

Knowledge and Attitude Towards COVID-19 and Associated Mental Health Status among Students of Sultan Qaboos University, Oman

M. Mazharul Islam^{1*}, Ronald Wesonga¹, Iman Al Hasani¹, Afra Al Manei²

¹**Department of Statistics, College of Science, Sultan Qaboos University, P.O. Box 36, PC 123, Al-Khod, Muscat, Sultanate of Oman;** ²**Department of Planning and Statistics, Sultan Qaboos University, Muscat, Sultanate of Oman.** *Email: mislam@squ.edu.om.

ABSTRACT: This study examined COVID-19-related knowledge and attitude towards COVID-19 and associated mental health status during COVID-19 pandemic among the students of Sultan Qaboos University (SQU), using an online cross-sectional survey conducted from 26 March - 25 April 2021. Both descriptive and inferential statistical techniques, including multiple logistic regression analysis, were used for data analysis. Of the 1,951 respondents, 60% were women, and the mean age of the respondents was 22 ± 4.6 years. Approximately 13% of the students' COVID-19 status was tested and 3.6% were found to be infected with the COVID-19 virus. Overall, students demonstrated a high level (81%) of knowledge and a positive attitude (83%) towards COVID-19. Knowledge appeared as a significant predictor of positive attitude. Despite the high level of knowledge and positive attitudes, some misconceptions and stigma prevailed for a group of students, since approximately one-third of the students opined that COVID-19 was a natural catastrophe and 13% of the students were in favor of keeping it secret if it was infected, which could impede the success of the COVID-19 prevention program. The study documented a high prevalence of mild to severe levels of depression (66.3%), anxiety (69.2%), and stress (71%) among the students. Younger age, female sex, undergraduate students, single marital status, college of study, and good knowledge about COVID-19 appeared as significant predictors of mental health problems among students. For improving the mental health and well-being of the students, the SQU authorities should provide accessible psychological support to the students, with particular attention to the identified sub-group of students. Efforts should be made to remove the COVID-19-related stigma through mass-media campaigns.

Keywords: Knowledge; Attitude; COVID-19; Mental health; Depression; Anxiety; Stress; Students; Oman.

المعرفة والموقف تجاه كوفيد-19 وحال الصحة النفسية المرتبطة بهما لدى طلاب جامعة السلطان قابوس، عمان

م. مظهر الإسلام، رونالد وسونغا، إيمان الحسني، أفراح المعنى

الملخص: تناولت هذه الدراسة المعرفة والآراء المتعلقة بـCOVID-19 وحال الصحة النفسية المرتبطة بهما أثناء جائحة كوفيد-19 بين طلاب جامعة السلطان قابوس، باستخدام مسح مقطعي عبر الإنترن特 تم إجراؤه في 26 مارس - 25 أبريل 2021 بين طلاب جامعة السلطان قابوس. واستخدمت كل من التقنيات الإحصائية الوصفية والاستنتاجية، بما في ذلك تحليل الانحدار اللوجستي المتعدد، لتحليل البيانات. من بين 1951 مشاركاً، 60% كانوا من الإناث، وكان متوسط عمر المشاركون 22 ± 4.6 سنة. تم اختبار حوالي 13% من حالة كوفيد-19 للطلاب وتبين أن 3.6% منهم مصابون بفيروس كوفيد-19. بشكل عام، أظهر الطلاب مستوى عالي (81%) من المعرفة وموافقاً إيجابياً (83%) تجاه كوفيد-19. ظهرت المعرفة كمؤشر مهم للموقف الإيجابي. على الرغم من المستوى العالي من المعرفة والآراء الإيجابية، إلا أن هناك بعض المفاهيم الخاطئة أو الوصمة السائدة لدى مجموعة من الطلاب، حيث رأى حوالي ثلث الطلاب أن فيروس كورونا COVID-19 كان كارثة طبيعية وكان 13% من الطلاب يؤمنون بإبقاء الأمر سراً إذا أصيبوا، مما قد يعيق نجاح برنامج الوقاية من فيروس كورونا. وفقت الدراسة ارتفاع معدل انتشار مستويات الإكتئاب من الخفيفة إلى الشديدة (66.3%)، والتلقّف (69.2%)، والتوتر (71%) بين الطلاب. وظهر أن صغر العمر، وطلاب البكالوريوس، والحالة الاجتماعية العازبة، والكلية الدراسية، والمعرفة الجيدة حول كوفيد-19، تتبّع بشكل مهم مشاكل الصحة النفسية بين الطلاب. لتحسين الصحة العقلية ورفاهية الطلاب، يجب على هيئة جامعة السلطان قابوس توفير الدعم النفسي الممكن للطلاب، مع إيلاء اهتمام خاص للمجموعة الفرعية المحددة من الطلاب. وينبغي بذل الجهود لإزالة الوصمة المرتبطة بفيروس كورونا (كوفيد-19) من خلال الحملات الإعلامية.

الكلمات المفتاحية: المعرفة؛ الموقف؛ كوفيد-19؛ الصحة النفسية؛ الإكتئاب؛ القلق؛ التوتر؛ الطلبة؛ عمان.



1. Introduction

The coronavirus disease 2019, in short COVID-19, with different variants emerged as a major public health crisis across the world in December 2019 in the Wuhan region of China and rapidly spread all over the world within three months of time, and the WHO declared it as the pandemic in March 2020 [1, 2]. COVID-19 can cause a range of illnesses in humans, from the common cold to severe acute respiratory syndrome (SARS) [3-5]. It is a highly infectious disease believed to spread through respiratory aerosol generated through coughing and sneezing by an infected person [6], and its main clinical symptoms include fever, dry cough, breathing difficulty, muscle or body aches, fatigue, myalgia, and dyspnea [7,8]. Other symptoms are sore throat, diarrhea, loss of taste or smell, and arthralgia [9-11].

