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RESEARCH ARTICLE

Socio-demographic Association with Knowledge, Attitude, and Practice (KAP) towards COVID-19 Vaccines: A Young Population Cross-sectional Study in Lebanon

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Abstract:

Background:

Since its first emergence in Wuhan, China, in late 2019, the coronavirus disease 2019 (COVID-19) has become the biggest public health threat on an international scale. Vaccination remains the first line of defence against the widespread of the virus.

Objective:

This study aimed to assess the socio-demographic association with knowledge, attitude, and practice (KAP) towards the different COVID-19 vaccines in the young Lebanese population.

Methods:

This cross-sectional study was conducted in Lebanon between January 24th to 31st, 2021. A total of 1350 respondents answered the questionnaire. Questions included four dimensions (11 related to socio-demographic characteristics, 22 knowledge questions, 5 attitude questions, and 5 related to the practices). One-way ANOVA was used to analyse the differences between the KAP variables and the socio-demographic variables. When significant differences were found (p-value < 0.05), Duncan's Multiple Range test was applied to determine the significant differences between the means.

Results:

The average knowledge about COVID-19 vaccines among our participants was 52.88%; 52.81% showed good attitude toward the different types of vaccines, and 53.98% demonstrated good practices. The socio-demographic variables having a significant influence on the knowledge and practices towards the COVID-19 vaccines were the living place, the educational level, the school in which the students belong, the type of job (health-related or non-health related job), and the income range. The type of insurance that respondents have was significantly associated with practices but not with knowledge.

Conclusion:

This study showed significant differences in KAP among Lebanese people regarding COVID-19 vaccines, mainly affected by gender, education, work field, and income. Our findings reflect fair knowledge, positive attitudes, and good practices toward the COVID-19 vaccine among the Lebanese population. Consequently, the ministry of public health must work harder to disseminate, in higher frequency, more accurate information about the vaccines and organize more vaccination campaigns to increase trust level in the efficacy of the vaccine and decrease public hesitation.

Keywords: COVID-19, Vaccines, Knowledge, Attitudes, Practices, Socio-demographic variables.

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1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an emerging respiratory disease caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), a positive-sense single-stranded ribonucleic acid (ssRNA) virus [1]. Since its emergence in Wuhan, China, in 2019, the virus has spread to every continent, with more than 483,556,595 confirmed positive cases and 6,132,461 deaths globally (as of 30/3/2022) [2]. Reducing the virus morbidity and mortality in any country depends not only on the application of public health protocols but also on raising community awareness toward disease

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prevention and its possible cure. Taking into consideration that there is no specific antiviral treatment for COVID-19 until now, immunization is one of the most effective public health interventions to prevent the spread of the virus [3]. The pharmaceutical industry has been racing to develop and manufacture safe and effective COVID-19 vaccines where various platforms for COVID-19 vaccines development are undergoing evaluations, such as virus vectored vaccines, protein subunit vaccines, DNA and RNA vaccines, and monoclonal antibodies [4]. On an unprecedented fast timeline and among the ten approved vaccines up until January 19th, 2022, the different mRNA-based vaccines: Pfizer-BioNTech and Moderna, as well as Janssen, have been authorized by the Food and Drug Administration (FDA) for emergency use as they have presented an outstanding efficacy in preventing COVID-19 among adults [5 - 7]. Recently, WHO has issued an emergency use for Novavax and Covovax, expanding the list of validated vaccines [8]. Although great progress has been made and COVID-19 vaccines are finally within reach, there are still important challenges to overcome, such as the vaccine's sufficient production, equitable distribution, and the issue of vaccination acceptance by the general population that affects the success of immunization plans. On the other hand, the main challenging aspects are the fact that none of these vaccines can prevent virus transmission and the continuous evolution of new variants starting from alpha, beta to delta, and more recently, the Omicron variant [9].

In previous pandemics like H1N1 and influenza, studies showed that vaccine acceptance rate was significantly variable both within and across countries ranging from 8% to 67% due to the attitude towards vaccination and ethnicity [10]. Vaccine acceptance rates decreased in late 2009 in several European countries [11] due to safety beliefs and distrust of government sources and vaccine companies [12]. In addition, the experience of Ebola vaccination in several African countries demonstrated that the introduction of new vaccines could be met with social resistance and political distrust in addition to worries about cost and effectiveness [13, 14]. Moreover, previous studies on the acceptability of future vaccines in West Africa against malaria and HIV have shown that the cost, safety, and perceived susceptibility of the vaccine to the virus affected the decision whether or not to take a vaccine [8, 9]. Thus, vaccine acceptance hesitancy among a population is most probably due to false beliefs, lack of appropriate information, distrust in institutions related to vaccination, and concerns about its side effects [10, 15 - 17].

