Knowledge, Attitudes, and Practices Toward Coronavirus and Associated Anxiety Symptoms Among University Students: A Cross-Sectional Study During the Early Stages of the COVID-19 Pandemic in Bangladesh

Muhammad Mainuddin Patwary1,2*, Asma Safia Disha1,2, Mondira Bardhan1,2, Md. Zahidul Haque1,2, Md. Pervez Kabir1,2, Sharif Mutasim Billah1,2, Md. Riad Hossain3, Md. Ashraful Alam4, Matthew H. E. M. Browning5, Faysal Kabir Shuvo6, Awais Piracha7, Bo Zhao8, Sarya Swed9, Jaffer Shah10* and Sheikh Shoib11

OPEN ACCESS
Edited by:
Daria Smirnova,
Samara State Medical University,
Russia
Reviewed by:
Francesco Chirico,
Catholic University of the Sacred Heart, Rome, Italy
Haroon Ahmed,
COMSATS University, Islamabad Campus, Pakistan*
*Correspondence:
Muhammad Mainuddin Patwary
raju.es111012@gmail.com
Jaffer Shah
jaffer.shah@kateb.edu.af

Specialty section:
This article was submitted to Public Mental Health, a section of the journal Frontiers in Psychiatry

Received: 16 January 2022
Accepted: 17 February 2022
Published: 01 April 2022

Background: University students’ knowledge, attitude, and practice (KAP) toward COVID-19 are vital to prevent the spread of the virus, especially in the context of developing countries. Consequently, the present study aimed to determine the KAP levels of university students and associated anxiety during the earlier stage of the pandemic in Bangladesh.

Methods: A cross-sectional, online study with 544 university students was conducted during April 17–May 1, 2020. The questionnaire incorporated several KAP-related test items aligned with the World Health Organization (WHO) guidelines. Anxiety was measured with the 2-item Generalized Anxiety Disorder scale (GAD-2). Multivariable logistic regression analysis was performed to determine the association between KAP levels and anxiety adjusting for sociodemographic variables. Subgroup analyses included rerunning models stratified by gender and quarantine status.

Results: Approximately 50% of students showed high levels of knowledge about COVID-19 guidelines, 59% reported behavioral practices that aligned with COVID-19 guidelines, and 39% had negative attitudes toward COVID-19 guidelines. Attitudes differed by anxiety ($\chi^2 = 23.55, p < 0.001$); specifically, negative attitudes were associated with higher anxiety (OR: 2.40, 95% CI = 1.66–3.46, $p < 0.001$). Associations were significant for male (OR = 2.36; 95% CI = 1.45–3.84, $p < 0.001$) and female (OR = 2.45; 95% CI = 1.3–4.34; $p < 0.001$) students. Stratified analyses found non-quarantined students with negative attitudes had three times the chance of experiencing
The rapidly spreading coronavirus disease 2019 (COVID-19) has been recognized as a worldwide public health concern. The World Health Organization (WHO) declared COVID-19 a public health emergency of international concern on 30 January 2020 and urged all nations to work together to halt the epidemic (1). In response, countries around the world implemented a variety of containment measures, including the closure of educational and other government and non-government institutions, prohibition of large-scale social gatherings, restrictions on local, national, and international travel, and complete lockdowns to prevent viral transmission (2, 3). Despite these precautions, the world has recorded a massive number of infected cases, about 262 million, with 5.2 million deaths to-date because of the highly contagious nature of the coronavirus (4).

The first COVID-19 case in Bangladesh was reported on March 08, 2020 (5). As one of the most densely populated countries, Bangladesh faced particularly demanding challenges to manage the knowledge, attitudes, and behavior practices regarding COVID-19 in its massive population (6, 7). As of August 14, 2021, Bangladesh reported COVID-19 cases surpassed 1.4 million, and COVID-19-related deaths exceeded 23,600 (5). To control the spread of the virus, the Bangladesh government has taken several precautionary measures, including educational institution shutdowns, ceasing all social gatherings, closing government and non-government entities except emergency services, restricting tourism, and limiting intra-country travel (7–9). Besides, several organizations voluntarily promoted massive advertisements regarding COVID-19 on awareness-raising, proper handwashing practices, wearing facemask appropriately, and maintaining social distancing, among other measures (10).

For Bangladesh to further control the virus, each citizen must be informed, maintain attitudes that support adherence to behavioral practices, and practice measures that reduce health risks and viral transmission (11). Therefore, appropriate knowledge, attitude, and practice (KAP) levels toward this infectious disease are cognitive keys to this public health emergency (12). KAP entails a variety of ideas regarding the disease's etiology and exacerbating variables, and the identification of symptoms, treatment options, and repercussions (13). Studies during the Severe Acute Respiratory Syndrome (SARS) pandemic showed poor level of KAP concerning contagious diseases was an obstacle to containment (14). During the COVID-19 pandemic, some scholars believe that poor knowledge and orthodox religious beliefs may be responsible for negative attitudes and ineffective containment strategies (6).