At the outset of the pandemic, there was no proven vaccine or treatment for the disease. Therefore, to contain the spread of the infection within the population, strict infection control measures arising from the knowledge of the transmission mechanisms of the disease were imposed by the countries worldwide [6,12]. The strategies that were established worldwide were largely behavioral, such as social distancing, cleanliness, regular hand washing, and use of face masks in public. The compliance of these initiatives was primarily dependent on one's knowledge and attitudes towards the disease [9,11-13]. In addition, many countries implemented a series of measures, including quarantine, lock-down, suspension of local and international travel flights, bans on large gatherings, mandatory use of face masks, social distancing, closure of schools and universities and of business, home or online education of students, stay-at-home orders, and even curfews [5,14-16]. Despite these efforts, many people tend to ignore them due to poor knowledge and attitudinal issues. Adequate knowledge and positive attitudes of the public are expected to influence the degree of adherence to the personal protective measures, social stigma, clinical outcome and mental health. Hence, it is important to study these domains in any population for developing the effective coping mechanism.

The COVID-19 pandemic has brought into focus the mental health of various sub-groups of the population. Studies have shown that the pandemic created new stressors, including fear of infections, worry for oneself or survival for the loved ones, frustration, boredom, inadequate supplies, inadequate information, financial loss, and stigma [17-20].

Although young adults were found to have a lesser risk of having COVID-19 infection than their older counterparts, they are the most vulnerable group with regards to the deterioration of mental health due to the COVID-19 pandemic [21-24]. Student life, particularly the university student life marks a transitional period for students, during which students have to cope with many social, economic, developmental, and above all academic requirements, making them increasingly vulnerable to stress, anxiety, and depression as well as diabetes, rheumatic diseases and obesity [25-29]. COVID-19 pandemic adds a new dimension to their depression, anxiety, and stress levels.

Knowledge and attitude concerning COVID-19 was found to have significant association with the level of its spread, control and management in many countries across the world [11, 30-32]. Moreover, the situation could be even worse among students at higher institutions of learning because of deteriorating mental health status, resulting in a destabilizing effect on their normal academic performance. Although many studies have been conducted to assess knowledge and attitude of general population and health professionals since the emergence of the COVID-19 pandemic, there is a still scarcity of information regarding knowledge and attitude towards COVID-19 and the associated mental health status among the university students. The aim of this study was to explore the level of knowledge and attitude towards COVID-19 among the university students in Oman, and examined the impact of COVID-19 on mental health of the students. The study also examined the association between knowledge, attitude and mental health status of students and identified the predictors of knowledge and attitude towards COVID-19 and the mental health status during COVID-19. It also tested the hypothesis that COVID-19 elevates the burden of mental health issues among the students than general population. The findings of the study may have important policy implications both at university and national level.

2. Methods

2.1 Study design and participants

The data for this study was obtained through a cross-sectional online survey among the students of Sultan Qaboos University (SQU) in Oman, between 26 March and 25 April 2021. SQU is the only public university in Oman and students from all over the country are admitted on a competitive basis. At the time of the survey, there were 17,019 registered undergraduate and postgraduate students in SQU, of whom 53% were female. Due to strict social distancing measures, stay-at-home orders, and the rapidly evolving pandemic during the study period, the survey was conducted online to collect data in a timely manner. All SQU students had access to social media and institutional e-mail systems.

An online semi-structured questionnaire was developed by using the Questioner platform (<https://www.questionPro.com>) in both English and Arabic, and it was hosted via a unique uniform resource locator (URL). The link to the questionnaire was sent through emails to all students. An information sheet and a consent form were available on the first page of the questionnaire. Participating students were free to withdraw at any time without giving explanations and no personal identification was requested so as to retain information confidentiality. A total of 3,180 students clicked on the survey link, but 1,915 students provided complete responses.

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2.2 Data collection tools and measurements

Students' knowledge about COVID-19 was assessed using 13 true-false questions on three dimension of knowledge: (1) signs and symptoms, (2) mode of transmission, and (3) prevention mechanism (Table 2). Each correct response was scored as 1 point and incorrect response as 0, giving a maximum score of 13 and a minimum score of 0. The higher the points scored, the more knowledgeable the student. The mean score was 9.8. The overall knowledge was then categorized into poor for the scores less than 9 and good for the scores 9 and above.

The attitude was assessed using a 7-item question, each with responses of agree or disagree. A score of 1 was assigned for a response reflecting a positive attitude and 0 for a response reflecting a negative attitude, giving a maximum score of 7 and a minimum score of 0, with mean 5.4. Thus the overall attitude was categorized as negative for the scores less than 5 and positive for the scores 5 and above.

To assess the mental health status, a shorter version of the Depression Anxiety Stress Scale (DASS) has been used [33]. This version, known as the Depression Anxiety Stress Scale 21 (DASS21), has been validated in many countries as a reliable self-administered psychological instrument consisting of 21 items in three domains. Each domain comprises seven items, assessing three dimensions of mental health symptoms: depression, anxiety and stress. Respondents were required to indicate the presence of these symptom(s) over the past week on a 4-point Likert scale scoring from 0 to 3 (0: did not apply at all over the last week, 1: applied to some degree, or some of the time; 2: applied a considerable degree, or a good part of the time; 3: applied very much or most of the time). This instrument is frequently used in clinical and non-clinical trials [33-36], possessing well-established psychometric properties in reliably measuring depression, anxiety, and stress. We performed the Cronbach's alpha reliability test for the tool, and they were found to be 0.91, 0.84 and 0.90 respectively. The score for each of the DASS21 subscales, seven items per subscale, were summed up which ranges from 0 to 21. The scores were then categorized as "normal", "mild", "moderate", and "severe", according to the DASS21 manual [33].