Early in the COVID-19 pandemic, studies have found satisfying results concerning the willingness to receive the hypothetical vaccine in high-income countries [11, 12, 18, 19]. However, 26% of adults were unsure or unwilling to get a COVID-19 vaccine, and around one-quarter of French [20] and US [21] adults, even if it is for free. Studies have reported that longer testing, increased efficacy, and development were significantly associated with increased vaccine acceptance in the US [22]. Research conducted later on during the pandemic revealed that an even greater proportion of the UK adult population (36%) was either unsure or would not get the vaccine [23]. Similar studies carried out in Arab countries showed a low rate of vaccine acceptability, such as among the Jordanian population (37.4%) [23], while a higher rate was observed among the Saudi population (64.7%) [24]. In Indonesia, the acceptance of a COVID-19 vaccine was highly influenced by the baseline effectiveness of the vaccine [25]. Thus, the low level of confidence in the COVID-19 vaccine is likely related to the vaccine efficacy and safety [26], in addition to trust in the government and those developing and administering the vaccines [26]. Therefore, compressing the timeline of developing a new pathogen vaccine, which used to take years, if not decades, could negatively correlate with its acceptance [27]. Furthermore, many of the vaccine platforms, such as the mRNA vaccine and adenovirus carrier vaccine, are new and have never been used in humans before, which might provoke uncertainties about their safety and efficacy over time.

In Lebanon, few studies have evaluated the awareness of the population toward COVID-19 [28 - 31]. In a study conducted by our team, we found generally good knowledge, attitudes, and practices (KAP) towards COVID-19; particularly, we found that around 90% of our sample was optimistic about COVID-19 vaccines [29]. Since there were no published studies to determine KAP regarding the COVID-19 vaccines among the Lebanese population, we aimed to verify that KAP among the young Lebanese population regarding the COVID-19 vaccine is satisfactory as we found it towards COVID-19. In addition, we examined the different socio-demographic factors and whether they associate differently with KAP regarding COVID-19 vaccines.

2. MATERIALS AND METHODS

2.1. Study Design and Data Collection

This cross-sectional survey was conducted between January 24th to 31st, 2021, one month prior to the arrival of the first vaccines to Lebanon. A structured questionnaire (in English and Arabic) was designed and developed by the authors of this work. To assess the validity and reliability of the survey, a pilot study was conducted on 28 individuals, after which the questionnaire was adjusted based on the received comments. The reliability of the questionnaire was also assessed by calculating the alpha Cronbach's coefficient. Reliability coefficients were satisfactory for the three dimensions of the questionnaire (Knowledge: alpha-Cronbach=0.67, attitudes, and practices: alpha-Cronbach=0.646). The prepared survey was shared through the social media accounts of the authors of this manuscript (Facebook, Instagram, and LinkedIn). In addition, members of the research team shared the survey link through their E-mail lists and contact lists in the chatting group “WhatsApp”. Since the authors are university professors, a large portion of the respondents are students. The number of individuals who received the google form is estimated to be around 8000, with a response rate of around 17%. A reminder was sent, two weeks after receiving the questionnaire, to complete it. A copy of the questionnaire is provided as a supplementary document.

Eighteen years old (or above) Lebanese were invited to answer this questionnaire. The identity of the respondents was not asked in the questionnaire, and their participation was voluntary. There was no penalty for not participating and no reward for doing so. Moreover, respondents were free to

withdraw at any time.

The convenience method of sampling was used due to the restrictions and lockdown status that the country was following, causing limited resources to be used. This study worked on increasing the sample size as much as possible to ensure its representation of the Lebanese population which was reported to be 6825000 in 2021. The sample size was calculated using the RAOSOFT sample size calculator with ±5% as a margin of error, 99% confidence level, and 50% margin of error of response distribution. The calculator estimated the representative sample size to be 669 respondents. By reaching 1350 responses, we decreased the margin of error to 3.5% and increased the confidence interval to more than 99.9%.

2.2. Variables

The questionnaire included dimensions on KAP towards COVID-19 vaccines. The data were collected in an excel sheet and analysed. The results were expressed as mean, standard deviation, percentages, and frequencies. Questions were grouped into four categories reflecting i) the participants' socio-demographic characteristics: eleven questions about age, gender, marital status, monthly income, major, work, residence, health insurance, and educational background, ii) twenty-two questions reflecting the knowledge they have like "What is the time normally needed to develop a vaccine and to have the FDA approval/ authorization?" iii) five questions about attitude such as "Which vaccine technique is more convincing/ safe and effective for you?" and finally iv) five questions related to the practice, such as "Do you want to take the COVID-19 vaccine?".

For the questions related to knowledge, participants scored 0 on each question with the wrong answer and 1 for each question with the right answer in all questions except the questions that included more than one correct answer. In these questions, where applicable, participants scored 1 (good knowledge) if they answered 3 or more out of 5 correct answers, scored 0.5 (average knowledge) if they answered 1–2 correct answers, and scored 0 (poor knowledge) if they did not guess any of the correct answers. The sum of scores was calculated for the two dimensions of knowledge and practices, considering the sum of the score for each individual question in each dimension.

2.3. Statistical Analysis

Descriptive statistics showed the frequency and percentage (%) of participants who correctly answered the different questions related to KAP towards COVID-19 vaccines. One-way ANOVA was used to analyse the differences between the variables of knowledge, attitude, and practice with the socio-demographic variables, and a t-test was applied when two variables were compared, such as gender. When significant differences were found (p-value < 0.05), Duncan's Multiple Range test was applied to determine the significant differences between the means.

3. RESULTS

A total number of 1350 participants completed the survey. The majority were females (71.48%), and 55.9% had a bachelor's degree. Additionally, 45.4% of the respondents did not have any monthly household income, followed by an income between 750,000 and 1,500,000 Lebanese Lira (LL) (16.59%), less than 750,000 LL (15.92%), between 1,500,000 and 3,000,000 LL (12.59%), and more than 3,000,000 LL (9.48%). Most were single (76.06%) and resided in urban areas (58%). Other demographic characteristics of the samples are summarized in Table **1**.