Knowledge, attitude, and practice surrounding health-related habits, along with environmental and financial factors, status of quarantine, lockdown measures and fear of COVID-19 may influence anxiety levels during the pandemic (15, 16). According to a previous study on Brazilian people, respondents experienced fear and mental distress due to multi-level coping strategies (17). Another study conducted in Latvia found that poor health conditions, fear of contracting COVID-19, having family members contract COVID-19, family conflicts, lack of religiosity and caring for a vulnerable person were associated with depression and anxiety (18). Several studies on infectious diseases found that knowledge and attitude toward these diseases were related to serious psychological distress, fear, and stigma among people that challenged efforts to prevent disease spread (19–21). In the 2003 SARS outbreak, lower levels of anxiety were associated with higher levels of knowledge and positive attitudes toward infectious disease transmission (22). A cross-sectional study of Chinese college students during COVID-19 found that knowledge and attitudes were protective against mental distress (21). Another study in Latvia reported that preventive behaviors during COVID-19 were associated with COVID-19 threat appraisal, trust in information sources, and fear (23). Another study identified protective factors of COVID-19 including disbelief in the effectiveness of precautionary behavior were associated with lockdown-induced anxiety (24). A global analysis of 40 countries reported that physical inactivity, excessive use of the internet, tendency to stay up late, sleeping pills and dreams of being trapped contributed to anxiety during the COVID-19 lockdown (25). Ding et al. (26) conducted a study of 817 pregnant women and reported that high knowledge scores were associated with less anxiety. Alaloul et al. (27) reported high levels of anxiety were associated with preventive measures in Oman during the pandemic. Other studies in Singapore, China and Italy found that self-efficacy and information sufficiency was associated with lower anxiety levels, while higher anxiety levels were catalysts to adopt preventive behaviors (28). Another study in Indonesia found that individuals with correct responses to knowledge tests had significantly lower anxiety scores. That study also found individuals reporting practices that conflicted with WHO guidance, such as attending crowded places, showed higher anxiety scores (29). Collectively, these studies suggest KAP level are associated with anxiety during the pandemic. However,
some contradictory evidence also exists; high anxiety levels in India (30) and China (31) were found even in respondents with reasonably good levels of knowledge about the virus. Chowdhury et al. (32) reported anxiety due to COVID-19 was negatively associated with risky behavior during COVID-19 outbreaks. Based on this literature and the emerging COVID-19 situation, it remains important to determine level of KAP surrounding the coronavirus and its associations with anxiety. Such knowledge would provide further insight into how Bangladesh can prevent the further spread of the contagion and downstream impacts of its citizens’ mental health.

At present in Bangladesh, the literacy rate of current status stands for 74.9%, while the Net Enrollment Rate (NER) on primary education is almost 97.94% and over 1.3 million students receive tertiary level of education, of which 74% were male, and 26% were female (33, 34). In the present study, we studied KAP surrounding COVID-19 and anxiety among university students. This sample was chosen because we expected they would be motivated and insightful regarding positive attitudes toward COVID-19 containment measures. In Bangladesh, there have been several studies on the KAP of students and young adults (35–39). Further, Hossain and his research team investigated Bangladeshi general people’s KAP toward COVID-19 and their underlying fear levels in relation to sociodemographic factors (40). However, the KAP of university students and their association with mental distress has yet to be investigated. Based on this research gap, the present study aimed to determine KAP toward COVID-19 and associated anxiety of university students during the earlier stage of the pandemic in Bangladesh. More specifically, this study aimed to:

a. Determine Knowledge, Attitude, and Practice (KAP) levels of university students toward COVID-19.

b. Test associations between KAP levels and anxiety during the COVID-19 lockdown period.

c. Explore gender-based differences in associations between KAP levels and anxiety.

d. Examine quarantine status-based differences in KAP levels and anxiety associations.

MATERIALS AND METHODS

Study Participants and Sampling Procedure

A cross-sectional study was conducted during the first wave of the pandemic among university students of Bangladesh to understand their KAP levels and anxiety during the COVID-19 pandemic. Inclusion criteria included current enrollment as a university student and the decision to participate in our study. The questionnaire was prepared in English and then translated to the local language (Bangla). A snowball sampling procedure was used to collect the data. First, we distributed a web-based structured questionnaire through attainable social networks (e.g., Facebook, WhatsApp, and Instagram). Then, we requested our social network communities to provide their responses and asked them to share the questionnaire with their networks. The questionnaire was prepared following the World Health Organization (1) guidelines. It was divided into the following sections: (a) demographic information, (b) knowledge toward the COVID-19 pandemic, (c) attitudes toward the spread of COVID-19, (d) related practices to control the spread of COVID-19, and (e) anxiety.

The questionnaire’s relevance was determined by consulting a panel of experts. A relevance analysis was used to determine the content validity of each questionnaire block. Experts offered constructive feedback on readability, general relevance, and specific relevance to the study’s aims. The questionnaire was then pilot with 25 participants to gather additional feedback. The questionnaire was modified based on this feedback and made more understandable. Cronbach’s alpha values were used to determine the reliability index of both the pilot and final questionnaires. All values were more than 0.75, suggesting that the reliability was satisfactory (41).

Previous studies using our suite of measures were unavailable; therefore, we used an online calculator to estimate our necessary sample size (42). We followed the recommended conservative value (50%) for the proportion of our sample displaying our factor of interest. Thus, we calculated the minimum required number of respondents using an online sample size calculator, which was determined at 427 based on a 10% non-response rate, 5% precision, and 50% proportion, with a 95% confidence range for the overall population size of 3.2 million of tertiary level students in Bangladesh (43).

We gathered 744 responses between April 17 and May 01, 2020. As our target population was university students, we cross-checked our data and found that among the respondents, 544 students from different universities of Bangladesh responded. Thus, a total of 544 responses were used for the final analysis. All survey items were answered by all participants, so missing data analysis was not required. Electronic consent was obtained from all participants prior to their completion of the survey. The participant could opt out at any time. Additionally, the survey did not ask participants to provide their names or email addresses, ensuring that the participant could not be identified. Accordingly, the research ethical clearance board of the Institute of Disaster Management, Khulna University of Engineering & Technology, Khulna, Bangladesh waived the approval for this study.

Measures

The survey gathered information on the independent (KAP levels) and dependent variable (anxiety) as well as basic information on university students. This basic information included their gender, age, degree of education, residential status, living status, quarantine status, and sources of information during the COVID-19 epidemic.

