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1 Article

2 Conspiracy beliefs are associated with lower 3 knowledge and higher anxiety levels regarding 4 COVID-19 among students at the University of 5 Jordan

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18 **ABSTRACT: Background:** The world has been afflicted heavily by the burden of coronavirus
19 disease 2019 (COVID-19) that overwhelmed health care systems and caused severe economic and
20 educational deficits, in addition to anxiety among the public. The main aim of this study was to
21 evaluate the mutual effects of belief that the pandemic was the result of a conspiracy on knowledge
22 and anxiety levels among students at the University of Jordan (UJ). An electronic-based survey was
23 conducted between March 29th, 2020 and March 31st, 2020. The targeted population involved all
24 undergraduate and postgraduate students from Health, Scientific and Humanities Schools at UJ.
25 Survey sections included 26 items on: socio-demographic information, knowledge and sources of
26 information about the disease, attitude towards the false notion that COVID-19 stemmed from a
27 conspiracy and items to assess the anxiety level among students during the quarantine period. The
28 total number of participants was 1540 students. **The mean age of study participants was 22 years
29 and females predominated the study population (n=1145, 74.4%). The majority of participants
30 perceived the disease as moderately dangerous (n=1079, 70.1%). Males, Jordanians and participants
31 with lower income were more inclined to feel that the COVID-19 is very dangerous.** Lower level of
32 knowledge and higher level of anxiety about COVID-19 were associated with the belief that the
33 disease is part of a conspiracy. Females and participants with lower income were more likely to
34 believe that the disease is related to conspiracy. Belief in conspiracy regarding the origin of COVID-
35 19 was associated with misinformation about the availability of vaccine and the therapeutic use of
36 antibiotics for COVID-19 treatment. Ministry of Health in Jordan was the most common source of
37 information about COVID-19 reported by the participants (n=1018). The false belief that COVID-19
38 was the result of a global conspiracy could be the consequence of lower level of knowledge about
39 the virus and could lead to higher level of anxiety, which should be considered in the awareness
40 tools of various media platforms about the current pandemic.

41 **Keywords:** Novel coronavirus; SARS-CoV-2; Middle East; Facebook; Instagram; Twitter;
42 WhatsApp; TV; news

43

44 **1. Introduction**

45 The humankind is under continuous threat elicited by emerging and re-emerging infectious
46 diseases and the current coronavirus disease 2019 (COVID-19) pandemic is the full-blown
47 manifestation of such a threat [1-3]. In 2020, the World Health Organization (WHO) declared that the
48 disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as a pandemic [4].
49 The world was overwhelmed by the rapid escalation of events, exponential increase in the number
50 of cases and mortality rate of the disease, which was reported in China, the first epicenter of COVID-
51 19 [5-7].

52 The novel respiratory disease COVID-19, has a median incubation period of 5 days (2-14 days)
53 with most common symptoms including fever, dry cough and fatigue [8]. Other signs and symptoms
54 that were reported to a lesser degree included productive cough, dyspnea, myalgia, sore throat and
55 headache [9].

56 With no specific antiviral treatment options available so far, the prevention of the disease
57 remains the mainstay approach to halt the spread of the virus [10]. The preventive measures revolve
58 mainly around social distancing and strict quarantine [11]. Avoiding crowded places and keeping a
59 safe distance from anyone, are considered among the most important preventive measures, as SARS-
60 CoV-2 is known to be transmitted via droplets [12, 13]. Since the virus is also known to be transmitted
61 through close contact, any form of physical social greetings should be avoided [12]. The preventative
62 approach also includes: practicing regular hygiene and sanitation measures such as hand washing,
63 constant disinfection of surfaces and wearing masks and gloves as appropriate [14]. Abstaining from
64 travel and avoiding people who have been to countries highly impacted by the pandemic is of
65 paramount importance [14]. It is crucial as well to prevent the spread of infection, which is done by
66 practicing coughing and sneezing etiquette and self-isolating in case of suspected infection with the
67 virus [11, 14].