2.3 Statistical analysis

The study considered knowledge, attitude and symptoms of depression, anxiety, and stress as the main outcome variables and socio-demographic and COVID-19 related factors as explanatory variables. Both descriptive and inferential statistical techniques as well as relevant statistical tests were employed for data analysis. Descriptive statistics such as frequency, proportion, mean and standard deviation were used to describe the level and pattern of knowledge, attitude, depression, anxiety, and stress. Cross tabulation along with a chi-square test was used to analyze the differentials of the prevalence of good knowledge, positive attitude and mild to severe levels of depression, anxiety, and stress across the socio-demographic and COVID-19 related factors. To identify the significant predictors of the outcome variables such as knowledge, attitude, depression, anxiety, and stress, multiple logistic regression techniques were employed by considering the outcome variables as dichotomous response variables (yes/no). We have dichotomized knowledge scores as good (scores ≥ 9) with coding 1 and poor (scores < 9) with coding 0. Attitude was dichotomized as negative (scores < 5) with coding 0 and positive with coding 1. Participants with a cut-off score of ≥ 10 in depression, ≥ 8 in anxiety, and ≥ 15 in stress dimensions were considered as having mild-severe form of these disorders as referenced by the DASS-21 manual [33]. We coded these cut-off scores of depression, anxiety and stress as 1 and 0 otherwise.

We set up the logistic regression model as follows: As per our study, we define an outcome variable as

$$y = \begin{cases} 1, & \text{if the outcome variable assume value 1} \\ 0, & \text{if the outcome variable assume value 0} \end{cases}$$

and x_1, x_2, \dots, x_n are a set of selected explanatory variables. The logistic regression model is then expressed as

$$\ln \left[\frac{P(y=1|x)}{1-P(y=1|x)} \right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \beta_p x_p$$

where $P(y=1|x) = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1 + \dots + \beta_p x_p)}}$ is the probability that the outcome variable takes on value 1 and

$\beta_0, \beta_1, \dots, \beta_p$ are the regression coefficients. However, $\beta_0, \beta_1, \dots, \beta_p$ do not have direct interpretation because they measure the effect of a predictor on the log of odds of the outcome variable, not the direct effect on outcome variable. Thus, e^{β_i} which is defined as odds ratio (OR), measuring the amount of change in probability of outcome variable for one unit change in explanatory variable. All the statistical analysis was performed using SPSS Version 23.0. A p-value < 0.05 was considered to be statistically significant.

3. Results

Characteristics of respondents

Of the total 1,915 participants, about 60% were female. More than half (56%) of the participants were young adults of age 20-24 years and were living in city areas (Table 1). The average age of the participants was 22 ± 4.6 years. The participating students were mostly (87%) undergraduate students, while about 10% of participants were postgraduate students. Slightly over half (54%) of the students were from the recent cohorts of 2019 and 2020. About

8% of students were married. The sample included 71 students (3.6%) who had tested COVID-19 positive. However, only 251 (13%) students underwent testing for the COVID-19 infection status.

Table 1. Percentage distribution of students according to demographic and socio-economic characteristics, 2021.

Characteristics	Number	Percent
Total sample	1951	100.0
Age		
< 20	588	30.1
20-24	1096	56.2
25-29	135	6.9
30+	132	6.8
Mean age (SD)	22.01 (4.6)	
Gender		
Male	782	40.1
Female	1169	59.9
College of study (major)		
Arts and Social Sciences	240	12.3
Agricultural & Marine Sciences	146	7.5
Education	318	16.3
Economics and Political Science	300	15.4
Engineering	319	16.4
Law	116	5.9
Medicine & Health Sciences	138	7.1
Science	324	16.6
Nursing	50	2.6
Level of study		
Foundation (pre-major)	49	2.5
Under graduate	1702	87.2
Post-Graduate	200	10.3
Admission cohort		
Before 2016	83	4.3
2016	235	12.0
2017	258	13.2
2018	316	16.2
2019	372	19.1
2020	687	35.2
Place of residence		
Urban	1092	56.0
Rural	859	44.0
Marital status		
Single	1797	92.1
Married	154	7.9
Dwelling type		
Traditional Arabian house	1277	65.5
Flat house	101	5.2
Villa	573	29.4
Monthly HH income (in Omani Rials)		
< 1000	822	42.1
1000 - 2000	785	40.2
>2000	344	17.6
Test for COVID-19		
Not tested	1700	87.1
Tested Negative	180	9.2
Tested positive	71	3.6

Knowledge about COVID-19

Overall students exhibited high levels of knowledge about COVID-19, as 81% of the students had good knowledge. About 82% of the students correctly answered that COVID-19 is a viral disease (Table 2). More than ninety percent (95%) of the students reported coughing/sneezing as signs and symptoms of COVID-19, while difficulty

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in breathing was reported by 85% of the students. Other symptoms like fever and muscle/body aching were mentioned by 78% and 60% students, respectively. About 81% of the students knew that the COVID-19 virus can be transmitted to another person through the mouth, nose and eyes, 83% knew that transmission can happen through touching an infected person and 63% knew that being in close contact with the infected person could be the cause of transmission. About 90% students correctly reported that social distancing, wearing mask and keeping had clean can prevent COVID-19 infection, while about 77% reported that avoiding contact with infected person and avoiding travel or visit to crowded places can prevent COVID-19 infection.

Table 2. Percentage of students providing correct response to the questions related to knowledge about COVID-19, 2021.

