledge and attitude would determine the preventive behavioral practices related to COVID-19. However, the findings in this regard are mixed among the available literature. Some studies have found similar results like our study, where knowledge and attitudes are not significant predictors of preventive behavioral practices [36, 37]. Though knowledge did not appear as a significant predictor of preventive behavioral practices, education, which was the predictor of knowledge, appeared as a significant predictor in increasing the preventing behavioral practices toward COVID-19 after controlling the effects of other covariates. Education gives opportunities for respondents to become aware of their environment and health. The higher educated respondents also get an opportunity in terms of access to health information and health promotion. Thus, education plays a vital role in behavior modification, and the finding of our study is also supported by the findings of other studies [5, 20, 28, 31, 32].

5. Conclusions and recommendations

The respondents of this study had moderate knowledge about COVID-19 with more positive attitudes toward COVID-19 and high rates of preventive behavioral practices toward COVID-19. However, knowledge has been found lower among men, relatively less educated, living in a rural area, and unmarried. On the other hand, negative attitudes existed among those who were relatively less educated, working in the government and public sector, students and unemployed, living in a rural area, and had less knowledge about COVID-19. The study found no influence of knowledge and attitudes on preventive behavioral practices related to COVID-19 though education appeared as a highly significant predictor of practices. This study suggests increasing education as a long-term strategy and taking immediate action to increase knowledge and decrease negative attitudes toward COVID-19 through targeted health education initiatives as a short-term strategy. Different platforms, such as social media and electronic media, can raise COVID-19 related awareness through health education programs.

6. Limitations of the study

Though the findings of this study will help the policymakers to identify the target group for health education programs for preventing COVID-19, some limitations of this study should be considered in interpreting the results. Firstly, this study was conducted among the

respondents who can read and write and have access to the internet. This selection criteria for the respondents limited the external validity of this study as the literacy rate in Bangladesh among the population aged 15 years and above is 74.7 percent [38], and around 62 percent population have access to the internet [39]. Thus, in terms of the education, this study could not reach to one-forth of the total population. On the other hand, among the respondents who participated in this study, the distribution of education is to some extent overestimated compared to national data. The Table 1 shows that 56.4 percent of the respondents had post-graduate (Masters) level education, and another 24.8 percent of respondents had undergraduate level education. Only 6.6 percent of the respondents had the education up to higher secondary. However, the national data shows that only 13.2 percent of population had higher than secondary level of education [40]. Thus, the higher degree of over-representation may have inflated the estimates of this study which may lack the generalizability of this study. Secondly, this study used convenience and snowball sampling, which also influenced the representativeness of the sample. Thus, the data was not representative of the distribution of the Bangladeshi population by age, sex, and place of residence. However, we used the weightage of these variables to make the data representative. Finally, this study collected self-reported data that may suffer from reporting bias.

Declarations

Author contribution statement

M.B. Hossain, M.Z. Alam, M.S. Islam, S. Sultan and M.M. Faysal: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

S. Rima, M.A. Hossain, M.M. Mahmood, S.S. Kashfi, A. al Mamun, H.T. Monia and S.S. Shoma: Performed the experiments; Contributed reagents, materials, analysis tools or 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 associated with this study has been deposited at Mendeley at doi:10.17632/8F5X85F5G3.1.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

Supplementary content related to this article has been published online at https://doi.org/10.1016/j.heliyon.2020.e05799.

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