68 Despite the rapid increase in the number of publications regarding COVID-19 in the literature,
69 some aspects of the disease have not been clearly identified yet. This vagueness can lead to a huge
70 stream of misinformation about the virus and the disease [15]. These aspects involve the origin of the
71 virus, availability of specific antiviral treatment and effective vaccine, in addition to questioning the
72 accuracy of the recently developed diagnostic modalities [15]. In the current day and age, the
73 widespread access to internet and the extensive use of social media outlets to get information can be
74 a double-edged sword [16-18]. On one end, information can be delivered to a huge target population
75 within a short period of time. However, this information might be faulty and can spread easily
76 without having a credible source [16, 18, 19].

77 The fear and anxiety that accompanied COVID-19 pandemic can have devastating effects on the
78 mental health of people and might have a negative psychological and social impact [20, 21]. Providing
79 accurate and timely information can result in clearance of vagueness and relief of anxiety [19].

80 The conspiracy beliefs can be defined as unsubstantiated and implausible beliefs that involve
81 the role of malevolent force in plotting major events, when other explanations are more probable [22].
82 Such beliefs can have negative health and social effects which were seen in the past and continue to
83 exist to this day [23]. The striking example regarding the effect of conspiracy is the HIV epidemic in
84 South Africa, where the belief in conspiracy resulted in governmental policies with devastating
85 effects on public health [24]. Another example, is the vaccination conspiracy theories, with sinister
86 outcomes manifested by re-occurrence of outbreaks of infectious diseases including measles, mumps
87 and rubella [25, 26].

88 Jordan was affected by COVID-19 similar to most countries of the world, with 381 reported cases
89 and seven deaths as a result of the disease, at the time of manuscript writing [7]. On March 18th,
90 curfew and quarantine were first implemented in the country following earlier closure of schools and
91 universities with recommendations to avoid large gatherings, which took place on March 15th. The
92 students in general and particularly university students were heavily affected by the conditions
93 surrounding the disease including forced stay at home during the quarantine. Thus, the aims of the
94 current study were to evaluate the overall knowledge about COVID-19 and SARS-CoV-2 among the
95 University of Jordan (UJ) students from different Schools. In addition, we aimed to assess the attitude

96 of UJ students towards the perceived danger of the disease and the quarantine measures issued by
97 the government. Moreover, we sought to evaluate possible deleterious effects of conspiracy belief
98 regarding the origin of COVID-19, particularly; the potential impact on knowledge and anxiety levels
99 among UJ students. Finally, we aimed to investigate the sources of information about the disease
100 among the students.

101 2. Materials and Methods

102 This study was conducted using an online-based questionnaire that was distributed among
103 students at UJ, which is the largest and oldest University in Jordan with about 49,000 enrolled
104 students as of 2019/2020 Academic year [27]. *Despite its caveats, an online-based survey was the sole*
105 *sampling strategy that was feasible considering the conditions of lockdown in Jordan during*
106 *sampling.* Participation in the study was voluntary and an informed-consent was provided at the
107 introductory section of the questionnaire (Supplementary File 1).

108 2.1. Description of the questionnaire

109 Pilot testing involved distributing the questionnaire draft to seven participants (who did not
110 take part in the final survey), which resulted in minor changes in language and content. The
111 questionnaire was distributed in Arabic and comprised 26 items on socio-demographic information
112 (age, nationality, gender, University program and School, marital status and monthly income of the
113 family), conditions of living during the quarantine period, attitude regarding the perceived danger
114 of the disease and towards the adherence to quarantine measures. To assess knowledge of the
115 participants on the virus and the disease, several items were included that evaluated signs and
116 symptoms, transmission routes, protective measures, therapeutic use of antibiotics, availability of
117 vaccine for COVID-19, and belief in the assumption that summer heat can inactivate SARS-CoV-2. In
118 addition, the survey items included a section on sources of information about the disease including
119 social media platforms. A specific item was used to evaluate the belief of each participant that
120 COVID-19 pandemic is part of a global conspiracy. Finally, a section to assess the anxiety level among
121 participants was included and comprised seven questions with four potential responses.

122 Invitation to participate in this survey was distributed among UJ students via Facebook and
123 WhatsApp. The survey was conducted from 29th March 2020 (14:00) till March 31st (16:00), thus
124 spanning 50 hours.

