RESEARCH ARTICLE

Factors associated with knowledge, attitudes, and practices of the general Lebanese population toward the coronavirus disease 2019

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Abstract

People's practice, including adherence to disease prevention strategies, is influenced by their knowledge and attitude, which differ by sex. This study aimed to validate a tool that measures knowledge, attitude, and practice (KAP) toward COVID-19 and explore the related factors, including socioeconomic features and sex disparities. An online cross-sectional study conducted between December 20, 2020, and January 5, 2021, enrolled 405 participants from the general Lebanese population using a snowball sampling technique. The COVID-19 KAP scales were constructed and validated. After confirming the validity of the generated scales, the results showed that a university education level (adjusted odds ratio [aOR] = 3.90) was related to a better knowledge of COVID-19. A higher household crowding index (aOR = 0.41), a higher anxiety (aOR = 0.88), and do not know if there was an indirect contact with a COVID-19 patient (aOR = 0.44) were significantly associated with low knowledge of COVID-19. Having a family member working in the medical field (aOR = 1.76) and higher COVID-19 fear scores (aOR = 1.04) were associated with a more acceptable attitude toward COVID-19. Furthermore, higher knowledge scores (aOR = 1.14), higher attitude scores (aOR = 1.41), higher COVID-19 fear scores (aOR = 1.10), and more time spent on COVID-19 information (aOR = 1.91) were associated with good practice during the COVID-19 pandemic. However, these associations differed by sex, except for the crowding index, which were inversely associated with knowledge in both sexes, while education level and indirect exposure to COVID-19 were significant only among females. Knowledge about COVID-19 did not affect attitudes, but a good attitude was related to better practice in both sexes. Moreover, higher fear and more time spent on COVID-19 information were significantly associated with better practice among females. Overall, this study validated tools to highlight the
knowledge, attitude, and practice among the general population during the COVID-19 outbreak in Lebanon. Our findings suggest the need for health education programs tailored differentially according to sex, taking into account education, age, and socioeconomic status to raise awareness of COVID-19 and promote more acceptable attitudes and sustained safe practices among the general Lebanese population.

**Keywords:** Coronavirus disease 2019; Knowledge; Attitude; Practice; Fear of COVID-19; General population

1. Introduction

Caused by the SARS-CoV-2 virus, coronavirus disease (COVID-19) is a rapidly spreading disease that led to a global public health issue classified as a pandemic in March 2020 by the World Health Organization (WHO) (WHO, 2020). In September 2022, the WHO which declared that the end of the pandemic is now in sight (United Nations, 2022). In Lebanon, the first confirmed COVID-19 case was reported on February 21, 2020 (Bizri et al., 2020), and on March 10, the first coronavirus-related death was recorded. On March 15, the Lebanese government declared a state of medical emergency to control and curb the rapid spread of the COVID-19 outbreak in the country (Bizri et al., 2020). As of November 30, 2022, the total of COVID-19 deaths in Lebanon was 10,736 from a total number of 1,220,443 reported cases (WHO, 2022).

Public health and social interventions are required to prevent disease transmission. Several measures were adopted, such as the ban on public gatherings and the closures of borders (the airport, seaports, and land entrances), daycare centers, schools, universities, nightclubs, pubs, gyms, theaters, malls, restaurants, and public gardens (Bizri et al., 2020). These measures were successful in handling the pandemic at its beginning. However, people's commitment to these measures, which is influenced by their level of knowledge, attitudes, and practices (KAP) regarding COVID-19, is crucial for their success (Al-Hanawi et al., 2020).

It is well known that a confused understanding and a pessimistic outlook toward an emerging infectious disease will contribute to unnecessary worry and chaos, even excessive panic, thus exacerbating the disease outbreak (Blendon et al., 2004). Prior evidence indicates that good public knowledge, behaviors, and practices are crucial for effective pandemic management and disease avoidance (Tooher et al., 2013; Bell, 2004; Lau et al., 2003; Tang & Wong, 2003), such as the 2003 severe acute respiratory syndrome (SARS) outbreak (Bell, 2004). Understanding perception and current practices can help determine the factors that encourage the population to adopt healthy practices and responsive behaviors; also, adequate control of COVID-19 relies on community involvement, which influences the application of preventive measures.

According to the literature, people are more likely to practice prevention if they have confidence in its effectiveness, have a good level of knowledge and awareness of the disease, and perceive the risks (Lin et al., 2014, Brug et al., 2004, Aburto et al., 2010). Previous findings indicate that a higher level of knowledge is associated with the use of prevention strategies and behaviors and subsequent better attitudes Afzal et al., 2020; (Papagiannis et al., 2020; Tamang et al., 2020). Moreover, fear of the consequences of the pandemic and the perception of risks are crucial in decision-making to halt disease progression and transmission (Baldassarre et al., 2020). Lessons from the SARS epidemic in 2003 in China show that people's lower attitudes and knowledge of infectious illnesses are related to more panic feelings, making preventative efforts more difficult (Zhong et al., 2020).