Table 1. Socio-demographic characteristics of participants (n=1350).

Socio-demographic characteristics	Frequency (%)
Gender	-
Female	965 (71.48)
Male	385 (25.51)
Age (years)	-
18-21	595 (44.07)
22-25	312 (23.11)
26-30	132 (9.777)
31-40	186 (13.77)
>40	125 (9.25)
Marital Status	-
Single	1027 (76.07)
Married	323 (23.92)
Residence	-
Rural	567 (42)
Urban	783 (58)
Education	-
High school or less	307 (22.74)
Bachelor's degree	755 (55.92)
Master's degree	232 (17.18)

(Table 1) contd.....

Socio-demographic characteristics	Frequency (%)
Doctorate degree	56 (4.148)
Area of Study	-
School of Public Health	106 (13.00)
School of Arts and Science	401 (49.20)
School of Business and Law	73 (8.957)
School of Education	25 (3.06)
School of Engineering	85 (10.42)
School of Medicine	37 (4.53)
School of Pharmacy	88 (10.79)
Occupation	-
Health-related jobs	261 (49.06)
Non-health related jobs	271 (50.93)
Monthly Income (Lebanese Lira: L.L.)	-
0.0	613 (45.40)
Less than 750,000	215 (15.92)
Between 750,000 and 1,500,000	224 (16.59)
Between 1,500,000 and 3,000,000	170 (12.59)
More than 3,000,000	128 (9.48)
Health Insurance Coverage	-
Private insurance	246 (18.22)
National Social Security Fund (NSSF)	537 (39.77)
Not available	319 (23.62)
Other	248 (18.37)
Chronic Diseases	-
Yes	136 (10.07)
No	1214 (89.92)

Abbreviation: Socio: Sociological.

Table **2** depicts the knowledge of respondents about COVID-19 vaccines. This study showed that the Lebanese' basic knowledge of COVID-19 vaccines is moderate. The average knowledge score was about 52.88%. Knowledge regarding the emergence of new strains was the highest (92.2%), whereas that of the different types of available vaccines was the lowest (22%).

Table 2. Questions related to knowledge about COVID-19 vaccines, average correct answers and standard errors, number, and percentage of participants' answers.

Knowledge	n (%)	Average per Question (S.E.)	n with Correct Answers (%)	n with Incorrect Answers (%)
Time needed for vaccine development (many years)	1350 (100)	48.3 (1.36)	653 (48.37)	697 (51.62)
Vaccine protection mechanism (stimulates the production of antibodies)	1350 (100)	88.7 (0.86)	1198 (88.74)	152 (11.25)
Vaccine safety (depends on the vaccine)	1350 (100)	58.0 (1.34)	783 (58)	567 (42)
Presence of vaccine's side effects (depends on the vaccine and person being vaccinated)	1350 (100)	64.4 (1.30)	870 (64.44)	480 (35.55)
Vaccine injection route (intramuscular upper arm)	1350 (100)	73.3 (1.20)	990 (73.33)	360 (26.66)
Vaccine selection basis (effectiveness)	1350 (100)	65.1 (1.29)	880 (65.18)	470 (34.81)
Vaccine eligibility (everyone except pregnant women, children under 12, and people with allergies to vaccines)	1350 (100)	47.2 (0.62)	929 (68.81)	421 (31.18)
Eligibility of COVID-19 recovered patients to the vaccine (yes)	1350 (100)	32.5 (1.27)	440 (32.59)	910 (67.40)
Vaccine priority (healthcare workers)	1350 (100)	24.0 (1.16)	324 (24)	1026 (76)
Vaccine brands (Moderna, Pfizer-BioNtech, Sputnik, Sinopharm, Sinovac, CanSion Biologics, AstraZeneca, and Johnson and Johnson)	1350 (100)	57.0 (1.04)	838 (62.07)	512 (37.92)
Vaccines with FDA approval (Moderna and Pfizer-BioNtech)	1350 (100)	29.5 (1.00)	594 (44)	756 (56)
Vaccines have equal effectiveness (no)	1350 (100)	75.4 (1.17)	1019 (75.48)	331 (24.51)
Vaccine types (use mRNA, use inactivated virus, or use adenovirus)	1350 (100)	22.0 (0.42)	892 (66.07)	458 (33.92)
Vaccine doses (one or two doses, depending on the vaccine)	1350 (100)	34.8 (1.29)	471 (34.88)	879 (65.11)

(Table 2) contd.....

Knowledge	n (%)	Average per Question (S.E.)	n with Correct Answers (%)	n with Incorrect Answers (%)
Mixing doses from different two-dose vaccines (no)	1350 (100)	37.9 (1.32)	512 (37.92)	838 (62.07)
Vaccine protection duration (not determined yet)	1350 (100)	37.8 (1.32)	511 (37.85)	839 (62.14)
Vaccine counteraction (not determined yet)	1350 (100)	44.8 (1.35)	605 (44.81)	745 (55.18)
Vaccine side effects symptoms (fever, fatigue, chills, pain or allergy at injection site, headache, severe allergy, and transient facial paralysis)	1350 (100)	43.0 (1.10)	680 (50.37)	670 (49.62)
Vaccine storage temperature (depends on the vaccine type)	1350 (100)	58.9 (1.33)	796 (58.96)	554 (41.03)
Influenza vaccines effectiveness against COVID-19 (no)	1350 (100)	75.7 (1.16)	1022 (75.70)	328 (24.29)
The emergence of new COVID-19 strains (yes)	1350 (100)	92.2 (0.72)	1246 (92.29)	104 (7.703)
Average	1350 (100)	52.88	581.62	532.05

Abbreviations: S.E.: Standard effort; COVID-19: Coronavirus disease 2019.