- Participants’ knowledge of the COVID-19 pandemic was assessed using 24 yes/no questions about the illness type, mode of transmission, and likelihood of exposure to transmission risk. Respondents were asked to answer questions as true or false, with the option of “don’t know.” Correct responses received a score of one, while incorrect...
and frequencies (%), while continuous data were displayed as means and standard deviations (SD). Associations between KAP levels and anxiety were tested with Pearson chi-square tests and Student's t-tests. To determine associations between KAP levels and anxiety while adjusting for other factors, multivariable logistic regression models were run. Controls included gender, age, education, place of residence, living status, quarantine status, and information sources. Stratified analyses were conducted to examine associations between KAP levels and anxiety in men vs. women and in students under vs. outside of quarantine. The significance of associations was determined with odds ratios (OR) and 95% confidence intervals (CI). A two-tailed test with a significance level of \( p < 0.05 \) was considered statistically significant. The R Statistical Package (version 4.0), developed by R Core Team released on 2021 and IBM SPSS Statistics, Version 26.0. IBM Corp., Armonk, NY, United States were used to analyze the data.

RESULTS

Sample Demographics

Demographic characteristics of students are displayed in Table 1. Of the total, 56.99% were men, and 43.01% were women. The majority (72.43%) were 25 years old or less. Most were undergraduate students (66.54%), followed by graduate (27.21%) and post-graduate (6.25%) students. A total of 84.74% were urban residents, and 78.86% lived with family members. Approximately one-third (32.17%) were in quarantine during the survey period. The largest share of respondents used social media to collect information about the pandemic (89.34%), followed by traditional media (77.57%), governmental agencies (77.21%), online media (60.85%), and healthcare staff (31.43%). Females \((\chi^2 = 12.34, p < 0.05)\), participants over the age of 25 \((\chi^2 = 19.32, p < 0.05)\), graduate students \((\chi^2 = 18.34, p < 0.05)\), and non-quarantined students \((\chi^2 = 4.56, p < 0.05)\) were more likely to show high anxiety relative to their counterparts.

Knowledge, Attitudes, Practices, and Anxiety Levels

Frequencies of correct and incorrect answers to knowledge-related questions are provided in Supplementary Table 1. Almost all students (91.91%) agreed with the statement, “COVID-19 is an infectious disease.” About 94.67% of students answered correctly for droplets as one of the transmission routes of the virus, followed by a face-to-face talk (77.39%), handshaking (97.06%), fecal-oral transmission (66.36%), mosquito bites (72.06%), and touching of objects used by an infected person (96.32%). Most students responded incorrectly that food, air, and pets could transmit COVID-19. More than nine-in-ten students knew the common symptoms of COVID-19 such as fever (95.77%), dry cough (90.81%), sore throat (91.91%), and difficulty breathing (93.93%). Most students provided incorrect answers for nose bleeds (95.77%) and aches and pains (60.29%). Another 87.50% of students gave the correct answer for the incubation period as understood at the time of this study (1–14 days). When respondents were asked about individuals at most risk of COVID-19, most students correctly answered
that people over 60 years old (97.61%), people with chronic illness (92.28%), healthcare professionals (91.36%), and pregnant women (54.23%) were at increased risk of COVID-19. On the other hand, 71.14% of participants believed that young people were not at high risk of COVID-19. One exception was noticed for children, where more than half provided the incorrect answer.

Supplementary Table 2 shows the positive and negative attitudes students held toward COVID-19 during the lockdown. Nearly half of the respondents believed that life would be back to normal soon. However, 29.41% were not optimistic and reported being undecided about this statement. Approximately 70% believed in the necessity of social support during the pandemic. In contrast, more than half were worried about their economic condition being at risk. Another 39.89% consented that they were worried about their academic routine while almost one-third were undecided about this. Besides, 31.25% were undecided about infected people facing stigma in the society.

Regarding practices toward COVID-19, 56.86% of respondents reported that they were staying at home (Supplementary Table 3). The vast majority did not wash their hands more frequently with soap and water (91.36%) or avoid social gatherings (92.83%) and public transports (86.21%).

Table 2 shows the KAP scores of students with and without anxiety during COVID-19. Of the total, 50.55% (N = 275) demonstrated a high level of knowledge, 38.61% showed a negative attitude, and 59.01% maintained good practices regarding the COVID-19 pandemic. Students with anxiety had significantly higher negative attitudes about COVID-19 (52.85%, $\chi^2 = 23.55$, $p < 0.001$). There were no statistically significant differences in knowledge and practice scores between students with and without high anxiety.

## Associations Between Knowledge, Attitude, and Practice Levels and Anxiety

Bivariate correlations between KAP levels and anxiety are reported in Table 3. Knowledge was positively correlated with attitudes ($r = 0.156$, $p < 0.01$) and practices ($r = 0.227$, $p < 0.01$). Attitudes were also positively correlated with practices ($r = 0.178$, $p < 0.01$). Anxiety was positively correlated with attitudes ($r = 0.287$, $p < 0.01$) but not with knowledge or practices ($p > 0.05$).

Table 4 presents the results of a logistic regression model used to determine fully adjusted associations between KAP
TABLE 2 | Knowledge, attitude, and practice (KAP) levels toward COVID-19 among students with and without anxiety, and significant tests between each level and anxiety.

| KAP score | N (%) | \( \chi^2 \) | p-value |
|-----------|-------|--------------|---------|
|           | Total | Without anxiety | With anxiety |
| Knowledge |       |               |          |
| High      | 275 (50.55) | 157 (57.09) | 118 (42.91) | 1.836 | 0.192 |
| Low       | 269 (49.45) | 138 (51.30) | 131 (48.70) |       |       |
| Attitudes |       |               |          |
| Positive  | 334 (61.39) | 186 (65.20) | 151 (44.80) | 23.55 | 0.000*** |
| Negative  | 210 (38.61) | 99 (34.74)  | 111 (52.85) |       |       |
| Practices |       |               |          |
| Good      | 321 (59.01) | 173 (58.93) | 148 (46.11) | 0.035 | 0.853 |
| Bad       | 223 (40.99) | 122 (41.07) | 101 (53.89) |       |       |

Chi-square test was conducted to identify significance difference. **p < 0.001 (2-tailed).