125 2.2. Ethical permission

126 The study was approved by the Department of Pathology, Microbiology and Forensic Medicine
127 and by the Scientific Research Committee at the School of Medicine/UJ (Meeting #2 of the week 14,
128 2020 using WhatsApp conference call). *In addition, the study was approved by the Institutional*
129 *Review Board (IRB) at Jordan University Hospital (Ref. No. 10-2020-8556, decision 80/2020).*
130 Participation in the study was voluntary and anonymous. An informed consent was ensured by the
131 presence of an introductory section of the questionnaire, with submission of responses implying the
132 agreement to participate. All collected data were treated confidentially.

133 2.3. COVID-19 knowledge score (K-score) calculation

134 To evaluate the overall knowledge of each participant about COVID-19 and SARS-CoV-2, a total
135 of 12 items each worth of a single point were included with a correct response to each item being
136 considered as a single point yielding a maximum score of 12. These items involved questions on signs
137 and symptoms (five items with one point weight for each correct answer), routes of transmission
138 (four items with one point awarded for each correct answer, and for blood transmission, non-
139 selection was regarded as a correct answer), antibiotic treatment, availability of vaccine and effect of
140 summer heat on the epidemic each worth a single point for each correct answer.

141 2.4. Anxiety score calculation

142 We based the anxiety score system on the 7-item Generalized Anxiety Disorder Scale (GAD-7),
143 which is a reliable and commonly used system to assess the level of anxiety [28]. This system is
144 modelled based on four possible responses (not at all response was scored as zero, several days
145 response was scored as 1, more than half the days was scored as 2 and everyday was scored as 3) to
146 seven questions about their feelings during the past two weeks prior to survey in our study (the
147 quarantine period, Supplementary File 1) [29]. The maximum score of 21 was regarded as the highest
148 level of anxiety while zero was considered to represent the lowest level. GAD-7 scale of 0-4 indicates
149 no anxiety, 5-9 indicates mild anxiety, 10-14 indicates moderate anxiety, and a score of 15 and above
150 indicates severe anxiety [29].

151 2.5. Statistical analysis

152 We used Chi-squared test (χ^2) to examine the significance of relationships between categorical
153 variables. To compare differences between two independent groups when the dependent variable is
154 continuous, we used Mann-Whitney U test (M-W), and for more than two independent groups, we
155 used Kruskal-Wallis test (K-W) instead. We also used two-sided t-test to compare differences
156 between the means of two groups. P-values less than 0.050 were considered significant. All statistical
157 analyses were conducted in IBM SPSS Statistics 22.0 for Windows.

158 3. Results

159 3.1. Characteristics of the study population

160 The total number of participants in the study who completed the questionnaire was 1540. The
161 mean age of study participants was 22 years (median: 21 years, interquartile range (IQR): 20-22 years).
162 Females predominated the study population (n=1145, 74.4%) and the majority were Jordanians
163 (n=1386, 90.2%). Undergraduate students comprised 89.5% (n=1378) of the study participants and
164 43.1% (n=664) were students at Health Schools, with highest participation from the School of
165 Dentistry (n=259, 16.8%), while the lowest number was from the School of Law (n=4, 0.3%,
166 Supplementary File 2). The highest number of study participants reported a household monthly
167 income of 500-1000 JDs (n=646, 41.9%). The vast majority of participants were single (n=1440, 94.1%,
168 Table 1) and spent the last two weeks of curfew with their families (n=1407, 91.7%).

169 3.2. Knowledge of COVID-19 transmission, prevention and control

170 Regarding knowledge on signs and symptoms of the disease, fever was the most frequent sign
171 to be correctly identified by the participants (n=1500, 97.4%) followed by shortness of breath (n=1448,
172 94.0%) and cough (n=1309, 85.0%).

173 For possible transmission routes of the virus, touching infected surfaces (fomites) was the most
174 common route to be correctly identified (n=1485, 96.4%) followed by coughing and sneezing (n=1325,
175 86.0%). Close contact in crowded places was missed as a potential route of transmission in 21.0% of
176 the participants (n=324). Transmission via blood was incorrectly identified by 17.8% of the
177 participants (n=274).