Table **3** shows the attitude and practices of respondents toward COVID-19 vaccines. Our results demonstrated that, on average, 52.81% of the participants had good attitude toward COVID-19 vaccines. The majority of respondents have already taken the PCR test (90.1%) to check whether they were, or not, infected by the virus, which showed a high level of self-awareness toward COVID-19. In addition, 61.4% of the participants considered the vaccine to be safe and effective and were willing to take any of the COVID-19 vaccines (59%) to stop the spread of the disease and avoid being infected again (50.7%). A total of 75.4% would choose a COVID-19 vaccine based on a recommendation from a credible scientific source. On the other hand, 2.87% believed they could skip the vaccine because they were infected by COVID-19 and cured. The rest did not want to be vaccinated because they thought, for example, that the virus does not exist or because SARS-CoV-2 is very similar to the normal flu; thus, no vaccination is needed.

As indicated in Table **4**, for the practices-based questions, men had significantly ($p<0.05$) better practices towards COVID-19 vaccines than women ($p=0.002$), but the average knowledge was not significantly different in both genders.

Table 3. Questions related to attitude and practices about COVID-19 vaccines, average correct answers and standard errors, number, and percentage of participants' answers.

Attitude	n (%)	Average Per Question (S.E.)	n with Correct Answers (%)	n with Incorrect Answers (%)
Vaccine technique that is perceived to be safe and effective (mRNA, inactivated virus, or adenovirus-based techniques)	1350 (100)	61.4 (1.32)	829 (61.40)	521 (38.59)
Self-protection awareness towards COVID-19 (I have been tested at least once for COVID-19)	1350 (100)	90.1 (0.81)	1217 (90.14)	133 (9.851)
Planning to take the vaccine (yes)	1350 (100)	59.0 (1.33)	797 (59.03)	553 (40.96)
Reasons for wanting to take the vaccine (to stop the spread of the disease and to avoid being infected)	705 (52.22)	50.7 (0.76)	325 (24.07)	380 (28.14)
Reasons for not wanting to take the vaccine (I have been previously infected with the virus)	591 (43.77)	2.87 (0.68)	17 (1.259)	574 (42.51)
Practices	-	52.814	417.800	432.200
Response to vaccine side effects (visit the nearest doctor/hospital)	1350 (100)	61.4 (1.32)	829 (61.40)	521 (38.59)
Received the influenza vaccine in the last two years (yes)	1350 (100)	17.2 (1.02)	233 (17.25)	1117 (82.74)
Planned vaccine of choice (Moderna, Pfizer-BioNtech, Sputnik, Sinopharm, Sinovac, Cansino Biologics, AstraZeneca, and Johnson and Johnson)	1350 (100)	41.4 (1.34)	560 (41.48)	790 (58.51)
Reason for vaccine choice (Following the recommendation from credible scientific sources)	725 (53.70)	75.4 (1.59)	547 (40.51)	178 (13.18)
Practicing post-vaccination follow-up (yes)	1350 (100)	74.5 (1.18)	1007 (74.59)	343 (25.40)
Average	-	53.98	453.80	388.60

Abbreviations: S. E: Standard effort; COVID-19: Coronavirus disease 2019.

Socio-demographic characteristics of participants (n=1350)

Table 4. Mean knowledge and practices with socio-demographic variables and attitudes.

-	Knowledge Mean (S.E.)	p-value	Practices Mean (S.E.)	p-value
Gender	-	-	-	-
Female	52.7 (0.49)	0.602	48.2 (0.92)	0.002
Male	53.2 (0.78)		53.6 (1.45)	

(Table 4) contd.....