Furthermore, contagious disease propagation rates might vary depending on several demographic and socioeconomic characteristics and aspects of healthcare system of a society (Buja et al., 2020). Public health systems should identify these factors to provide reliable information that can guide mitigation strategies since viruses have deleterious effects on the economy and health (Buja et al., 2020). The latter can be significantly affected by deteriorated economic situations through lower income and more unemployment, leading to increased morbidity and decreased use of private health-care services (Musgrove, 2004). For example, poor economic and demographic conditions contributed to the spread of the Ebola virus through restricted access to food, education, and adequate living conditions (Mun, 2017).

Another notable factor is sex. Indeed, males and females differ in their preventive practices, attitudes, and perceptions of COVID-19 (Galasso et al., 2020; Li et al., 2020). Women seem to be more knowledgeable and have a better attitude toward disease preventive measures (Alnakli, 2016; Alshammary et al., 2021; Sultana et al., 2022). They are more likely than men to apply the restrictions and perceive the epidemic as a severe health issue (Galasso et al., 2020). Men appear to be more ready than women to tolerate the disease risks and often have lower estimations of COVID-19-related threats (Lewis & Duch, 2021). Thus, it is decisive to understand the differences in knowledge,
attitude, and behaviors toward COVID-19 for better and more focused public health measures among subgroups.

A knowledge (K), attitude (A), and practice (P) study can be used to understand public awareness of COVID-19 and evaluate preventive measure gaps. It also gives insights into the characteristics and perceptions of society and subgroups, which, in turn, enables authorities to take effective action. The number of KAP studies in Eastern Mediterranean countries during the COVID-19 pandemic is limited (Abdelhafiz et al., 2020; Al Ahdab, 2021; Alnasser et al., 2021; Kakemam et al., 2020). At the time of the COVID-19 breakout, the general public in Iran had a positive perception of the disease (Kakemam et al., 2020), while in Syria, KAP toward COVID-19 was modest (Al Ahdab, 2021).

The present study was conducted in Lebanon for several reasons, most importantly, the accessibility to the population and the unique context of severe economic crises, which have resulted in a decline in the quality of medical care and likely contributed to the sharp rise in COVID-19 cases (Shallal et al., 2021) and more deaths since hospitals have had to ration their supplies or risk closing (United Nations, 2021). To the best of our knowledge, six studies measured KAP toward COVID-19 in Lebanon in English (Abou-Abbas et al., 2020; Domiati et al., 2020; Saadeh et al., 2020; Sakr et al., 2021; Zeenny et al., 2020). Of those, five probed youth (Sakr et al., 2021), nurses (Saadeh et al., 2020), hospital pharmacists (Zeenny et al., 2020), physicians (Abou-Abbas et al., 2020), and community pharmacists (Zeenny et al., 2021). The sixth study used non-validated measures to evaluate KAP in a sample of 410 Lebanese adults from the general population, of whom 75% reported having adequate knowledge to protect themselves from COVID-19 (Domiati et al., 2020). Thus, given the limited evidence about factors related to KAP during the COVID-19 pandemic in Lebanon and the scarce information regarding sex disparities, the assessment of KAP toward COVID-19 was deemed essential as it helps evaluate preventive measures and health education needs among Lebanese individuals (Raina, 2013).

Therefore, this study aimed to validate a scale that measures KAP toward COVID-19 among the general Lebanese population and to explore KAP-related factors and sex disparities.

2. Data and methods

2.1. Data sources

2.1.1. Study design and methods

A cross-sectional online survey was carried out in Lebanon between December 20, 2020, and January 5, 2021, using a snowball sampling technique to recruit a sample of 405 Lebanese adults. An anonymous self-administered questionnaire was created on Google Forms and then shared on different social media platforms (WhatsApp, Facebook, and Instagram). All Lebanese adults with access to the internet were eligible to participate. Participants were informed of the study objectives before they enrolled, and participation in the study was voluntary.

2.1.2. Sample size calculation

The G-Power software version 3.1.94 calculated a minimum sample of n=395 with an effect size of 0.02 (small), considering an alpha error of 5%, a power of 80%, and allowing for 15 predictors to be included in the model. A total of 405 participants were included in the study.

2.2. Methods

2.2.1. Questionnaire and scales

The online survey included two sections and was available in English and Arabic.