Knowledge items	Correct response	
	Number	%
COVID-19 caused by a virus	1606	82.3
The symptoms of COVID-19 are:		
Coughing and sneezing	1856	95.1
Breathing difficulty	1661	85.1
Fever	1522	78.0
Muscle/body aching	1180	60.4
Transmission mechanisms of COVID-19:		
Being in close contact with an infected person	1219	62.5
Touching the infected person	1619	83.0
Mouth, nose and eyes are the routes of entry of coronavirus into human body	1585	81.2
Prevention mechanism of COVID-19:		
Social distancing	1778	91.1
Wearing mask	1737	89.0
Keeping hand clean	1749	89.6
Avoiding contact with infected person	1491	76.4
Avoiding travel and visit to crowded places	1508	77.3
Mean knowledge scores (SD)	9.8 (1.34)	
Overall knowledge about COVID-19		
Good	1589	81.4
Poor	362	18.6

Gender, urban/rural place of residence, cohort of study and college of study showed significant associations with knowledge about COVID-19 (Table 3). Female students were found to be 1.3 times more likely to have good knowledge about COVID-19 (AOR=1.32, 95% CI [1.08 -1.68]). As expected, students from the College of Medicine and Health Sciences (91%) and College of Nursing (90%) exhibited higher knowledge, while students from the College of Arts and Social Sciences (74.6%), as well as students from the College of Education (74.8%) had lower levels of good knowledge about COVID-19. Students from older cohorts were more likely to have good knowledge about COVID-19 compared to the students from recent cohorts (Table 3). Students living in urban areas had 1.43 times higher odds of good knowledge than their rural counterparts (AOR=1.43, 95% CI [1.11 - 1.85]).

Table 3. Percentage of students with poor and good knowledge about COVID-19 according to background characteristics, and results of logistic regression analysis showing odds of good knowledge about COVID-19, 2021.

Characteristics	Knowledge about COVID-19			Logistic regression analysis of good knowledge			
	Poor	Good	p-value [†]	B	AOR	95% CI	p-Value
Total sample	18.6	81.4					
Age			0.621				
< 20	17.7	82.3		0.29	1.33	0.82 - 2.14	0.237
20-24	18.3	81.7		0.25	1.28	0.81 - 2.01	0.283
25-29	20.7	79.3		0.11	1.12	0.61 - 2.05	0.711
30+ (ref.)	22.0	78.0			1.00		
Gender			0.013				
Male (ref.)	20.2	79.8			1.00		
Female	15.5	84.5		0.26	1.30	1.08 - 1.68	0.037
College of study (major)			<0.001				

Arts and Social Sciences	25.4	74.6		-1.17	0.31	0.11 - 0.82	0.018
Agricultural & Marine Sciences	15.1	84.9		-0.54	0.58	0.20 - 1.66	0.316
Education	25.2	74.8		-1.17	0.31	0.12 - 0.82	0.019
Economics and Political Science	18.3	81.7		-0.82	0.44	0.16 - 1.18	0.104
Engineering	15.7	84.3		-0.51	0.60	0.22 - 1.62	0.317
Law	21.6	78.4		-0.92	0.40	0.14 - 1.13	0.085
Medicine & Health Sciences	8.7	91.3		0.15	1.16	0.38 - 3.53	0.794
Science	16.0	84.0		-0.58	0.56	0.21 - 1.50	0.251
Nursing (ref.)	10.0	90.0			1.00		
Level of study			0.423				
Foundation (pre-major)	22.4	77.6		-0.12	0.89	0.37 - 2.12	0.800
Under graduate	18.7	81.3		-0.45	0.64	0.37 - 1.13	0.123
Post-graduate (ref.)	16.0	84.0			1.00		
Admission cohort			0.021				
Before 2016	13.5	86.5		0.33	1.39	1.02 - 2.53	0.018
2016	11.9	88.1		0.63	1.88	1.19 - 2.95	0.006
2017	17.1	82.9		0.20	1.22	0.82 - 1.81	0.320
2018	22.5	77.5		-0.19	0.83	0.59 - 1.17	0.294
2019	20.2	79.8		-0.07	0.93	0.67 - 1.28	0.647
2020 (ref.)	19.2	80.8			1.00		
Place of residence			0.001				
Urban	15.9	84.1		0.36	1.43	1.11 - 1.85	0.005
Rural (ref.)	21.9	78.1			1.00		
Marital status			0.734				
Single	18.6	81.4		0.07	1.07	0.58 - 1.93	0.564
Married (ref.)	17.5	82.5			1.00		
Dwelling type			0.759				
Traditional Arabian house	19.0	81.0		0.10	1.10	0.83 - 1.46	0.592
Flat house	17.8	82.2		-0.17	0.84	0.46 - 1.51	0.497
Villa (ref.)	17.6	82.4			1.00		
Monthly HH income (in OR)			0.042				
< 1000	19.7	80.3		-0.22	0.80	0.56 - 1.16	0.249
1000 - 2000	19.2	80.8		-0.29	0.75	0.52 - 1.08	0.124
>2000 (ref.)	13.2	86.8			1.00		
Test for COVID-19			0.619				
Not tested	18.9	81.1		-0.06	0.94	0.49 - 1.82	0.875
Tested Negative	16.1	83.9		0.01	1.01	0.47 - 2.13	0.453
Tested positive (ref.)	16.9	83.1			1.00		

Note: † p-value relate to Chi-square test to compare the level of knowledge in different sub-groups of respondents. B = Regression coefficient, for reference category it is Zero.