178 Of the eight protective and control measures that were asked in the survey, the majority of
179 participants precisely identified all protective measure (n=1193, 77.5%) and an additional 134
180 participants missed only a single protective measure out of the eight items in the survey (8.7%),
181 followed by 85 participants who missed two items (5.5%).

182 Regarding the current lack of an effective vaccine against SARS-CoV-2, the vast majority of
183 participants provided a correct answer (n=1433, 93.1%). In addition, the majority of participants
184 identified the useless effect of antibiotics in treating COVID-19 (n=1365, 88.6%). Summer heat ability
185 to inactivate the virus was incorrectly reported by 40.3% of the study participants (n=621).
186

Table 1. Characteristics of the study participants.

Characteristic	N¹ (%)
Age (median, SD ²)	21 (3.7)
Gender	
<i>Male</i>	394 (25.6)
<i>Female</i>	1145 (74.4)
Nationality	
<i>Jordanian</i>	1386 (90.2)
<i>Non-Jordanian</i> ³	151 (9.8)
Program ⁴	
<i>BSc</i>	1378 (89.5)
<i>MSc</i>	138 (9.0)
<i>PhD</i>	24 (1.6)
Schools ⁵	
<i>Health</i> ⁶	664 (48.5)
<i>Scientific</i> ⁷	392 (28.6)
<i>Humanities</i> ⁸	313 (22.9)
Marital status	
<i>Single</i>	1440 (94.1)
<i>Married</i>	85 (5.6)
<i>Divorced</i>	6 (0.4)
Monthly income ⁹	
<i>Less than 500 JDs</i> ¹⁰	397 (25.8)
<i>500-1000 JDs</i>	646 (41.9)
<i>More than 1000 JDs</i>	497 (32.3)

188 ¹N: Number, some categories will not add up to 1540 because of missing information; ²SD: Standard
189 deviation; ³Non-Jordanian: Participants of non-Jordanian origin included 22 different nationalities,
190 with the most common being Palestine (n=42), Iraq (n=33) and Kuwait (n=28); ⁴Program: BSc is
191 Bachelor of Science, MSc is Masters of Science and PhD is Doctor of Philosophy; ⁵Schools of Business
192 and King Abdullah II School of Information Technology were excluded from this analysis because
193 they represent two different categories (Humanities for the former and Scientific for the later); ⁶Health
194 Schools: Include the Schools of Medicine, Dentistry, Pharmacy, Nursing and Rehabilitation Sciences;
195 ⁷Scientific Schools: Include the Schools of Engineering, Agriculture, and Science; ⁸Humanities: Include
196 Schools of Arts and Foreign Languages, Physical Education, Archaeology and Tourism, Sharia,
197 Educational Sciences, Arts and Design and Law; ⁹Monthly income: The self-reported monthly income
198 of the family; ¹⁰JD: Jordanian Dinar.

Table 2. Response of study participants regarding danger of COVID-19, knowledge and belief in conspiracy.