The first section of the questionnaire consisted of sociodemographic characteristics, that is, age, sex, marital status (currently married vs. no), education level (university level vs. not), employment status (employed in medical field, employed in non-medical field, and unemployed), religion (Christian, Muslim, and others), the number of occupants and the number of rooms in the house, excluding the kitchen and bathrooms, and whether or not any family member worked in the medical sector. It also included questions about having tested positive for COVID-19 versus not, having ever tested for COVID-19 versus not, and having a family member who has been infected with COVID-19 (yes, no, and do not know). The household crowding index was calculated by dividing the number of people living in the home by the number of rooms (excluding the kitchen and bathrooms). The second section included the following assessment scales:

2.2.1.1. Knowledge, attitude, and practice (KAP) toward the COVID-19 pandemic

The KAP toward COVID-19 scales was inspired by the previous studies conducted among health practitioners and the general population (Domiat et al., 2020; Ferdous et al., 2020; Al-Hanawi et al., 2020; Reuben et al., 2020, Saadeh et al., 2020; Saefi et al., 2020; Sindkhedkar et al., 2020; Zeenny et al., 2021). More details on the items used for each of the below scales can be found in the supplementary file.

2.2.1.1.1. Knowledge scale

A set of 14 multiple-choice items with single- and multiple-option answers was used to test general knowledge of COVID-19. All answers were coded as binary variables
(1= Yes and 0= No); multiple-option questions were considered separate variables. The correct answers to the multiple-choice questions were scored 1 point for yes and 0 points for no. The total score was created by summing the correct answers to the multiple choice with those of the binary variables. The total score ranged from 0 to 22, where a higher score indicated higher knowledge about COVID-19 (Supplementary File, Table S1).

2.2.1.2. Attitude scale

Six questions measured attitudes toward preventive measures, adherence to government actions, and adaptation toward COVID-19. All are graded on a 3-point Likert scale from 1 (disagree) to 3 (agree). The total score calculated by summing the six responses ranged from 6 to 18. A higher score indicated a more acceptable attitude toward COVID-19 (Supplementary File, Table S2).

2.2.1.3. Practice scale

Twenty-three items assessed good practice and behavior regarding preventive measures against COVID-19. All were graded on a 5-point Likert scale from the worst (1 = never) to the best (5 = always). The total practice score calculated by summing the 23 items ranged from 23 to 115, with higher scores indicating good practice toward COVID-19 (Supplementary File, Table S3).

2.2.1.4. Translation procedure

The used scales were translated from English to Arabic using the forward and backward translation process except for the FCV-19S scale. The translation from English to Arabic was done by two authors, and the back-translation was done by two others. Discrepancies between the original English version and the translated edition is resolved by consensus.

2.2.2. Statistical analysis

Data were analyzed on SPSS software version 24. A descriptive analysis was performed using absolute frequencies and percentages for categorical variables and means and standard deviations (SD) for quantitative measures. Construct validity of the knowledge, attitude, and practice scales was evaluated using principal component analysis (PCA). This method shares many similarities with exploratory factor analysis to determine the efficacy of the model and the validity of KAP scales. Kaiser–Meyer–Olkin’s measure of sampling adequacy and Bartlett’s test of sphericity were calculated to ensure the model's adequacy. Factors with eigenvalues values larger than 1 were retained, and the scree plot method was used to determine the number of components to extract (Kanyongo, 2005). Only items with a factor loading >0.4 were considered (Ellis, 2017). This procedure helped generate the KAP scales. Cronbach’s alpha was also used to evaluate the internal consistency of the studied scales; values of ≥0.9, 0.8 – 0.9, 0.7 – 0.8, 0.6 – 0.7, and <0.6 indicate that reliability is excellent, good, good to acceptable, acceptable, and not acceptable, respectively (Ursachi et al., 2015).

Bivariate analyses were then conducted. For each independent variable, medians (interquartile range [IQR]) were used to compare between categories: Due to non-normal distribution of the outcome continuous variables (KAP scores), non-parametric tests were used to compare the ranks of these outcome continuous variables (Kruskal–Wallis to compare between three groups and Mann–Whitney to compare between two groups). In addition, the Spearman test was used to correlate between continuous variables. Significant results were defined as p <0.05.

Afterward, since the transformation of the KAP scores did not normalize their distribution, they were dichotomized into two groups at the median level of each scale, since they were not normally distributed. Dichotomization was done as follows. First, the knowledge score was dichotomized into low (values less than 17.00) versus high knowledge (values greater than or equal to 17.01). Second, the attitude score was dichotomized into fearful (values less than 17.00) versus acceptable attitude (values greater than or equal to 17.01). Third, the practice score was dichotomized into flawed (values less than 104.00) versus good practice (values greater than or equal to 104.01). Other categorizations of each scale only altered the results slightly, indicating that our current classification for three scales is relatively valid.