TABLE 3 | Correlations between knowledge, attitude, and practice (KAP) levels toward COVID-19 and anxiety among university students in Bangladesh during the early phases of the pandemic (N = 544).

| Knowledge | Attitudes | Practices | Anxiety |
|-----------|-----------|-----------|---------|
| Knowledge | 1         |           |         |
| Attitudes | 0.156**   | 1         |         |
| Practices | 0.227**   | 0.178**   | 1       |
| Anxiety   | 0.007     | 0.287**   | 0.081   | 1       |

**p < 0.01 (2-tailed).

TABLE 4 | Multivariate logistic regression models to determine associations between knowledge, attitude, and practice (KAP) levels toward COVID-19 and anxiety among university students in Bangladesh during the early phases of the pandemic (N = 544).

| KAP levels | Crude model | Fully adjusted modela |
|------------|-------------|----------------------|
|            | OR (95% CI) | P-value | OR (95% CI) | P-value |
| Knowledge  |             |         |             |         |
| Low        | 0.72 (0.51–1.03) | 0.06 | 0.71 (0.50–1.02) | 0.06 |
| High       | 1.00 (ref.) |         | 1.00 (ref.) |         |
| Attitudes  |             |         |             |         |
| Negative   | 2.43 (1.71–3.45) | 0.000*** | 2.40 (1.66–3.46) | 0.000*** |
| Positive   | 1.00 (ref.) |         | 1.00 (ref.) |         |
| Practices  |             |         |             |         |
| Bad        | 0.95 (0.66–1.35) | 0.78 | 0.90 (0.62–1.32) | 0.60 |
| Good       | 1.00 (ref.) |         | 1.00 (ref.) |         |

Abbreviations: OR, odds ratio; CI, confidence interval; ref, reference. a Adjusted for gender, age, education, place of residence, living status, quarantine status, and information sources. **p < 0.001 (2-tailed).

DISCUSSION

Summary of the Findings

As one of the densely populated countries in the world, Bangladesh has faced challenges to implementing non-therapeutic measures such as avoiding social gatherings and public transport, wearing masks, washing hands frequently, and other practices. In this catastrophic condition, higher education is one of the worst affected sectors of society. However, past research suggests that adequate knowledge, positive attitudes, and good behavioral practices of students not only supports health and safety but also prevents mental distress. Thus, our study investigated KAP levels toward COVID-19 and associated anxiety in university students during the early stage of the pandemic.

Our results show that approximately half of the students had sufficient levels of knowledge and more than half adhered to COVID-19 precautionary practices. These findings corroborate a previous study with over 10,000 Bangladeshi adults that reported high levels of knowledge regarding COVID-19 preventative behaviors (48). Such findings speak to the effectiveness of delivering massive online public health education during lockdown (49). However, more than half of the students gave incorrect answers regarding the transmission of COVID-19 by food, air, and pets. Also, a few students incorrectly did not think that aches and pains were symptoms of the disease and half of respondents incorrectly associated the occurrence of COVID-19 with nasal congestion. The latter belief could be attributed to mistakes of linking the common fever with cold symptoms (50). The origin of the other incorrect beliefs is unclear but indicates that additional education and research are needed.

Less than half of the students showed negative attitudes toward COVID-19. Mostly, students were unclear about whether their economic conditions and academic careers would be disrupted due to the pandemic. This ambiguity can negatively affect mental health and decision-making ability (51). Similar to other studies (52, 53), half of students realized the importance of social support during the pandemic. Furthermore, nearly one-third of students

levels and anxiety. After accounting for co-variables (gender, age, education, place of residence, living status, quarantine status, and information sources), participants with negative attitudes toward COVID-19 expressed 2.4 times higher risk of anxiety (95% CI: 1.66–3.46, \( p = 0.000 \)). Associations between practices and anxiety were not statistically significant, whereas associations between knowledge and anxiety were negative and approached significance (OR = 0.71, 95% CI: 0.50–1.02, \( p = 0.06 \)). However, none of adjusted variables were found significant (Supplementary Table 4).

Adjusted associations between KAP and anxiety levels stratified by gender and quarantine status are displayed in Figures 1, 2, and Supplementary Tables 5, 6. Both men and women who had negative attitudes toward COVID-19 were at greater risk of anxiety (Male: OR = 2.36; 95% CI: 1.45–3.84; Female: OR = 2.45; 95% CI: 1.3–4.34; \( p < 0.001 \)) (Figure 1 and Supplementary Table 5). Non-quarantined students showing negative attitudes had over three times the chance of experiencing anxiety (OR = 3.14, 95% CI: 1.98–4.98, \( p < 0.001 \)), and non-quarantined students with a low level of knowledge had half the risk of experiencing anxiety (OR = 0.49, 95% CI: 0.31–0.78, \( p < 0.01 \)). In the case of quarantined students, no significant associations between KAP levels and anxiety were observed (Figure 2 and Supplementary Table 6).
believed that COVID-19 contributed to societal stigma. These findings highlight the importance of social factors on KAP and mental health among university students during the lockdown, which requires the attention of relevant departments.

Compared to other studies (i.e., 54, 55), our study showed a reduced rate of precautionary behaviors toward COVID-19. Despite having sufficient knowledge, half of students did not adhere to such measures, which was similar to the finding reported by Ferdous et al. (56). Such avoidance can stem from lack of clarity in recommended behavioral measures as well as uncertainty regarding their effectiveness against COVID-19 (57). The percentage of students not adhering to these behaviors was much higher than in some past research (22). One explanation may be the educational gap, which reflects a lack of understanding about public health information. Since our study participants were students, they returned to their homes during

**FIGURE 1** Differences in KAP and anxiety levels by gender during the COVID-19 lockdown. Abbreviations: OR, odds ratio; CI, confidence interval; ref, reference. Adjusted for age, education, place of residence, living status, quarantine status, and information sources.