AOR = Adjusted odds ratio, CI = Confidence Interval

ref. = Reference category, Odds ratio is 1.00 for reference category

Attitudes towards COVID-19

About 90% of the students said that COVID-19 is a fatal disease and 93% believed that one can get infected with COVID-19 any time. However, more than one-third (35.2%) of the students believed that COVID-19 is a natural catastrophe, indicating that a group of students were stigmatized to some extent. Majority of students agreed positively to other attitudinal statements. The mean score of positive agreement was found to be 5.4 out of 7. The overall attitude was defined as positive attitude for the scores 5 and above. According to this definition, students were found to have high level of positive attitudes towards COVID-19, as 83% students had positive attitudes.

Students' positive attitudes towards COVID-19 were found to vary significantly with age, gender, college of study, marital status and knowledge about COVID-19. However, logistic regression analysis, after controlling the background characteristics, identified gender, marital status and knowledge about COVID-19 as significant predictors of positive attitudes about COVID-19. Female students were found to be 1.56 time more likely to have positive attitude towards COVID-19 than the male students (AOR=1.56, 95% CI [1.03 - 2.38]). Positive attitude was found to be about 6 times higher among the students with marital status single, compared to married students (AOR= 5.96, 95% CI [2.52 -14.09]), about 3 times higher among the students with good knowledge. Compared to the students with poor knowledge (AOR=3.13, 95% CI [2.04 - 4.76]).

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Prevalence of mental health conditions and their differentials

Table 6 presents the prevalence of 3 mental health conditions namely depression, anxiety, and stress among the students. Overall, the prevalence of mild to moderate levels of depression, anxiety, and stress were found to be 66.3%, 69.2%, and 71.0%, respectively. The prevalence of severe level of depression, anxiety and stress were found to be 37.3%, 40.2% and 23.7%, respectively, which indicates that the severe form of mental conditions explained the major part of the overall prevalence.

Table 6. Prevalence of Depression, Anxiety and Stress among students.

Level	Depression		Anxiety		Stress	
	Number	%	Number	%	Number	%
Normal	657	33.7	601	30.8	566	29.0
Mild	265	13.6	191	9.8	325	16.7
Moderate	302	15.5	375	19.2	598	30.6
Severe	727	37.3	784	40.2	462	23.7
Total	1951	100.0	1951	100.0	1951	100.0

The bivariate analyses presented in Table 7 indicate that students' gender, college of study, level of study, admission cohort, marital status, and knowledge of COVID-19 have significant differential effects on the prevalence of the symptoms of the 3 mental health conditions. The prevalence of symptoms of the 3 mental health conditions was found to be significantly higher among females, undergraduate and single students. Students with good knowledge about COVID-19 were found to have a higher prevalence of depression and anxiety than the students with inadequate knowledge, but the lower prevalence of stress (69.5% vs. 77.3). Students from the College of Arts and Social Sciences showed the higher prevalence of depression, while students from the college of Nursing exhibited the lowest prevalence (54.0%) of depression. On the other hand, the prevalence of anxiety was found to be highest (79.7%) among the students from the College of Medicine and Health Sciences, and lowest among the students from the College of Education (61.9%). Students from the recent cohort showed a higher prevalence of depression, anxiety, distress, and FMD than that of older cohorts.

Determinants of depression, anxiety, and stress

Table 8 presents the results of multiple logistic regression analysis showing the adjusted effects of the characteristics of students on having any symptoms of depression, anxiety, and stress. The adjusted effect of a factor was measured by the adjusted odds ratio (AOR) obtained after controlling the effects of other factors. The results indicate that female students had more than 2 times higher odds of all the 3 mental health conditions compared to male students (AORs and 95% CIs: 2.04 (1.77-2.33) for depression, 2.07(1.67-2.57) for anxiety, 2.51(2.00-3.16) for stress). Students from the College of Arts and Social Sciences, College of Engineering and College of Science were reported to have had more than 2 times higher odds of depression, compared with students from the college of nursing. Students living in the urban area had 27% higher odds of having stress than their rural counterparts (AOR=1.27, 95% CI [1.02-1.61]). Unmarried (single) students were found to have 1.65 times higher odds of being stressed than the married students (AOR=1.65, 95% CI [1.03-2.69]). Knowledge about COVID-19 showed a significant association with the symptom of stress. Students with good knowledge about COVID-19 had 35% lower odds of having stress than the students with no or inadequate knowledge (AOR=0.65, 95% CI [0.44-0.79]). Students from the recent cohorts were more likely to have had mental distress, and anxiety than the older cohorts. However attitudes towards COVID-19 showed no significant association with mental health conditions.

Table 7. Prevalence of mild to severe depression, anxiety and stress by characteristics of students.

Characteristics	Depression ^a		Anxiety ^b		Stress ^c	
	Mild-severe	p-value ^d	Mild-severe	p-value ^d	Mild-severe	p-value ^d
Total sample	66.3		69.2		71.0	
Age		0.672		0.892		0.137
< 20	68.2		69.0		75.0	
20-24	65.7		69.7		71.6	
25-29	63.7		68.1		70.2	
30+	65.9		66.7		71.1	
Gender		<0.001		<0.001		<0.001
Male	60.0		60.6		60.2	
Female	75.3		74.9		78.2	
College of study (major)		0.042		0.017		0.244
Arts and Social Sciences	71.3		69.2		75.8	