-	Knowledge Mean (S.E.)	p-value	Practices Mean (S.E.)	p-value
Age (years)	-	-	-	-
18-21	52.1 (0.63)	0.223	48.9 (1.17)	0.152
22-25	52.7 (0.87)		53.4 (1.62)	
26-30	55.4 (1.33)		47.9 (2.49)	
31-40	53.6 (1.12)		48.5 (2.10)	
≥40	53.4 (1.37)		48.4 (2.56)	
Marital Status	-	-	-	-
Single	52.7 (0.47)	0.404	50.0 (0.89)	0.441
Married	53.5 (0.85)		48.6 (1.59)	
Residence	-	-	-	-
Rural	51.7 (0.64)	0.016	47.5 (1.20)	0.016
Urban	53.7 (0.54)		51.3 (1.02)	
Education	-	-	-	-
High school or less	49.5 (0.86)	<0.001	48.6 (1.63)	0.049
Bachelor's degree	53.0 (0.55)		50.0 (1.04)	
Master's degree	55.3 (0.99)		48.0 (1.88)	
Doctorate degree	59.6 (2.03)		59.5 (3.83)	
Area of Study	-	-	-	-
School of Public Health	54.7 (0.73)	<0.001	50.7 (1.40)	0.049
School of Arts and Science	47.8 (1.73)		46.8 (3.29)	
School of Business and Law	49.6 (2.96)		45.6 (5.62)	
School of Education	49.6 (1.60)		52.3 (3.05)	
School of Engineering	56.2 (2.43)		48.1 (4.62)	
School of Medicine	58.5 (1.57)		60.3 (2.99)	
School of Pharmacy	54.0 (1.43)		51.6 (2.73)	
Occupation	-	-	-	-
Health-related jobs	57.9 (0.94)	<0.001	59.1 (1.71)	<0.001
Non-health-related jobs	50.9 (0.60)		49.1 (1.10)	
Monthly income (Lebanese Lira: L.L.)	-	-	-	-
0.0	51.7 (0.61)	<0.001	47.1 (1.14)	<0.001
Less than 750,000	52.6 (1.03)		49.2 (1.94)	
Between 750,000 and 1,500,000	51.4 (1.01)		51.6 (1.90)	
Between 1,500,000 and 3,000,000	54.3 (1.16)		48.2 (2.18)	
More than 3,000,000	59.8 (1.34)		61.5 (2.51)	
Health Insurance Coverage	-	-	-	-
Private insurance	53.8 (0.98)	0.298	56.8 (1.81)	<0.001
National Social Security Fund (NSSF)	53.4 (0.66)		49.7 (1.23)	
Not available	51.8 (0.86)		47.4 (1.59)	
Other	52.3 (0.97)		45.7 (1.81)	
Chronic Disease	-	-	-	-
Yes	53.3 (1.31)	0.730	52.5 (2.46)	0.241
No	52.8 (0.44)		49.4 (0.82)	
Planning to take the vaccine (Not to be deleted)	-	-	-	-
Yes	55.9 (0.52)	<0.001	61.8 (0.87)	<0.001
No	48.5 (0.63)		32.3 (1.05)	

Abbreviation: S.E.: Standard Error; COVID-19: Coronavirus disease 2019

The knowledge and practice scores of the participants were significantly different across the area of residence, educational level, occupations, and income. Results showed that participants living in the urban regions had higher knowledge and practices than their counterparts living in rural regions. Participants holding a Ph.D. or M.D. degree had significantly better practices than those who hold a Master's degree or less. Moreover, participants having a Master's degree or a Bachelor's degree had significantly higher knowledge than those holding a high school degree or below. It is worth mentioning that students of pharmacy and medicine had significantly higher knowledge than the participants enrolled in the school of education, business, law, and engineering. In addition, participants who worked in health-related jobs had

significantly higher knowledge ($p<0.001$) and practices ($p<0.001$) than participants who worked in non-health-related fields. However, no significant differences were identified in the knowledge or practice scores across ages, marital status, and the presence of any chronic disease among the participants.

4. DISCUSSION

Respondents participating in the current study answered correctly at an overall average of 52.88% to the questions related to the knowledge of COVID-19 vaccines. However, we found significant deviations in the averages depending on the questions asked. Answers to questions about vaccine development duration, vaccine eligibility, counteraction, and side effects were around average (48.3, 47.2, 44.8, and 43%, respectively). On the other hand, the questions related to the knowledge of participants toward the COVID-19 vaccine types/ techniques, vaccines with FDA approval, vaccine doses, the righteousness of mixing two doses from different vaccines, and vaccine protection duration were answered correctly below the overall average (22.0, 29.5, 34.8, 37.9, and 37.8%, respectively). Moreover, the questions related to the eligibility of vaccines for recovered COVID-19 patients and the individuals with the highest priority to be vaccinated were below the overall averages (32.5 and 24%, respectively). However, questions regarding the vaccine protection mechanism, safety, comparison of side effects, injection routes, brands, effectiveness and storage temperatures of the already available vaccines, and the effectiveness of Influenza vaccines against COVID-19 were answered correctly at a much higher rate (88.7, 58, 64.4, 65.1, 57, 75.4, 58.9, and 75.7%, respectively). It is important to highlight that 92.2% of the participants were knowledgeable and aware of the emergence of new COVID-19 strains at the time of data collection. The correct overall knowledge was found to be correlated to the findings of a study conducted in Bangladesh where participants correctly answered the questions related to the COVID-19 vaccines with an overall average rate of 57% [32]. Similarly, the average of correct knowledge was found to be at 55% in India [33] and more than 69.5% in Greece [34], which was greater than our findings. On the other hand, a similar study in West India found that only 9% of the respondents were aware of the COVID-19 vaccine [35]. However, a study conducted in Italy on the participants' knowledge regarding vaccination, in general, showed that only 14.1% were aware and knowledgeable about all the vaccines recommended for them [36], while another study conducted in Bulgaria obtained higher correct knowledge percentages toward Influenza vaccination (71.2%) [37]. It might be worth noting that at the time of data collection in this study, the participants were more knowledgeable about the different brands of vaccines, effectiveness, safety, side effects, and storage temperature of COVID-19 vaccines but had poor knowledge about the concepts related to the techniques used in the preparation of COVID-19 vaccines (mRNA, inactivated virus or using adenovirus), the vaccines that got FDA approval, and the time needed to develop immunity against COVID-19 after vaccination. These discrepancies in knowledge regarding COVID-19 vaccines observed in the questions in our study might be related to insufficient exposure to scientific information or a lack of public awareness about COVID-19 vaccinations.