**FIGURE 2** Differences in KAP and anxiety levels by quarantine status during the COVID-19 lockdown. Abbreviations: OR, odds ratio; CI, confidence interval; ref, reference. Adjusted for age, gender, education, place of residence, living status, and information sources.
lockdown in areas with limited access to information, particularly in rural areas. In addition, people in low-middle income countries, like Bangladesh, generally have poor personal hygiene practices and are less conscious about their health; for instance, only 40% of people have access to facilities to wash their hands with soap and water (58, 59). These factors might contribute to a lack of understanding of COVID-19 protective measures. Although a good knowledge level on infection transmission was found among the students, there was still opportunity to improve these levels. It is widely accepted that a population that is more informed about the disease would adhere to preventative and treatment measures more effectively (56).

Many surveyed students experienced anxiety, including 52% of males and 48% of females. In the early stage of COVID-19, the prevalence of moderate to severe psychiatric symptoms has been documented in several studies (60–63). Prior to the pandemic, the prevalence rate of anxiety was 4.1%, which is approximately five times lower than the present situation (64). Reasons for the higher rates in our sample could be explained by the large share of students (78%) living with their families; one of the reasons for anxiety comes from the fear of spreading the virus between family members through thyself (65). In addition, over 90% of students experiencing anxiety in our sample used social media, such as Twitter and Facebook to update and get information about COVID-19. Past research has found that indirect exposure to mass trauma via media may result in anxiety disorder (66). A recent study conducted in mainland China discovered that increased exposure to social media increased the risk of experiencing anxiety (67).

Our study found that negative attitudes toward COVID-19 were potential risk factors for developing anxiety during the lockdown. In other words, anxiety was comparatively lower among participants who showed positive attitudes toward COVID-19. According to previous research among college students, scholars denoted that positive attitudes were protective against anxiety (OR = 0.822, 95% CI = 0.762–0.887) (21). They mentioned that if people could increase their confidence in resisting COVID-19, it would be advantageous to their mental wellbeing. Another study indicated that young adults intending to gather information about COVID-19 were less likely to develop anxiety (28). As stated in the literature, certain behaviors and responses vary by age and gender (54). One of the reasons for developing anxiety among university students could relate to their academic disruptions. The lockdown caused considerable disruptions that created learning gaps among many students. Such disruptions may have impacted students’ mental health since they were more likely to graduate later than expected (68). To comply with strict precautions, educational institutions had to transfer in-person learning to virtual online classes that created extra burdens among many students (69, 70). Additionally, disruptions in academic activities may have led to uncertainty about future career prospects and therefore increased anxiety (71). Finally, the increasing case counts, lack of proper treatment, absence of available vaccine during the time of this study, media speculation and sensational news could have made students more vulnerable to develop psychological distress during early stage of the COVID-19 pandemic (72–75).

Regarding our stratified analyses, showing negative attitudes was significantly associated with anxiety for males, females, and non-quarantined students. Females indicated stronger effects than males as well. Similar findings were reported elsewhere (21); female students with negative attitudes were more likely to develop anxiety. Usually females are more vulnerable to anxiety and depression because of their social expectations. The situations may be exacerbated during the time of a crisis. An extensive review conducted in 30 countries found a greater prevalence of depression among women (76). Studies have also reported that women are 1.6 times more likely to develop mental disorders than men (77, 78). It is important to mention that women must multitask in household duties while providing caregiving roles. In addition, the closing of educational institutions might have put additional pressures on women. To balance such overloads, women appear to be at particular risk of developing higher disorders (79). When stratified by quarantine status, respondents having negative attitudes and not being in quarantine tended to show higher risks of anxiety. This finding is contrary to an earlier study that showed students in quarantine were more anxious than non-quarantined students (80). This contradictory finding may be explained by the possibility of non-quarantine students being less aware of the impacts of COVID-19 during the early stages of the pandemic. An earlier study (81) reported that two-thirds of student participants had confidence that COVID-19 wouldn’t be a problem in Bangladesh. Despite the government holiday, students could not communicate with their friends in person due to COVID-19 restrictions, which would could have triggered depression and anxiety (82). The prolonged lockdown restricted students from going outdoors and having family outings, and forced to students to remain in the house idly. Consequently, students appear to have more provision to internet access, social media and news exposure and missed out on the salutatory benefits of physical activity and exposure to restorative environments (i.e., green spaces) (83). Furthermore, many news outlets prioritized sensational news and people frequently shared false and negative news that may have sparked mental stress among young adults, particularly students (84).

Implications
The findings of this study have theoretical and practical implications. Our study is the first of its kind in Bangladeshi university students to examine associations between KAP levels and anxiety. This study therefore expands our understanding about the roles of knowledge, attitudes, and behavioral practices on the mental health of young adults during the COVID-19 pandemic. Even though our study had some limitations, its findings could be relevant for university authorities and policymakers adopting public health interventions in effective and timely manners. Our study suggests that KAPs required to protect students from COVID-19 during the study period were at only moderate levels. Public health education programs should specific target behavioral practices regarding COVID-19 at universities, given the low levels of this dimension of KAPs in our sample. Such programs can be coordinated the Ministry of Education and Ministry of Health and Family Welfare in collaboration with universities. Also, given our notable finding
that negative attitudes and less knowledge were associated with anxiety, teachers can play an important role in improving mental health through education and reinforcing positive outlooks toward the COVID-19 situation.