Feature	Nationality	Nationality		Gender			Schools of UJ ¹		Monthly income of the family ²					
		Jordanian	non-Jordanian ³	Male	Female	P-value ⁸	Health and Scientific Schools ⁴	Humanities Schools ⁵	P-value	Less than 500 JDs ⁶	500-1000 JDs	More than 1000 JDs	P-value	
Survey item	Response	N ⁷ (%)	N (%)	N (%)	N (%)	P-value	N (%)	N (%)	P-value	N (%)	N (%)	N (%)	P-value	
Is COVID-19 dangerous? ⁹	<i>Not dangerous</i>	26 (1.9)	7 (4.6)	0.02	9 (2.3)	24 (2.1)	<0.001	24 (2.3)	8 (2.6)	<0.001	10 (2.5)	10 (1.5)	13 (2.6)	<0.001
	<i>Moderately dangerous</i>	965 (69.6)	112 (74.2)	0	233 (59.1)	845 (73.8)	<0.001	782 (74.1)	191 (61.0)	<0.001	236 (59.4)	469 (72.6)	374 (75.3)	<0.001
	<i>Very dangerous</i>	395 (28.5)	32 (21.2)		152 (38.6)	276 (24.1)		250 (23.7)	114 (36.4)		151 (38.0)	167 (25.9)	110 (22.1)	
Coronavirus infection can be treated using an antibiotic	<i>Correct response</i>	1226 (88.5)	137 (90.7)	0.40	348 (88.3)	1016 (88.7)	0.8	965 (91.4)	249 (79.6)	<0.001	337 (84.9)	577 (89.3)	451 (90.7)	0.018
	<i>Incorrect response</i>	160 (11.5)	14 (9.3)	3	46 (11.7)	129 (11.3)	26	91 (8.6)	64 (20.4)		60 (15.1)	69 (10.7)	46 (9.3)	
There is a vaccine available for COVID-19	<i>Correct response</i>	1288 (92.9)	143 (94.7)	0.41	370 (93.9)	1062 (92.8)	0.4	990 (93.8)	284 (90.7)	0.065	359 (90.4)	602 (93.2)	472 (95.0)	0.029
	<i>Incorrect response</i>	98 (7.1)	8 (5.3)	4	24 (6.1)	83 (7.2)	36	66 (6.3)	29 (9.3)		38 (9.6)	44 (6.8)	25 (5.0)	
Summer heat can kill the COVID-19 virus	<i>Correct response</i>	820 (59.2)	98 (64.9)	0.17	235 (59.6)	684 (59.7)	0.9	701 (66.4)	135 (43.1)	<0.001	198 (49.9)	388 (60.1)	333 (67.0)	<0.001
	<i>Incorrect response</i>	566 (40.8)	53 (35.1)	2	159 (40.4)	461 (40.3)	74	355 (33.6)	178 (56.9)		199 (50.1)	258 (39.9)	164 (33.0)	

Do you think the COVID-19 pandemic is part of a global conspiracy theory?	No	458 (33.0)	58 (38.4)		163 (41. 4)	355 (31.0)		395 (37.4)	82 (26.2)		101 (25.4)	213 (33.0)	204 (41.0)	
	Yes	228 (16.5)	24 (15.9)	0.40 2	51 (12. 9)	202 (17.6)	0.0 01	144 (13.6)	69 (22.0)	<0. 001	80 (20.2)	107 (16.6)	66 (13.3)	<0. 001
	Maybe	700 (50.5)	69 (45.7)		180 (45. 7)	588 (51.4)		517 (49.0)	162 (51.8)		216 (54.4)	326 (50.5)	227 (45.7)	