Four logistic regressions were performed taking the above-mentioned dichotomized dependent variables to conduct multivariable analyses. In the first logistic regression, knowledge was taken as the dependent variable and sociodemographic characteristics as the independent
variables. In the second logistic regression, attitude was taken as the dependent variable, and knowledge and sociodemographic characteristics as the independent variables. In the third logistic regression, practice was selected as the dependent variable, and knowledge and sociodemographic characteristics as the independent variables. The fourth model considered the practice score as the dependent variable and the knowledge and attitude as the independent variables. Variables that showed p < 0.2 in the bivariate analysis were included in the multivariable models to decrease potential confounders. Afterward, another set of three logistic regressions, taking the same dependent and independent variables, was conducted after stratification by sex. In all cases, models’ equations for significant variables were presented.

3. Results

3.1. Sample description

The mean age was 28.38 ± 12.02 years, and most participants were female (79.8%) and single (68.1%). Only 10.1% had a family member who was infected by COVID-19, and only 27.9% had a family history of COVID-19. Table 1 summarizes all sociodemographic characteristics.

3.2. Principal component analyses of the KAP scales

Using the principal component analysis (PCA), the COVID-19 knowledge scale items produced eight factors that had an eigenvalue over 1. The first component (knowledge of preventive measures) explained the most variance by 15.89%, followed by the second component (knowledge of the transmission mode of the virus), 7.97%. The total variance was 58.38%. The Cronbach’s alpha value of the COVID-19 knowledge scale was 0.626 (Table S1). The COVID-19 attitude scale items produced two factors that had an eigenvalue over 1. The total variance was 56.55%, with a Cronbach’s alpha value of 0.615 (Table S2). Regarding the COVID-19 practice scale, it could yield four components with eigenvalues greater than one. The first component (protective measures) accounted for 37.77% of the total variance, while the second component (practice of preventive measures) contributed to 12.53%. The Cronbach’s alpha value of the COVID-19 practice scale was 0.899 (Table S3). Cronbach’s alpha values of the FCV-19S and CAS scales were 0.856 and 0.846, respectively.

3.3. Bivariate analyses

The mean scores of knowledge, attitudes, and practices were 16.29 ± 2.86, 16.5 ± 1.8, and 100.78 ± 12.11, respectively. No significant association was found between the KAP scores and sex (Figure 1). Married status, university degree, Christian religion, older age, and direct or indirect contact with COVID-19 patients were significantly associated with higher knowledge scores (Table 2). However, a higher household crowding index and higher anxiety were related to lower knowledge scores. Older age, being married, being

<table>
<thead>
<tr>
<th>Sociodemographic characteristics</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>405</td>
<td>100.0</td>
</tr>
<tr>
<td>Age</td>
<td>405</td>
<td>28.38 (12.02)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>82</td>
<td>20.2</td>
</tr>
<tr>
<td>Female</td>
<td>323</td>
<td>79.8</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently not married</td>
<td>276</td>
<td>68.1</td>
</tr>
<tr>
<td>Currently married</td>
<td>129</td>
<td>31.9</td>
</tr>
<tr>
<td>Education level</td>
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<td></td>
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<tr>
<td>Non-university level</td>
<td>42</td>
<td>10.4</td>
</tr>
<tr>
<td>University level</td>
<td>363</td>
<td>89.6</td>
</tr>
<tr>
<td>Employment status</td>
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<tr>
<td>Employed, medical field</td>
<td>65</td>
<td>16.1</td>
</tr>
<tr>
<td>Employed, non-medical</td>
<td>114</td>
<td>28.1</td>
</tr>
<tr>
<td>Unemployed</td>
<td>226</td>
<td>55.8</td>
</tr>
<tr>
<td>Family member in the medical field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>114</td>
<td>28.1</td>
</tr>
<tr>
<td>No</td>
<td>291</td>
<td>71.9</td>
</tr>
<tr>
<td>Living place</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>108</td>
<td>26.7</td>
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<tr>
<td>Urban</td>
<td>297</td>
<td>73.3</td>
</tr>
<tr>
<td>Religion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christian</td>
<td>71</td>
<td>17.5</td>
</tr>
<tr>
<td>Muslim</td>
<td>254</td>
<td>62.7</td>
</tr>
<tr>
<td>Other</td>
<td>80</td>
<td>19.7</td>
</tr>
<tr>
<td>Tested positive for COVID-19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>41</td>
<td>10.1</td>
</tr>
<tr>
<td>No</td>
<td>364</td>
<td>89.9</td>
</tr>
<tr>
<td>Ever tested for COVID-19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>164</td>
<td>40.5</td>
</tr>
<tr>
<td>No</td>
<td>241</td>
<td>59.5</td>
</tr>
<tr>
<td>Having a family member who has been infected with COVID-19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>113</td>
<td>27.9</td>
</tr>
<tr>
<td>No</td>
<td>277</td>
<td>68.4</td>
</tr>
<tr>
<td>I do not know</td>
<td>15</td>
<td>3.7</td>
</tr>
<tr>
<td>Household crowding index</td>
<td>405</td>
<td>1.14 (0.55)</td>
</tr>
</tbody>
</table>