Our participants generally had a positive attitude toward COVID-19 vaccines, particularly when it came to questions, such as which vaccine is considered to be safe and effective, self-awareness of COVID-19 as measured by repeated PCR testing, and willingness to be vaccinated against COVID-19 (61.4, 90.1, and 59.0%, respectively). Our study also found that 50.7% of participants, who are willing to be vaccinated, answered correctly that the main reason for vaccination is to stop the spread of the virus in the community, protect our body from the disease, or even to avoid living in the hassle of repetitive testing. This finding was consistent with the participants' attitude toward the main reason for vaccine acceptance in a relevant study conducted in the United States and China [21, 38, 39]. The percentage of participants' willingness to be vaccinated in our study was correlated to the finding of similar studies conducted worldwide. For example, a study conducted in Malta on the attitude toward COVID-19 vaccination revealed that over 50% of participants are willing to take the vaccine when it is available [40]. Similarly, the acceptance rates of participants to be vaccinated were found to be 52.0, 48.6, 57.7, 53.7, 54.9, 56.3, and 54.1% in the USA, France, Greece, Italy, Russia, Poland, and UK, respectively [41 - 45]. These aforementioned studies obtained almost similar acceptance rates to our participants (59.0%). On the other hand, similar studies conducted in Kuwait, Jordan, and Egypt reported an acceptance rate of 23.6, 28.4, and 43.5%, respectively [46, 47], which were less than our findings. Additionally, compared to our study, the vaccine acceptance rates were relatively high in other studies conducted in the United States (70%), West India (79%), India (86.3%), China (91.3%), Greece (78.5%), Turkey (66.0%), South Africa (64%), Ecuador (97.0%), Malaysia (94.3%), and Indonesia (93.3%) [24, 33, 35, 38, 47 - 52]. We cautiously compared our finding with another study conducted in Lebanon during the same period, where 93.5% of participants had a greater willingness to be vaccinated [53], which was higher than our finding (59.0%) but in sharp contrast to another study conducted in Lebanon, which investigated that over half of the population (58.8%) are willing to take the vaccine [54]. The high COVID-19 vaccine acceptance rates in some countries would help to control the pandemic properly. However, the low vaccination percentage in our study could be attributed to the low confidence in vaccine safety and effectiveness, distrust towards the government, the ministry of public health, or those administering the vaccines, or the general lack of faith in vaccines [40, 55]. Moreover, hesitancy was found to be usually enhanced by fake news in social media, a lack of trust about the safety and effectiveness of the newly developed vaccines, and the unprecedented pace of the vaccine's development [56, 57]. This could be the reason why we found a discrepancy in the attitude towards COVID-19 vaccines in this study and our previous study, where 90% of our sample was optimistic about COVID-19 vaccines, which was conducted before the beginning of the vaccination campaign in Lebanon [29]. In that study, participants were asked about their willingness to take the vaccine before the beginning of the public discourse, which lacked a serious direction from a credible source and was

fraught with misinformation.

Another variable we examined regarding COVID-19 vaccination attitudes was the explanation for the refusal to take the vaccine. Indeed, we found that 2.87% of participants believed they could skip the vaccine because they had previously been infected with COVID-19, while the remaining participants claimed that the virus does not exist or SARS-CoV-2 is the same as any other flu, and thus no vaccination is needed. This finding was in line with another study conducted in Malta, which showed that the main issue for not wanting to take the vaccine is the belief that COVID-19 is just like any other flu that will be cured easily without any need for vaccination [40]. Additionally, Kourlaba *et al.* (2021) reported that the respondents who had not been vaccinated for seasonal flu and those believing that the coronavirus was manufactured in a laboratory were significantly more likely to be negative for getting vaccinated for COVID-19 [34]. On the other hand, the findings of another study carried out in the USA showed that some participants believed that the vaccine against the coronavirus would not be effective, demonstrating the negative effects of perceived ineffective influenza vaccines on overall vaccine acceptance [18]. Neumann-Bohme *et al.* (2020) identified concerns about the side effects and safety of the vaccine, general rejection of vaccines, and beliefs of conspiracy theories as reasons for not wanting to vaccinate [56]. After all, positive attitudes toward vaccination can be encouraged through media advocacy and educational campaigns about the safety and effectiveness of different brands of vaccines and the seriousness of the new COVID-19 strains. Therefore, increasing the population's consciousness about these aspects will decrease hesitancy toward vaccination and encourage individuals to be vaccinated once the vaccine becomes available in Lebanon.