While a wealth of data has been collected on student’s mental health since March 2020, investigations on the psychological and behavioral consequences of lockdowns should continue to be conducted as the pandemic wanes. Simultaneously, interventions should be introduced at universities to alleviate the negative lingering effects of the pandemic on students. Internet based cognitive therapy (CBT) could be an effective way to treat anxiety that works through stress management and relaxation techniques and is convenient for students to complete. Strategies for public policy could also include greater availability of mental health clinicians and psychosocial support interventions. Ultimately, we hope the behavioral data gathered in the current study might serve as a reference for other COVID-19 researchers working on this important and critical area.

**Limitations of the Study**

There are some limitations to this research. First, our study was cross-sectional, which was insufficient to explain casual relationships between KAP levels and anxiety. To evaluate these hypothesized causal links, longitudinal investigations may be necessary. Secondly, response biases may have existed in the online and self-reported questionnaires. Without internet connections, respondents could not provide their opinions so our study could not reach these populations. In addition, there could be selection bias due to our use of a non-probability sampling method. Finally, we considered only the early stage of the COVID-19 pandemic, which was a short period of time relative to the entire pandemic. Consequently, our results may not apply to different times of the COVID-19, which means ongoing research should be conducted during the pandemic.

**CONCLUSION**

This is one of the first studies to examine knowledge, attitudes, and behavioral practices knowledge, attitude, and behavioral practice (KAP) levels toward COVID-19 and associated anxiety levels in university students during the first phase of the pandemic. The results provide insights into KAP levels and anxiety rates at this first phase. More than half of students showed high levels of knowledge and good behavioral practices; however, a significant portion of students also held negative attitudes toward COVID-19. Low knowledge levels and negative attitudes were risk factors for anxiety. Consequently, proactive interventions, such as economic and academic security and social support, might be necessary to encourage positive attitudes and psychological welfare. Social support to reduce social stigma is another recommendation. Simultaneously, authentic information sources should be ensured to expand virus-related knowledge and adopt good behavioral practices. The abovementioned suggestions would ultimately support the psychological wellbeing of university students during the ongoing pandemic.

**DATA AVAILABILITY STATEMENT**

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

**ETHICS STATEMENT**

The studies involving human participants were reviewed and approved by Institute of Disaster Management, Khulna University of Engineering & Technology, Khulna, Bangladesh. The patients/participants provided their written informed consent to participate in this study.

**AUTHOR CONTRIBUTIONS**

MP: conceptualization, methodology, formal analysis, writing-original draft, review, and editing. AD and MB: conceptualization and writing-original draft. MHA: conceptualization, data curation, and writing-original draft. SB, MHO, MA, MHB, FS, AP, BZ, SaS, JS, and ShS: writing-review and editing. All authors contributed to the article and approved the submitted version.

**ACKNOWLEDGMENTS**

We would like to extend our sincere thanks to all the respondents who voluntarily participated in the survey and provided valuable responses during the COVID-19 situation.

**SUPPLEMENTARY MATERIAL**

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.856202/full#supplementary-material

**REFERENCES**

1. World Health Organization. 2019-nCoV Outbreak is an Emergency of International Concern. Rome: World Health Organization (2020).
2. Pedersen MG, Meneghini M. A simple method to quantify country-specific effects of COVID-19 containment measures. medRxiv. [Preprint]. (2020). doi: 10.1101/2020.04.07.20057075
3. Patwary MM, Bardhan M, Disha AS, Hasan M, Haque MZ, Sultana R, et al. Determinants of COVID-19 vaccine acceptance among the adult population of Bangladesh using the health belief model and the theory of planned behavior model. Vaccines. (2021) 9:1393. doi: 10.3390/VACCINES9121393
4. World Health Organization. WHO Coronavirus (COVID-19) Dashboard. WHO Coronavirus (COVID-19) Dashboard With Vaccination Data. Rome: World Health Organization (2021).
5. IEDCR. Institute of Epidemiology, Disease Control and Research (IEDCR). Dhaka: IEDCR (2021).

6. Haque T, Hossain KM, Bhuiyan MMR, Ananna SA, Hussain MA, Islam MR, et al. Knowledge, attitude and practices (KAP) towards COVID-19 and assessment of risks of infection by SARS-CoV-2 among the Bangladeshi population; an online cross sectional survey. Res Square. (2020).

7. Patwary MM, Hossain MR, Shuvo FK, Ashraf S, Sultana R, Alam MA. Protecting sanitation workers in low-middle income countries amid COVID-19. Ann Work Expos Health. (2021) 65:492–3. doi: 10.1093/annweh/wwaa128

8. Anwar S, Nasrullah M, Hosen MJ. COVID-19 and Bangladesh: challenges and how to address them. Front Public Health. (2020) 8:154. doi: 10.3389/fpubh.2020.00154

9. Hossain MR, Patwary MM, Sultana R, Browning MHEM. Psychological distress among healthcare professionals during the early stages of the COVID-19 outbreak in low resource settings: a cross-sectional study in Bangladesh. Front Public Health. (2021) 9:701920. doi: 10.3389/fpubh.2021.701920

10. Banik R, Rahman M, Sikder MT, Rahman QM, Pranta MUR. Knowledge, attitudes, and practices related to the COVID-19 pandemic among Bangladeshi youth: a web-based cross-sectional analysis. J Public Health. (2021) 1:1–11. doi: 10.3389/fpubh.2020.01432–7

11. Bedford J, Enria D, Giesecke J, Heymann DL, Ihekweazu C, Kobinger G, et al. COVID-19: towards controlling of a pandemic. Lancet. (2020) 395:1015–8. doi: 10.1016/S0140-6736(20)30673-5

12. Aijole K, Atakiti I, Oyenaningkaya K. College students’ knowledge, attitudes and adherence to public service announcements on Ebola in Nigeria: suggestions for improving future Ebola prevention education programmes. Health Educ J. (2017) 76:648–60. doi: 10.1177/0017896917710969