Note: 'Mean (SD) of age and household crowding index
Christian, being a health care worker, having a university degree, having a family member working in the medical field, and scoring higher on the fear of COVID-19 scale were significantly associated with higher attitude scores. However, having tested positive for COVID-19, indirect contact with COVID-19 patients, higher household crowding index, and higher anxiety scores were related to lower attitude scores. Older age, being married, being Christian, having a university degree, not working in the medical field, and fearing COVID-19 were significantly associated with higher practice scores. Furthermore, spending more than 30 min/day on COVID-19 information, never having tested for COVID-19, never having tested positive for COVID-19, and having a family member working in the medical field were significantly associated with higher practice scores (Table 2).

### 3.4. Multivariable analyses

The first logistic regression taking knowledge (K) as the dependent variable in the whole sample showed that a university education level (adjusted odds ratio [aOR] = 3.90) was related to a better knowledge of COVID-19. A higher household crowding index (aOR = 0.41), a higher anxiety (aOR = 0.88), and do not know if there was an indirect contact with a COVID-19 patient (aOR = 0.44) were significantly associated with low knowledge of COVID-19 (Table 3, Model 1).

The second logistic regression taking acceptable attitude (A) as the dependent variable in the whole sample with knowledge score as a covariate showed that having a family member working in the medical field (aOR = 1.76) and higher COVID-19 fear scores (aOR = 1.04) were associated with a more acceptable attitude toward COVID-19 (Table 3, Model 2).

The third logistic regression, taking adequate practice (P) as the dependent variable in the whole sample and knowledge and attitude scores as covariates, showed that higher knowledge scores (aOR = 1.14), higher attitude scores (aOR = 1.41), higher COVID-19 fear scores (aOR = 1.10), and more time spent on COVID-19 information (aOR = 1.91) were associated with good practice during the COVID-19 pandemic (Table 3, Model 3).

### 3.5. Stratification by sex

In both groups, the stratified results showed that a higher household crowding index was significantly associated with lower knowledge. When considering the acceptable attitude as the dependent variable, the results showed that no significant association was found between the variables and the attitude (P > 0.05 for all).

Among males, being married was significantly associated with higher knowledge (Table 4a, Model 1). Taking the practice scale as the dependent variable, the results showed that high attitude scores (aOR = 2.77) were significantly associated with higher practice scores while not knowing if they had been an indirect contact with a COVID-19 patient (aOR = 0.01) which was significantly associated with lower practice (Table 4a, Model 3).

Among females, not knowing if they had been in indirect contact with COVID-19 patients (aOR = 0.36) was significantly associated with lower knowledge, while having a university degree (aOR = 3.87) was significantly associated with better knowledge (Table 4b, Model 1). Taking the practice scale as the dependent variable, the results showed that high attitude scores (aOR = 1.24), better knowledge (aOR = 1.17), higher fear score (aOR = 1.09), and spending more than 30 min/day on COVID-19 information (aOR = 2.25) were significantly associated with higher practice scores (Table 4b, Model 3).

### 4. Discussion

The present study assessed knowledge, attitudes, and practices toward COVID-19 using scales validated in the Lebanese population. As this study was conducted while the pandemic was in full swing, people had access to a wealth of information on the topic through various social media platforms, thus increasing their knowledge. In addition, attitudes toward COVID-19 were vastly influenced by the level of disease control in the country, where adequate management of COVID-19 led respondents to have more acceptable attitudes and adopt better practices overall.