Agricultural & Marine Sciences	65.1		71.9		67.1	
Education	60.7		61.9		66.7	
Economics and Political Science	65.7		71.3		73.3	
Engineering	69.6		69.3		68.7	
Law	60.3		62.9		69.8	
Medicine & Health Sciences	68.1		79.7		75.4	
Science	69.4		70.7		71.3	
Nursing	54.0		70.0		76.0	
Level of study		<0.001		<0.001		0.003
Foundation (pre-major)	63.3		61.2		65.3	
Under graduate	67.9		70.8		72.2	
Graduate	56.6		60.7		65.3	
Post-graduate (PhD)	37.0		37.0		44.4	
Admission cohort		0.208		<0.001		0.010
Before 2016	63		63.8		67.4	
2016	67.2		66.0		68.1	
2017	67.8		77.1		75.6	
2018	65.1		74.7		65.1	
2019	66.9		71.0		72.6	
2020	71.2		73.4		76.9	
Place of residence		0.719		0.739		0.137
Urban	66.7		69.5		72.3	
Rural	65.9		68.8		69.3	
Marital status		0.001		<0.001		<0.001
Single	67.4		70.3		72.2	
Married	53.9		56.5		56.5	
Dwelling type		0.663		0.144		0.443
Traditional Arabian house	67.0		69.7		71.4	
Flat house	63.4		60.4		65.3	
Villa	65.4		69.6		71.0	
Monthly HH income (in OR)		0.156		0.125		0.721
< 1000	68.6		69.7		71.9	
1000 - 2000	64.1		67.0		70.1	
>2000	66.0		73.0		70.9	
Test for COVID-19		0.543		0.753		0.175
Not tested	66.2		69.1		71.6	
Tested Negative	66.7		68.9		68.9	
Tested positive	69.0		73.2		62.0	
Knowledge		0.179		0.020		0.003
Good	65.6		68.0		69.5	
Poor	69.3		74.3		77.3	
Attitude		0.784		0.792		
Positive	66.5		69.1		71.2	0.593
Negative	65.7		69.8		69.8	

a Score of 10 or more were defined as mild-to-severe depression;

b Scores of 8 or more were defined as mild-to-severe anxiety;

c Scores of 15 or more were defined as mild-to-severe stress;

d p-value relate to Chi-square tests to compare the prevalence of mild-to-severe mental health symptoms in different sub-groups of populations.

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Table 8. Multiple logistic regression analysis showing the adjusted odds ratios (AORs) and the confidence intervals (CIs) of odds of symptoms of depression, anxiety and stress among students.

Characteristics	Depression			Anxiety			Stress		
	B	AOR(95%CI)	p-value	B	AOR(95%CI)	p-value	B	AOR(95%CI)	p-value
Age									
< 20	0.29	1.34(0.86, 2.08)	0.187	0.28	1.32(0.85, 2.05)	0.204	0.06	1.06(0.62, 1.61)	0.897
20-24	0.22	1.24(0.81, 1.88)	0.317	0.32	1.38(0.91, 2.10)	0.123	0.05	1.05(0.66, 1.64)	0.553
25-29	0.19	1.21(0.69, 2.08)	0.503	0.36	1.43(0.82, 2.50)	0.198	0.03	1.03((0.47, 1.56)	0.346
30+ (ref.)		1.00			1.00			1.00	
Gender									
Male (ref.)		1.00			1.00			1.00	
Female	0.36	1.44(1.16, 1.78)	<0.001	0.73	2.07(1.67, 2.57)	<0.001	0.92	2.51(2.00, 3.16)	<0.001
College of study (major)									
Arts and Social Sciences	0.77	2.16(1.11, 4.22)	0.024	-0.19	0.83(0.41, 1.68)	0.613	-0.24	0.79(0.36, 1.71)	0.559
Agricultural & Marine Sciences	0.42	1.52(0.75, 3.05)	0.240	-0.02	0.98(0.46, 2.05)	0.958	-0.73	0.48(0.21, 1.05)	0.067
Education	0.29	1.34(0.69, 2.58)	0.376	-0.48	0.62(0.31, 1.24)	0.178	-0.65	0.52(0.24, 1.11)	0.094
Economics and Political Science	0.49	1.63(0.85, 3.12)	0.142	-0.01	0.99(0.49, 1.99)	0.995	-0.30	0.74(0.35, 1.57)	0.439
Engineering	0.83	2.30(1.19, 4.43)	0.013	0.10	1.10(0.55, 2.21)	0.780	-0.25	0.78(0.37, 1.66)	0.530
Law	0.28	1.32(0.63, 2.72)	0.118	-0.34	0.71(0.33, 1.52)	0.377	-0.36	0.70(0.31, 1.61)	0.402
Medicine & Health Sciences	0.67	1.95(0.95, 3.99)	0.067	0.51	1.67(0.76, 3.63)	0.196	-0.09	0.91(0.41, 2.08)	0.839
Science	0.70	2.01(1.05, 3.85)	0.032	-0.02	0.98(0.49, 1.95)	0.955	-0.40	0.67(0.32, 1.40)	0.284
Nursing (ref.)		1.00			1.00			1.00	
Level of study									
Foundation (pre-major)	1.30	3.66(1.24, 10.82)	0.018	1.32	3.75(1.27, 11.12)	0.017	0.79	2.20(0.73, 6.59)	0.156
Under graduate	1.06	2.89(1.19, 7.07)	0.021	1.14	3.14(1.27, 7.73)	0.013	0.62	1.85(0.75, 4.52)	0.177
Graduate	0.68	1.97(0.82, 4.74)	0.129	0.92	2.51(1.03, 6.11)	0.041	0.60	1.82(0.75, 4.41)	0.180
Post-graduate (PhD) (ref.)	0.00	1.00			1.00			1.00	
Admission cohort									
Before 2016 (ref.)	0.00	1.00			1.00			1.00	
2016	-0.12	0.89 (0.52, 1.50)	0.661	0.43	1.54(0.88, 2.71)	0.127	-0.16	0.85(0.49, 1.46)	0.566
2017	-0.05	0.95(0.67, 1.35)	0.811	-0.08	0.92(0.65, 1.30)	0.658	-0.17	0.84(0.58, 1.20)	0.344
2018	0.01	1.01(0.73, 1.42)	0.928	0.52	1.69(1.18, 2.43)	0.004	0.26	1.30(0.90, 1.87)	0.157
2019	0.25	1.29(0.94, 1.76)	0.109	0.33	1.39(1.05, 1.92)	0.037	0.37	1.45(1.03, 2.03)	0.030
2020	0.13	1.14(0.85, 1.51)	0.386	0.30	1.35(1.03, 1.81)	0.043	0.21	1.23(0.90, 1.67)	0.179
Place of residence									
Urban	0.11	1.12(0.89, 1.39)	0.321	0.08	1.08(0.86, 1.35)	0.502	0.24	1.27(1.01, 1.61)	0.034
Rural (ref.)	0.00	1.00			1.00			1.00	
Marital status									
Single	0.02	1.02(0.63, 1.62)	0.943	0.07	1.07(0.67, 1.73)	0.756	0.50	1.65(1.02, 2.69)	0.038
Married (ref.)	0.00	1.00			1.00			1.00	
Dwelling type									
Traditional Arabian house	0.06	1.06(0.83, 1.35)	0.623	0.06	1.06(0.82, 1.36)	0.640	0.11	1.12(0.86, 1.45)	0.385
Flat house	0.19	1.21(0.73, 1.98)	0.454	-0.16	0.85(0.52, 1.40)	0.531	0.08	1.08(0.64, 1.81)	0.768
Villa (ref.)	0.00	1.00			1.00			1.00	
Monthly HH income (in OR)									
< 1000	0.18	1.20(0.89, 1.62)	0.224	-0.12	0.89(0.65, 1.23)	0.499	0.10	1.11(0.80, 1.53)	0.533
1000 - 2000	-0.04	0.96(0.72, 1.28)	0.824	-0.24	0.79(0.58, 1.07)	0.128	0.02	1.02(0.74, 1.39)	0.897
>2000 (ref.)	0.00	1.00			1.00			1.00	
Test for COVID-19									
Not tested	0.00	1.00			1.00			1.00	