As for the practice assessment, our sample participants exhibited good practices (above 50% average) on the question related to their prompt action after experiencing side effects from COVID-19 vaccination, where the vast majority of participants (61.4%) correctly answered that they would visit the nearest physician/hospital. Regarding the question related to the basis of vaccine choice, 75.4% of participants correctly answered that they would choose the vaccine based on a recommendation from a credible scientific source or doctors' recommendations. While the other participants answered that they would choose the vaccine based on effectiveness, costs, or even based on the previous success of the manufacturing company in the medical field. The correct average practice that we found regarding this question was comparable to a Chinese study where the majority of participants (80.6%) considered that their doctor's recommendation was an important factor affecting their vaccination choice, but over half of the respondents (59.9%) thought that the vaccine price was important [38]. On the other hand, a total of 35.3% of the Indian participants agreed to vaccination, without any preference toward any vaccine, if it was recommended by their physician [33]. Moreover, the results for vaccine choice are in line with the findings of international studies. A study carried out in Malta revealed that there is a strong positive correlation between willingness to take and choose the vaccine and valuing the advice of healthcare professionals [40]. Another study reported that the participants were significantly more likely to choose and receive the vaccine if their healthcare provider strongly recommended it [58]. These findings were consistent with previous studies assessing the choice or intention of vaccination against the Influenza virus, showing that doctor's recommendation is a significant predictor of vaccination behaviour [59, 60]. Indeed, participants often trust and rely on healthcare professionals for information about vaccines and the choice of vaccine for epidemic diseases.

Our findings showed that 41.4% of our participants would receive a vaccine of any brand against COVID-19 without any preference (Moderna, Pfizer-BioNtech, Sputnik, Sinopharm, Sinovac, Cansino Biologics, AstraZeneca and Johnson and Johnson). Similarly, a study in India reported that the majority of the participants (60.4%) did not care about the origin nor the type of COVID-19 vaccine (Indian-made vaccine or any imported vaccine) [33]. Conversely, our finding is in direct contrast with another study conducted in Lebanon during the same period of our study, which reported that the majority of participants preferred to take the German-American vaccine (BioNTech- Pfizer) while the Chinese vaccine, Sinopharm, was the second most trusted vaccine among the Lebanese population, and the Russian vaccine Sputnik V was the latest [54]. The same findings were obtained in an Indonesian study which demonstrated that the higher acceptance towards vaccination was associated with the choice of a 95% effective vaccine as BioNTech-Pfizer [24]. There are obvious disparities among several studies conducted worldwide regarding this issue. This might be related to the insufficient knowledge and mistrust about these newly-developed vaccines due to the rapid and unprecedented development of vaccines against this novel virus. These factors are reflected in the practices toward the selection of the participants' ultimate vaccine choice.

Regarding the question related to the regular check-up for immunity level after vaccination, 74.5% of participants answered correctly, reflecting their positive practices towards vaccination. Since taking the flu vaccine in the last years is a strong predictor of willingness to take the COVID-19 vaccine, this study showed that only 17.2% of our participants took the Influenza vaccine in the last two years. Comparably, this finding was in line with a study conducted in Lebanon showing that the majority (69.7%) of the study participants never received the influenza vaccine within the last five years, 20% were vaccinated occasionally, and only 10.3% were yearly vaccinated [51], which was relatively higher than our observation. Conversely, our finding was in sharp contrast to a study conducted in Malta, demonstrating that 30.1% of participants took the Influenza vaccine last year [40]. On the other hand, Wang *et al.* (2020) revealed that 14.6% of respondents received vaccinations against influenza in the past season [61], which was similar to our findings. However, Fisher *et al.* (2020) demonstrated that approximately one-half (52.8%) of participants had received the influenza vaccine previously [18]. Hence, our finding confirmed the positive correlation between the experience of participants from previous influenza vaccination history and the belief in vaccine effectiveness and their practices toward accepting immediate vaccination against COVID-19 when it becomes available. Thus, our study showed good practices as most of the answers reflected their overall average (53.98%) and correlated positively with their level of knowledge of the COVID-19 vaccine (52.88%).

To our knowledge, this is the first study in Lebanon assessing the effect of socio-demographic variables and attitudes on the knowledge and practices toward COVID-19 vaccines. The present study showed that the male participants had significantly ($p<0.05$) better attitudes and practices towards COVID-19 vaccines than female participants ($p=0.002$), but the knowledge was not significantly different in both genders. Similar results were found in many other studies conducted in the Arab community assessing their attitude toward COVID-19 vaccines, such as willingness to be vaccinated [24, 62]. On the other hand, this finding was in contrast with a KAP study conducted in Bangladesh during the same period as our study, where the knowledge and attitude regarding COVID-19 vaccinations were not associated with the participants' gender [32]. The good knowledge of male participants in the current study positively affected their attitudes and practices toward COVID-19 vaccines. The possible explanation for this observation is that the higher employment percentage for males than females (according to World Bank development indicators 2021) makes more males susceptible to COVID-19. Consequently, it is likely that males became more curious to know about the different vaccine platforms through social media or credible scientific sources.

In terms of age, our study showed that no significant differences were observed either in knowledge or practices towards the COVID-19 vaccines, although younger aged participants did score higher average for knowledge and practices, albeit not significantly. This result can be explained by the positive effect of social media on communicating valid information about COVID-19 to Lebanese people of all ages and stimulating their curiosity for knowledge. Another study previously reported a similar association when performing KAP surveys toward COVID-19 [63]. However, other studies showed different findings. Better attitudes and practices were observed among participants aged less than 30 years in some countries [36, 40], while in other countries older generation showed better KAP [10, 12]. However, disparities were also observed regarding the KAP toward COVID-19 vaccines without assessing the effect of age variable on their overall knowledge, attitude, and practice averages [33, 48, 61].