In this study, married participants working in the medical field or with a family member working in the medical field had high knowledge about COVID-19, while those with a high household crowding index had low knowledge about COVID-19. Furthermore, participants who had a family member working in the medical field and those with higher fear of COVID-19 scores had a more acceptable attitude.
Table 2. Bivariate analyses of knowledge, attitude, and practice scores

<table>
<thead>
<tr>
<th></th>
<th>Knowledge score</th>
<th>Attitude score</th>
<th>Practice score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median [IQR]</td>
<td>P-value*</td>
<td>Median [IQR]</td>
</tr>
<tr>
<td>Tested positive for COVID-19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 [15 – 18]</td>
<td>0.289</td>
<td>17 [16 – 18]</td>
</tr>
<tr>
<td>Yes</td>
<td>16 [13 – 18]</td>
<td></td>
<td>16 [13.5 – 18]</td>
</tr>
<tr>
<td>Ever tested for COVID-19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 [15 – 18]</td>
<td>0.293</td>
<td>17 [16 – 18]</td>
</tr>
<tr>
<td>Have a family member working in the medical field</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 [15 – 18]</td>
<td>0.065</td>
<td>17 [16 – 18]</td>
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<td>Urban-rural settings</td>
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<td>Urban</td>
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<tr>
<td>Single</td>
<td>17 [15 – 18]</td>
<td>0.012</td>
<td>17 [16 – 18]</td>
</tr>
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<td>Education level</td>
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<tr>
<td>Non-university degree</td>
<td>15.5 [11 – 17]</td>
<td>0.002</td>
<td>16.5 [14 – 18]</td>
</tr>
<tr>
<td>Time spent on COVID-19 information/day</td>
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<td></td>
<td></td>
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<tr>
<td>0 – 30 min</td>
<td>17 [15 – 18]</td>
<td>0.370</td>
<td>17 [16 – 18]</td>
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<td>Employment status</td>
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<tr>
<td>Non-medical and unemployed</td>
<td>17 [16 – 18]</td>
<td>0.055</td>
<td>17 [16 – 18]</td>
</tr>
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<td>Medical field</td>
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<td></td>
<td>18 [17 – 18]</td>
</tr>
<tr>
<td>Religion</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Christian</td>
<td>17 [16 – 18]</td>
<td>0.030</td>
<td>17 [16 – 18]</td>
</tr>
<tr>
<td>Had an indirect contact with COVID-19 a patient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 [15 – 18]</td>
<td>0.003</td>
<td>17 [16 – 18]</td>
</tr>
<tr>
<td>Had a direct contact with a COVID-19 patient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 [15 – 18]</td>
<td>0.024</td>
<td>17 [16 – 18]</td>
</tr>
<tr>
<td>Having a family member who has been infected with COVID-19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 [15 – 18]</td>
<td>0.223</td>
<td>17 [16 – 18]</td>
</tr>
</tbody>
</table>

(Cont’d...)
Table 2. (Continued)

| Knowledge score | Median [IQR] | r<sup>b</sup> | P-value<sup>a</sup> | | r<sup>b</sup> | P-value<sup>a</sup> | | r<sup>b</sup> | P-value<sup>a</sup> |
|-----------------|--------------|--------------|-----------------|---|--------------|-----------------|---|--------------|
| Age             | 0.150        | 0.002        | -0.244          | <0.001 | 0.201        | <0.001          | 0.186        | <0.001          |
| Fear score      | 0.010        | 0.834        | -0.099          | 0.047 | -0.085       | 0.087           | -0.074       | 0.136           |
| Anxiety score   | -0.188       | <0.001       |                |      |              |                 |              |                |

Note: P-values marked in bold are significant (P<0.05); <sup>a</sup>The Mann–Whitney U-test was used to compare two groups; the Kruskal–Wallis test was used to compare three groups; <sup>b</sup>Spearman correlation test was used

Regarding knowledge correlates, participants working in the medical field or with family members working in the medical field had high knowledge about COVID-19, in line with recent findings from China and Lebanon (Domiat<sup>1</sup> et al., 2020; Huynh et al., 2020). A possible explanation could be that, usually, health-care professionals are well-positioned to get information from reliable sources, integrate it, comprehend it, and explain it to their families, thus increasing their awareness of diseases and other ailments. Participants with a family member working in the medical field also had a more acceptable attitude toward COVID-19, suggesting that better health education could increase knowledge, change attitudes and behaviors, and prevent infectious illnesses (Verelst et al., 2016).

In this study, the high household crowding index was associated with lower knowledge about COVID-19, explained by the fact that respondents with a high household crowding index have low income and low education levels and thus lack knowledge about COVID-19 (Chai et al., 2022). The previous literature revealed that high household crowding index is associated with disease transmission, which is related to several factors, such as poor socioeconomic status (Chipeta et al., 2022) and poor knowledge about the disease progression and transmission. In the same line, participants who did not know whether they had indirect or direct contact with COVID-19 patients had lower knowledge in both males and females, explained by the fact that those with higher knowledge and awareness of transmission modes avoid contact with COVID-19 cases/suspected cases. Increased awareness and better attitudes among individuals who were in contact with previous COVID-19 patients can promote health-seeking behaviors to obtain more information from reliable sources and avoid getting the infection.