13. Szymona-Pałkowska K, Janowski K, Pedrycz A, Mucha D, Ambrozy T, et al. Factors related to COVID-19 preventive behaviors: a structural equation model. Front Psychol. (2021) 12:675621. doi: 10.3389/fpsyg.2021.675621

14. Erdelyi-Hamza B, Elek L, Kulg B, Kovács I, Fountoulakis KN, Smirnova D, et al. P.0640 Factors influencing changes in anxiety during the COVID-19 related lockdown: modifiable targets for prevention and intervention. Eur Neuropsychopharmacol. (2021) 53:5471. doi: 10.1016/j.euroneuro.2021.10.004

15. Smirnova D, Syunyakov T, Pavlichenko A, Bragin D, Fedotov I, Filatova V, et al. Interactions between anxiety levels and life habits changes in general population during the pandemic lockdown: decreased physical activity, falling asleep late and internet browsing about Covid-19 are risk factors for anxiety, whereas social media use is not. Psychiatr Danub. (2021) 33:119–29.

16. Ding W, Lu J, Zhou Y, Wei W, Zhou Z, Chen M. Knowledge, attitudes, practices, and influencing factors of anxiety among pregnant women in Wuhan during the outbreak of COVID-19: a cross-sectional study. BMC Pregnancy Childbirth. (2021) 21:80. doi: 10.1186/s12884-021-03561-7

17. Alhoul F, Alomari K, Al Qadire M, Al-Dwaikat T. Public knowledge, attitudes, and level of anxiety toward the COVID-19 pandemic among people living in Oman. Nurs Forum. (2021) 56:596–603. doi: 10.1111/nuf.12592

18. Lim JM, Tun ZM, Kumar V, Quaye SED, Offeddu V, Cook AR, et al. Population anxiety and positive behaviour change during the COVID-19 epidemic: cross-sectional surveys in Singapore, China and Italy. Influenza Other Respir Viruses. (2021) 15:45–55. doi: 10.1111/irv.12785

19. Rias YA, Rosyad YS, Chiropiola R, Wiratama BS, Sahtir CI, Weng SF, et al. Effects of spirituality, knowledge, attitudes, and practices toward anxiety regarding COVID-19 among the general population in INDONESIA: a cross-sectional study. J Clin Med. (2020) 9:3798. doi: 10.3390/jcm9123798

20. Roy D, Tripathy S, Kar SK, Sharma N, Verma SK, Kaushal V. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. Asia J Psychiatry. (2020) 51:102083. doi: 10.1016/j.ajp.2020.102083

21. Lin Y, Hu Z, Alias H, Wong LP. Knowledge, attitudes, impact, and anxiety regarding COVID-19 infection among the public in China. Front Public Health. (2020) 8:236. doi: 10.3389/fpubh.2020.00236

22. Riad A, Huang Y, Zheng L, Elavsky S. The associations of COVID-19 induced anxiety, related knowledge and protective behaviour. Health Psychol Res. (2021) 9:2476. doi: 10.5296/0141.24768

23. Chowdhury R, Sarkar M. Education in Bangladesh: changing contexts and emerging realities. In: Chowdhury R, Sarkar M editors. Engaging in Educational Research. Education in the Asia-Pacific Region: Issues, Concerns and Prospects. Berlin: Springer (2018). doi: 10.1007/978-981-13-0708-9_1

24. The World Bank. Literacy Rate, Adult Total (% of People Ages 15 and Above) - Bangladesh | Data. Washington, DC: The World Bank (2021).

25. Banik R, Rahman M, Sikder MT, Rahman QM, Ur M, Pranta R. Investigating knowledge, attitudes, and practices related to COVID-19 outbreak among Bangladeshi young adults: a web-based cross-sectional analysis. Res Square. (2020)

26. Rahman MM, Jhinuk JM, Nabila NH, Yeasmin MTM, Shohuj IA, Sayma TH, et al. Knowledge, attitude, and practices towards COVID-19 during the rapid rise period: a cross-sectional survey among public university students of Bangladesh. Sci Med J. (2021) 3:116–28. doi: 10.28991/SCIMEDJ-2021-03020-4

27. Rahman MM, Khan SJ, Sakib MS, Halim MA, Rahman MM, Jhinuk JM. COVID-19 responses among university students of Bangladesh: assessment of status and individual view toward COVID-19. J Hum Behav Soc Environ. (2021) 31:521–31. doi: 10.1080/10911359.2020.1822978

28. Wadood MA, Mamun A, Rafi MA, Islam M, Mowd S, Lee LL, et al. Knowledge, attitude, practice and perception regarding COVID-19 among students in Bangladesh: survey in Rajshahi University. medRxiv [Preprint]. (2020). doi: 10.1101/2020.04.21.2007475

29. Wadood MA, Mamun A, Rafi MA, Islam MK, Mowd S, Lee LL, et al. Survey on knowledge, attitude, perception and practice among university students during the COVID-19 pandemic. Sci Med J. (2021) 3:67–79. doi: 10.28991/SCIMEDJ-2021-03-01-9

30. Hossain MA, Jahid MIK, Hossain KMA, Walton LM, Uddin Z, Haque MO, et al. Knowledge, attitudes, and fear of COVID-19 during the rapid rise period in Bangladesh. PfLS One. (2020) 15:00239646. doi: 10.1371/JOURNAL.PONE.0239646

31. Bland JM, Altman DG. Statistics notes: cronbach’s alpha. BMJ. (1997) 314:572. doi: 10.1136/bmj.314.7080.572
42. Dhand NK, Khatkar MS. Statulator: An online statistical calculator. Sample Size Calculator for Estimating a Single Proportion. (2014). Available online at: https://statulator.com/

43. Mannan A. Achieving Our Higher Education Targets | The Daily Star. (2017). Available online at: https://www.thedailystar.net/education-employment/ achieving-your-higher-education-targets-1366513 (accessed January 1, 2022).