The correlation of marital status with knowledge and practices toward COVID-19 vaccines has been assessed and found to be insignificant. This result is similar to prior research investigating the association between socio-demographic factors and knowledge level during the COVID-19 pandemic in South Korea [63]. However, a study conducted in China showed that among the Chinese population, married respondents had better attitudes and practices and were more likely to accept immediate vaccination against the pandemic [61]. This difference could be due to the fact that the majority of our participants were single and thus had the averages skewed towards the lack of correlation between knowledge and practices with marital status. Moreover, people living in urban areas had significantly better knowledge and practices than those in rural areas. Moreover, educational level correlated positively ($p<0.05$) with knowledge and practices toward COVID-19 vaccines, similar to what another study has found [12].

Overall, this study indicated a significant association between the educational attainment of university students and to which school they belong, with different aspects of the KAP related to the COVID-19 vaccine. Similarly, participants who worked in health-related jobs had significantly higher knowledge and practices ($p<0.01$) than participants who worked in non-health-related fields. This variable had a significant consequence on attitude and practices. However, this finding is not surprising since students with health-related majors are associated significantly with good KAP in most epidemic diseases, including COVID-19 [10, 12, 64 - 67], and most probably on the knowledge and practices [68].

In terms of monthly income, our finding indicated that the participants with different income ranges were statistically significant in knowledge and practices ($p<0.01$). Higher knowledge and practices were found for participants who earned more than 3,000,000 LL than those who earned less. No significant correlation was observed between the participants who earned more than 3,000,000 L.L. monthly and those with an M.D. or a Ph.D. degree.

Our assessment of the knowledge and practices among participants enrolled in different types of health insurance revealed a significant correlation with practices but not with knowledge. Participants enrolled in private insurance had better practices than those enrolled in any other type of insurance. We did not find a positive correlation between participants who earned more than 3.000.000 L.L. and those who have private insurance regarding their practices toward COVID-19 vaccines. Finally, the most important variable that showed a significant difference regarding knowledge and practices toward COVID-19 vaccines was the participants' attitude, specifically their willingness to take the vaccine. The participants planning to be vaccinated had significantly higher knowledge compared to those not willing to be vaccinated.

Based on the discovered level of KAP among the same population targeted towards COVID-19, we expected to have similar satisfactory levels towards COVID-19 vaccines. This, however, was not the case. The population sample in this study was hesitant to participate in the vaccination campaign, where only 25% of the Lebanese population registered to take the vaccine [69]. It is not easy to explain why this difference exists between the two studies; a plausible explanation is the lack of trust the population might have towards the national public health institutions and the prevalence of fake news and misinformation [29].

CONCLUSION

The findings of this study highlight the importance of socio-demographic variables and their positive influence on knowledge and practices toward COVID-19 vaccines, which enhance their acceptability to be vaccinated against the pandemic once additional information about vaccine safety and efficacy becomes available in the public domain, preferably by a trusted and scientific source of information. Our findings strengthen the need to implement health education campaigns for the purpose of providing reliable information about the safety, side effects, and efficacy of different vaccine platforms. Moreover, it is important to note that awareness programs and

educative measures in students' curricula are highly recommended in universities and schools to remediate some gaps related to students' knowledge about epidemic diseases and their vaccination programs.

Up to this date, the Lebanese government has primarily relied on television and social media platforms and websites to deliver COVID-19 vaccine information updates. Recently, as part of the National COVID-19 Vaccines Deployment Campaign, the ministry of public health launched the AstraZeneca and Pfizer Vaccination Marathons, respectively, on May 29th, 2021 and January 8th, 2022, to encourage people to take the vaccine. Such efforts must be continued but need to be expanded to ensure adequate knowledge and positive attitudes and practices toward COVID-19 vaccinations, which will eventually reduce any hesitancy about accepting any of the vaccine platforms available in Lebanon.

The major limitation of this study was the fact that it was conducted at a time when the vaccine was not available to the public. Therefore, it was not easy to assess KAP fully under these conditions. Therefore, some correlations were made between the regular Influenza vaccines and the COVID-19 vaccine. This was, however, necessary to allow us to gauge the public's response and acceptance and adherence to the vaccination plan in this country. Another limitation is the low alpha Cronbach's coefficient for attitudes and practices. This is due to the confusion of the population towards the contradictive information received about the COVID-19 vaccines, added to the fact that the population was not familiar with the measures and vaccination strategy implemented in the country.

LIST OF ABBREVIATIONS

COVID-19	=	Coronavirus disease 2019
SARS-CoV-2	=	Severe Acute Respiratory Syndrome Coronavirus-2
ssRNA	=	Single Stranded Ribonucleic Acid
FDA	=	Food and Drug Administration
KAP	=	Knowledge, Attitude and Practice
LL	=	Lebanese Lira

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Lebanese International University Institutional Review Board (IRB) ethical committee under the reference: LIUIRB-201230-SS1.

HUMAN AND ANIMAL RIGHTS

No animals were used in the studies that are the basis of this research. All the humans were used in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013 (http://ethics.iit.edu/ecodes/node/3931).

CONSENT FOR PUBLICATION

A consent form was included in the questionnaire, clarifying the research objective and confirming that anonymity and confidentiality would be maintained and that participation is voluntary.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIAL

Data are available from the corresponding author upon reasonable request [B.H]. The questionnaire is found as supplementary material.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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SUPPLEMENTARY MATERIALS

Supplementary material is available on the Publisher's website.

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