Similar to the previous findings, an increase in age was also linked to lower awareness of COVID-19 (Adhena & Hidru, 2020; Akalu et al., 2020; Wolf et al., 2020; Zhong et al., 2020). Older adults use technology and social media less frequently, which could explain their poorer knowledge. Another reason might be the decline in cognition, hearing, and vision, making it difficult to read or comprehend medical instructions. Our results showed that participants of other religions had negative attitudes toward COVID-19 compared to Christians, consistent with the previous findings (Defar et al., 2021). A possible explanation is that participants of other religions are susceptible populations/groups highly bound to cultural
traditions, such as eating together (usually from the same plate) and sharing utensils, and private social acts like kissing older family members’ hands or heads (Hassan et al., 2021; Hussain, 2020). Therefore, social distancing and self-isolation during COVID-19 were hard to follow.
Table 4b. Adjusted odds ratios of knowledge, attitudes, and practices toward COVID-19 from multivariable analyses, females

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Knowledge Model 1</th>
<th>Attitudes Model 2</th>
<th>Practice 1 Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge score</td>
<td>--</td>
<td>1.04</td>
<td>1.17***</td>
</tr>
<tr>
<td>Attitude score</td>
<td>--</td>
<td>--</td>
<td>1.24*</td>
</tr>
<tr>
<td>Having a family member working in the medical field</td>
<td>Yes (no)</td>
<td>1.49</td>
<td>1.49</td>
</tr>
<tr>
<td>Indirect contact with a COVID-19 patient</td>
<td>Yes (no)</td>
<td>0.96</td>
<td>0.87</td>
</tr>
<tr>
<td>Do not know (no)</td>
<td>0.36*</td>
<td>0.69</td>
<td>0.67</td>
</tr>
<tr>
<td>Having a family member who has been infected with COVID-19</td>
<td>Yes (no)</td>
<td>0.61</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>Do not know (no)</td>
<td>1.00</td>
<td>0.49</td>
</tr>
<tr>
<td>Tested with COVID-19 (no)</td>
<td>0.92</td>
<td>1.04</td>
<td>0.58</td>
</tr>
<tr>
<td>Fear of COVID-19 score</td>
<td>1.01</td>
<td>1.03</td>
<td>1.09**</td>
</tr>
<tr>
<td>Time spent on COVID-19 information/day</td>
<td>30+min (&lt; 30)</td>
<td>1.17</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Covariates

- Age: 0.97 (Model 1), 0.97 (Model 2), 1.03 (Model 3)
- Urban (rural): 0.66 (Model 1), 0.66 (Model 2), 1.15 (Model 3)
- Currently married (no): 1.53 (Model 1), 1.02 (Model 2), 0.52+ (Model 3)
- College education (no): 3.87** (Model 1), 2.02 (Model 2), 2.60+ (Model 3)
- Currently employed (no): 0.91 (Model 1), 1.08 (Model 2), 1.20 (Model 3)
- Household crowding index: 0.44** (Model 1), 0.94 (Model 2), 1.26 (Model 3)
- Muslim (Christian): 0.60 (Model 1), 1.36 (Model 2), 1.04 (Model 3)
- Other religions (Christian): 0.56 (Model 1), 1.04 (Model 2), 1.05 (Model 3)
- Anxiety score: 0.88+ (Model 1), 0.94 (Model 2), 1.08 (Model 3)
- Wald Chi-square: 11.04 (Model 1), 27.73 (Model 2), 3.57 (Model 3)
- N: 323 (Model 1), 323 (Model 2), 323 (Model 3)

Note: The category in the parentheses is the reference group.
Knowledge dichotomized variable: Low (values less than 17.00) versus high knowledge (values greater than or equal to 17.01).
Attitude dichotomized variable: Fearful (values less than 17.00) versus acceptable attitude (values greater than or equal to 17.01). Practice dichotomized variable: Flawed (values less than or equal to 104.00) versus good practice (values greater than or equal to 104.01). +P<0.1, *P<0.05, **P<0.01, ***P<0.001

because of these traditions (Hassan et al., 2021). This result deserves more thorough research since it shows the association between religious practices and beliefs and different elements of health, including the capacity to manage diseases, but is contradictory to the acceptable attitude shown in challenging medical conditions (Albers et al., 2010, Kowalczyk et al., 2020).