(ref.)									
Tested Negative	0.08	1.08(0.78, 2.13)	0.514	-0.02	0.98(0.62, 1.12)	0.764	-0.12	0.89(0.68, 1.88)	0.651
Tested positive	0.21	1.23(0.97, 3.12)	0.128	0.11	1.12(0.73, 1.21)	0.286	-0.08	0.92(0.62, 1.98)	0.345
Knowledge									
Good	- 0.20	0.82(0.63 , 1.06)	0.131	-0.43	0.65(0.50, 0.87)	0.003	-0.49	0.61(0.46, 0.81)	0.001
Poor									
Attitude									
Positive	- 0.01	0.99(0.76, 1.28)	0.963	-0.08	0.92(0.71,1.21)	0.565	0.06	1.06(0.81, 1.39)	0.680
Negative									

Note: AOR= Adjusted Odds Ratio, ref= reference category; CI= confidence interval.

a Score of 10 or more were defined as mild-to-severe depression.

b Scores of 8 or more were defined as mild-to-severe anxiety. c Scores of 15 or more were defined as mild-to severe stress.

4. Discussion

The findings of this study indicate a high rate of effective knowledge about COVID-19 among the university students in Oman. Overall, 81% of the students had good knowledge about COVID-19 which is comparable with the findings in China (82.34%) [31], Saudi Arabia (80%) [37], Iran (87%) [38], and Pakistan (80%) [39]. However, the knowledge level among the students in our study is higher than observed in Bangladesh (50%) [40], Uganda (68%) [41], India (70%) [42], and Ethiopia (76%) [30], but lower than observed in the Philippines (92%) [43] and Iraq (92%) [44]. These differences in knowledge across the countries might be attributed to the differences in the study populations and the measuring tools to assess knowledge about COVID-19.

This study documented a high level of knowledge about COVID-19 etiology, signs and symptoms, main route of transmission, and prevention mechanisms among the university students, which is appreciable and would help in adopting and implementing preventive measures in spreading COVID-19. This finding is similar to that reported among the students in higher educational institution in the Philippines [39], Pakistan [39], Saudi Arabia [37], and Ethiopia [30].

Female students had significantly higher level of good knowledge about COVID-19 than the male students. This might be due to the fact that female students were more concerned about the disease and its preventive mechanisms. There were mixed results about the association between gender and the level of good knowledge about COVID-19. College of the study appeared as a significant predictor of knowledge of students about COVID-19 which was consistent with findings of other studies [30,31,41]. Students from the College of Medicine and Health Sciences and from the College of Nursing showed higher levels of knowledge about COVID-19 than others, which may be attributed to the training of these students about diseases, medicine and public health, as well as their commitment to the medical profession [41]. Students living in urban areas had a higher level of knowledge than their rural counterparts, which is consistent with the findings of previous studies [40,45,46]. This might be due to the fact that students living in urban areas might have higher chance of accessing the main sources of information including social media and internet. Cohort or study year was also another factor affecting knowledge about COVID-19. Students from older cohorts or more years of study had higher level of knowledge than their younger counterparts. The finding is consistent with findings of the studies in Ethiopia [30,47].