44. Hager E, Odetokun IA, Babalola M, Akoreluwak O, Al-Mustapha AI. Knowledge, attitude, and perceptions towards the 2019 coronavirus pandemic: a bi-national survey in Africa. PLoS One. (2020) 15:e0236918. doi: 10.1371/journal.pone.0236918

45. Hou F, Bi F, Jiao R, Luo D, Song K. Gender differences of depression and anxiety among social media users during the COVID-19 outbreak in China: a cross-sectional study. BMC Public Health. (2020) 20:1648. doi: 10.1186/s12889-020-09738-7

46. Pouso S, Borja Á, Fleming LE, Gómez-Baggethun E, White MP, Uyarra MC. Anxiety and depression in the republic of Ireland during the COVID-19 pandemic. Acta Psychiatr Scand. (2020) 142:249–56. doi: 10.1111/ACPS.13219

47. Özdim S, Özdim Ş.B. Levels and predictors of anxiety, depression and health anxiety during COVID-19 pandemic in Turkish society: the importance of gender. Int J Soc Psychiatry. (2020) 66:504–11. doi: 10.1177/0020764020927051

48. Shen L. COVID-19, anxiety, sleep disturbances and suicide. Sleep Med. (2020) 70:124. doi: 10.1016/j.sleep.2020.04.019

49. Shala M, Jetishi Çollaku P, Hoxha F, Blåca Balaj S, Preteni D. One year after the first cases of COVID-19: factors influencing the anxiety among Kosovar university students. J Health Soc Sci. (2021) 6:241–54. doi: 10.19204/2021/nrrf10

50. Guo X, Meng Z, Huang G, Fan J, Zhou W, Lin W, et al. Meta-analysis of the prevalence of anxiety disorders in mainland China from 2000 to 2015. Sci Rep. (2016) 16:28033. doi: 10.1038/srep28033

51. Moghanibashi-Mansourieh A. Assessing the anxiety level of Iranian general population during COVID-19 outbreak. Asian J Psychiatry. (2020) 51:102076. doi: 10.1016/j.ajp.2020.102076

52. Patwary MM, Bardhan M, Browning MHEM, Dishu AS, Haque Z, Billah SM, et al. Association between perceived trusted of COVID-19 information sources and mental health during the early stage of the Pandemic in Bangladesh. Healthcare. (2021) 10:24. doi: 10.3390/HEALTHCARE10010024

53. Gao J, Zheng P, Jia Y, Chen H, Mao Y, Chen S, et al. Mental health problems and social media exposure during COVID-19 outbreak. PLoS One. (2020) 15:e0231924. doi: 10.1371/journal.pone.0231924

54. Islam MA, Barna SD, Raihan H, Khan MNA, Hossain MT. Depression and anxiety among university students during the COVID-19 pandemic in Bangladesh: a web-based cross-sectional survey. PLoS One. (2020) 15:e0238162. doi: 10.1371/journal.pone.0238162

55. Patwary MM, Bardhan M, Browning MHEM, Dishu AS, Haque Z, Billah SM, et al. Association between perceived trusted of COVID-19 information sources and mental health during the early stage of the Pandemic in Bangladesh. Healthcare. (2021) 10:24. doi: 10.3390/HEALTHCARE10010024

56. Alateeq DA, Aljihani S, AlEesa D. Perceived stress among students in virtual classroom during the COVID-19 outbreak in KSA. J Taibah Univ Med Sci. (2020) 15:e0236918. doi: 10.1016/j.jtumed.2020.07.004

57. Patwary MM, Bardhan M, Dishu AS, Kabir MF, Hossain MR, Alam MA, et al. The impact of COVID-19 pandemic on mental health of university student: a cross-sectional study in Bangladesh. SSRN Electronic J. (2020)

58. Sahu P. Closure of universities due to coronavirus disease 2019 (COVID-19): impact on education and mental health of students and academic staff. Cureus. (2020) 12:e7541. doi: 10.7759/cureus.7541

59. Ayittey FK, Ayittey MK, Chiwero NB, Kamasah JS, Dzuvor C. Economic impacts of Wuhan 2019-nCoV on China and the world. J Med Virol. (2020) 92:473–5. doi: 10.1002/jmv.25706

60. Podder I, Agarwal K, Datta S. Comparative analysis of perceived stress in dermatologists and other physicians during national lockdown and COVID-19 pandemic with exploration of possible risk factors: a web-based cross-sectional study from Eastern India. Dermatol Ther. (2020) 33:e13788. doi: 10.1111/DTHT.13788

61. Shala M, Jetishi Çollaku P, Hoxha F, Blåca Balaj S, Preteni D. One year after the first cases of COVID-19: factors influencing the anxiety among Kosovar university students. J Health Soc Sci. (2021) 6:241–54. doi: 10.3390/2021/16:28033

62. Bartels M, Caccioppo JT, Van Beijsterveldt TCEM, Boomsma DI. Exploring the association between well-being and psychopathology in adolescents. Behav Genet. (2013) 43:177–90. doi: 10.1007/s10519-013-9589-7

63. Albert PR. Why is depression more prevalent in women? J Psychiatry Neurosci. (2020) 45:881–90. doi: 10.1501/jpn.2020.05.040

64. Sayeed A, Kundu S, Banna MH, Al Hasan MT, Begum MR, Khan MS. Mental health outcomes during the COVID-19 and perceptions towards the pandemic: findings from a cross-sectional study among Bangladeshi students.
Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2022 Patwary, Disha, Bardhan, Haque, Kabir, Billah, Hussain, Alam, Browning, Shuvo, Piracha, Zhao, Swed, Shah and Shoib. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.