Our study found an association between good practice during the COVID-19 pandemic and higher knowledge and fear levels. This result is consistent with a recent analysis that found that knowledge and attitude are strongly associated with better practice (Wake, 2020). Participants with high fear scores had a more acceptable attitude toward COVID-19, in line with findings in Saudi Arabia (Al-Hanawi et al., 2020). The acceptable attitude toward COVID-19 among individuals who exhibit anxiety and panic can be explained by their complete adherence to government actions and stringent measures against COVID-19, including lockdowns, national curfew, and closure of schools, universities, praying places, and other public spaces. Other studies conducted among the general population and health care workers also support these kinds of associations (Abdelhafiz et al., 2020; Bekele et al., 2020; Clements, 2020; Hossain et al., 2020; Karim et al., 2020; Roy et al., 2020; Zhong et al., 2020).

Our findings showed that spending more time on COVID-19 information and having higher knowledge and attitude scores were associated with good practice during the COVID-19 pandemic, similar to other studies (Clements, 2020; Zhong et al., 2020). Improving knowledge through raising awareness could have a positive effect on addressing factors associated with disease transmission. Thus, increased knowledge about COVID-19 favors the application of the required preventive measures needed to halt and regulate virus transmission (Aravindhan et al., 2021).

In this study, knowledge, attitude, or practice did not significantly differ among males and females. Nevertheless, knowledge affected practice among females but not among males, although the attitude score was associated with higher practice scores in both groups. Except for a Lebanese study, where male youth perceived the risk of COVID-19 infection to be much higher and exhibited more appropriate COVID-19 practices than female participants (Sakr et al., 2021), the previous studies reported conflicting data, with males often showing less knowledge, worse attitudes, and less cautious behaviors than females (Zhong et al., 2020; Haque et al., 2020, Maheshwari et al., 2020). Furthermore, this study is the first to show that, even if knowledgeable, men would not have a better practice, contrary to women. The appropriate practice of males during COVID-19 was related to age, profession, attitude, and anxiety, while it was associated with knowledge and education in females. According to a German study among 3245 participants, women could use social media and information platforms more frequently than men and might make more efforts to educate themselves about COVID-19 (Lemenager et al., 2020), which could partially explain our result. Risk-taking behaviors, known to be higher among males, could also explain this worthwhile finding, but more research would be necessary to understand its underlying reasons.
4.1. Limitations and strengths
This study has a few limitations. First, it was web-based and employed an online questionnaire to gather data, which explains the high participation rate of young, female, single, unemployed, and educated participants. The sample might not be representative of the entire population as it was recruited by the snowball technique, which does not allow for the generalization of the findings. This non-random method could also generate a selection bias since participants are nominated by people who know them. As in all KAP studies, a social desirability bias may exist, which could lead participants to underreport practices/behaviors related to the disease. Furthermore, a recall bias cannot be excluded since the results were self-reported and depended on the participant's memory. Finally, although our study provided valuable information on KAP and associated factors among the Lebanese population, the validity of the scales should be confirmed in future research, particularly for the knowledge and attitude scales where the variance explained was less than 60% and since the reliability analysis was only acceptable. Thus, studies that override the identified limitations are suggested to confirm our results.

Despite above limitations, our study has several strengths. First and the foremost, the questions used to evaluate KAP toward COVID-19 were adapted from the previous studies conducted among health practitioners and the general population and validated in our sample, thus reflecting the Lebanese context regarding these concepts; the practice scale was particularly shown to have good properties. Furthermore, our findings would help assess the protective measures in Lebanon, knowledge, and risk perception among Lebanese adults and contribute to the national efforts addressed to control the COVID-19 pandemic in Lebanon.

4.2. Clinical implications
This study aimed to assess the knowledge, attitude, and practice during the COVID-19 outbreak. The study has considerable implications for future actions, such as improving self-care by increasing COVID-19 prevention and control guidelines. Our results could also serve to better identify vulnerable groups and target them in future public health awareness campaigns.

5. Conclusions
This study validated three tools to highlight the knowledge, attitudes, and practices among the general population during the COVID-19 outbreak in Lebanon. It showed that working in the medical field, education level, and a previous history of COVID-19 were significant factors of KAP toward COVID-19. Furthermore, better knowledge and attitudes toward COVID-19 were associated with better preventive practices. Nevertheless, our findings suggested the need for health education programs tailored differentially according to sex, taking into account education, age, and socioeconomic status to raise awareness of COVID-19 and promote more acceptable attitudes and sustained safe practices among the general Lebanese population.

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Conflict of interest
The authors declare no conflicts of interest.

Author contributions
Conceptualization: Pascale Salameh and Diana Malaeb
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Writing – review & editing: Pascale Salameh, Chadia Haddad, Diana Malaeb, and Hala Sacre

Ethics approval and consent to participate
The ethics committee at the Psychiatric Hospital of the Cross approved the study protocol (HPC-038-2020). Online consent was obtained from all participants on the first page of the questionnaire.

Consent for publication
Not applicable.

Availability of data
The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

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