The results also indicated high level of positive attitudes towards COVID-19, as more than eighty percent (83%) of the students had a positive attitude towards COVID-19 which was in line with the findings of the studies in Pakistan (82%), Ethiopia (82%), 2021), and Nigeria (80%) [32,48,49]. However, to some extent, there exists a COVID-19 related stigma, as slightly more than one-third (35%) of the students believed that COVID-19 is a natural catastrophe. Regarding factors associated with positive attitude, female students were found to be more likely to have positive attitudes towards COVID-19 than their male counterparts. This finding is consistent with the findings of studies conducted in Saudi Arabia [50], Bangladesh [51], and Pakistan [52]. Good knowledge toward COVID-19 was found to be significantly associated with positive attitude about COVID-19, which is consistent with finding of the previous studies [30,53,54].

The results indicate high prevalence of depression, anxiety, and stress among university students in Oman. The prevalence of mild to severe level of depression, anxiety, and stress, were found to be 66.3%, 69.2%, and 71.0%, respectively. The severe forms of depression, anxiety and distress constituted the major part of the prevalence. More than one-third (37%) of the students exhibited a severe level of depression, while 40.2% exhibited severe anxiety, nearly one-fourth (23.7%) exhibited a severe level of stress.

There is no comparable study in Oman during the current pandemic to check the consistency of our findings of the prevalence of depression, anxiety, and stress among university students. However, a recent study documented that the prevalence of depression, anxiety, and distress were 25%, 22%, and 30%, respectively, among the general adult population of Oman [55]. In another recent multicounty cross-sectional study, Al Omari, *et al.* [56] reported that the prevalence of depression, anxiety, and stress were observed to be 56.2%, 39.4%, and 31%, respectively, among the

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Omani youth of age 15-24 years. All these results indicate that the prevalence of the 3 mental health conditions is substantially higher among the university students in Oman than the Omani general population. Even before the COVID-19 pandemic, many studies across the globe reported higher levels of depression, anxiety, and stress among students than the general population [29,57,58].

Students' mental health can be attributed to a series of factors that range from individual, interpersonal, and institutional levels [59]. On the individual level, students' low self-esteem and lack of coping abilities were correlated with higher levels of depression and even suicide [59,60]. On the institutional level, academic curriculum, campus climate, and faculty interaction largely determined students' experiences at school, which were potential factors that correlated with their mental health [61].

Our findings on mental health status of students in Oman are in close agreement with the findings of the study in Bangladesh [62], Europe and Asia [63], Turkey [64], and the Kingdom of Saudi Arabia [65]. Undergraduate students were found to have had about 3 time higher odds of having mild to severe level of depression and anxiety. This finding is consistent with the findings of the study among university students in Jordan [66], and in Saudi Arabia [65], showing that students with lower educational levels had higher odds of having symptoms of mental disorders.

Female students were found to have had more than 2 times higher risk for anxiety and about 1.5 times higher risk of depression. These findings are consistent with the findings of the multicounty studies of Ochnik et al [63] and Al Omari et al [56]. A recent study in Saudi Arabia also documented a 2.5 times higher risk of anxiety and stress and 1.7 times higher risk of depression among female students than male students [65]. The underlying reasons might be that females are more concerned about their success in a future career, physical appearance, and peer pressure. Also, females are more likely to undergo negative social changes that were brought by social media, consumer culture [67], and cultural expectations [68]. Good knowledge about COVID-19 was found to be negatively associated with anxiety and stress.

The study is not free from limitations. The most important limitations lie with the method of data collection and self-reporting. As the data was collected through online survey, which is associated with an under-coverage problem and lack of proper sampling design, resulting in sampling bias. This could limit the representativeness of the study findings. Under-coverage occurs because many potential respondents do not have easy access to internet or that many students declined to participate in the survey, and thus they were excluded. On the other hand, in an online survey, proper sampling design cannot be maintained as the respondents are self-selected, and thus introduced another kind of bias to the sample. Another limitation is the subjectivity of the students in providing information about knowledge, attitude and symptoms of mental health through a self-administered questionnaire. Despite using a validated and reliable questionnaire, it cannot be assumed that students were totally objective while providing information.

5. Conclusion

This study demonstrates a high prevalence of good knowledge and positive attitude of Omani students towards COVID-19, and at the same time high rate of depression, anxiety, and stress in the university population. Although the findings suggest an overall satisfactory level of knowledge and positive attitude, there still prevails some misconceptions or stigma to a group of students as about one-third of the students opined that COVID-19 is a natural catastrophe and 13% students were in favor of keeping it secret if infected the virus. Also about 18% students had negative attitudes and same percentage had poor knowledge about COVID-19. Positive attitude was found to be highly associated with good knowledge about COVID-19. Good knowledge about COVID-19 appeared as significant predictors of mental health problems. All these findings underscore the need for more educational programs and behavior change communication. It has been observed that the COVID-19 pandemic has increased the mental health issues of university students. More research is needed to identify the reasons for the high prevalence of mental health issues. Younger age, female gender, recent admission cohorts of students, undergraduate students, marital status, college of the study appeared as significant predictors of negative mental health symptoms among the students. The findings of high and elevated mental health symptoms among the university students of this study might have important policy implications for health planners, university administration, faculty members and the healthcare providers in improving the mental health status of university students. Effective mental health services and educational programs need to be designed for the students to meet their mental health needs and development of prevention mechanisms. The mental health services should include educating students about the signs and symptoms of mental illnesses (e.g., anxiety and depression), and their coping mechanisms. Educating students about correct knowledge and stress management methods would help overcome many of the challenges they are facing out of COVID-19 pandemic. Establishing counseling centers and mental health clinics in the university for monitoring and managing psychological problems among university students could be effective and the students should be encouraged to join these centers and clinics when they need such support. Emphasis should also be given to increase the community awareness, particularly among the parents, faculties and healthcare providers about student's mental health and wellbeing.

Conflict of interest

The authors declare no conflict of interest.

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