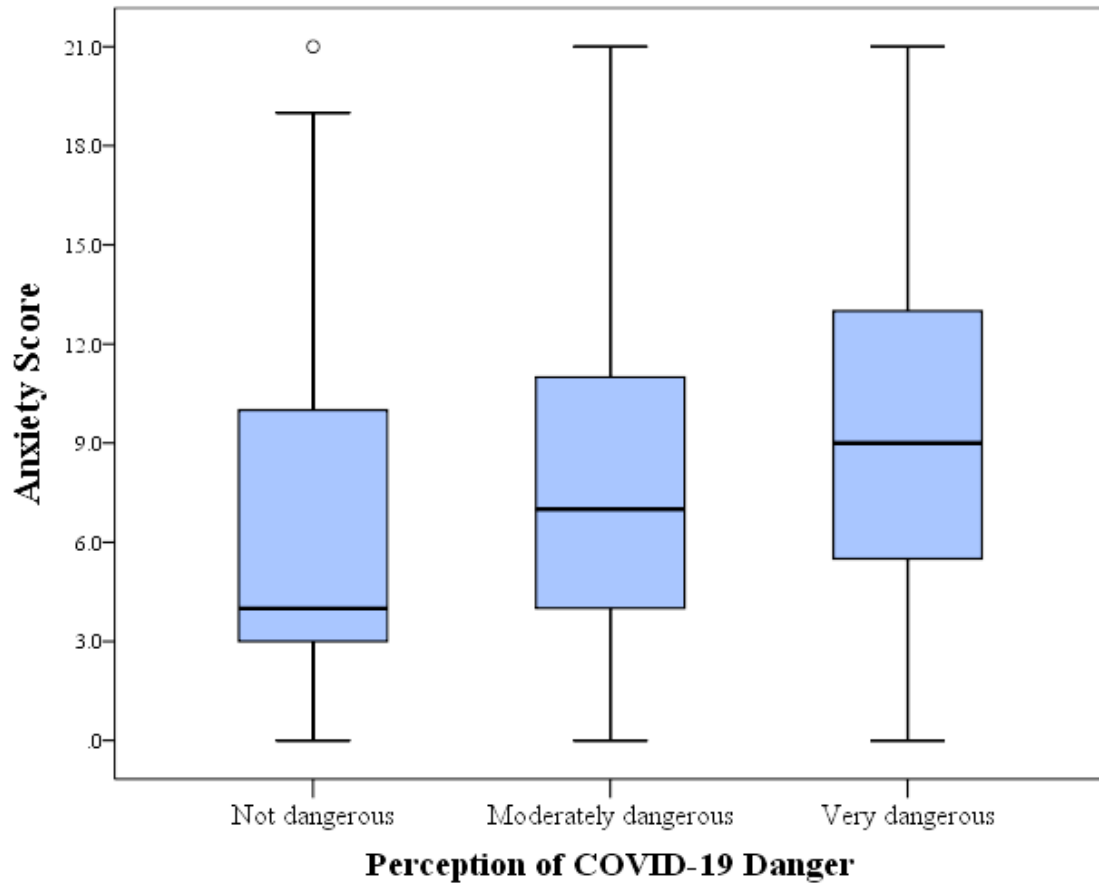
¹UJ: University of Jordan; ²Monthly income: The self-reported monthly income of the family; ³Non-Jordanian: Participants of non-Jordanian origin included 22 different nationalities, with the most common being Palestine (n=42), Iraq (n=33) and Kuwait (n=28); ⁴Health and Scientific Schools: Include the Schools of Medicine, Dentistry, Pharmacy, Nursing, Rehabilitation Sciences, Engineering, Agriculture, and Science; ⁵Humanities Schools: Include Schools of Arts and Foreign Languages, Physical Education, Archaeology and Tourism, Sharia, Educational Sciences, Arts and Design and Law; ⁶JD: Jordanian Dinar; ⁷N: Number; ⁸P-value: Calculated using chi-squared test (χ^2); ⁹COVID-19: Coronavirus disease 2019.

193 3.3. *Attitude towards COVID-19*

194 Regarding the attitude of the participants towards the perceived danger of the disease, the
195 majority reported that COVID-19 is moderately dangerous (n=1079, 70.1%) and 428 participants
196 reported that the disease is very dangerous (27.8%). Males were more likely to report that COVID-19
197 is very dangerous compared to females (38.6% vs. 24.1%, $p<0.001$; χ^2 , Table 2). Jordanian participants
198 had a significantly higher likelihood to report that the disease is very dangerous compared to their
199 non-Jordanian colleagues (28.5% vs. 21.2%, $p=0.020$; χ^2 , Table 2). Participants with families of lower
200 income were more likely to feel that COVID-19 is very dangerous compared to those with higher
201 income (38.0% vs. 22.1%, $p<0.001$; χ^2 , Table 2). Higher level of anxiety was found more frequently
202 among participants who felt the disease is more dangerous as estimated using anxiety scores (mean
203 anxiety score of 8.1 among those who reported the disease as moderately dangerous, as opposed to
204 mean anxiety score of 9.2 among those who reported that COVID-19 is very dangerous, $p<0.001$; K-
205 W, Figure 1). Correlation of age, level of study, marital status and belief in conspiracy regarding the
206 origin of the virus with perception of COVID-19 danger did not result in statistically significant
207 differences (Table 2). The vast majority of participants followed the government-issued quarantine
208 measures (n=1506, 98.2%). Married participants were less likely to adhere to quarantine measures
209 compared to single students (7.1% vs. 1.5%, $p=0.001$; χ^2). In addition, male participants were less
210 likely to adhere to quarantine measures compared to females (3.3% vs. 1.2%, $p=0.007$; χ^2). Also,
211 postgraduate students were more likely to break the quarantine measures (3.7% vs. 1.5%, $p=0.047$;
212 χ^2).

213 3.4. *Correlation of COVID-19 knowledge to different variables*

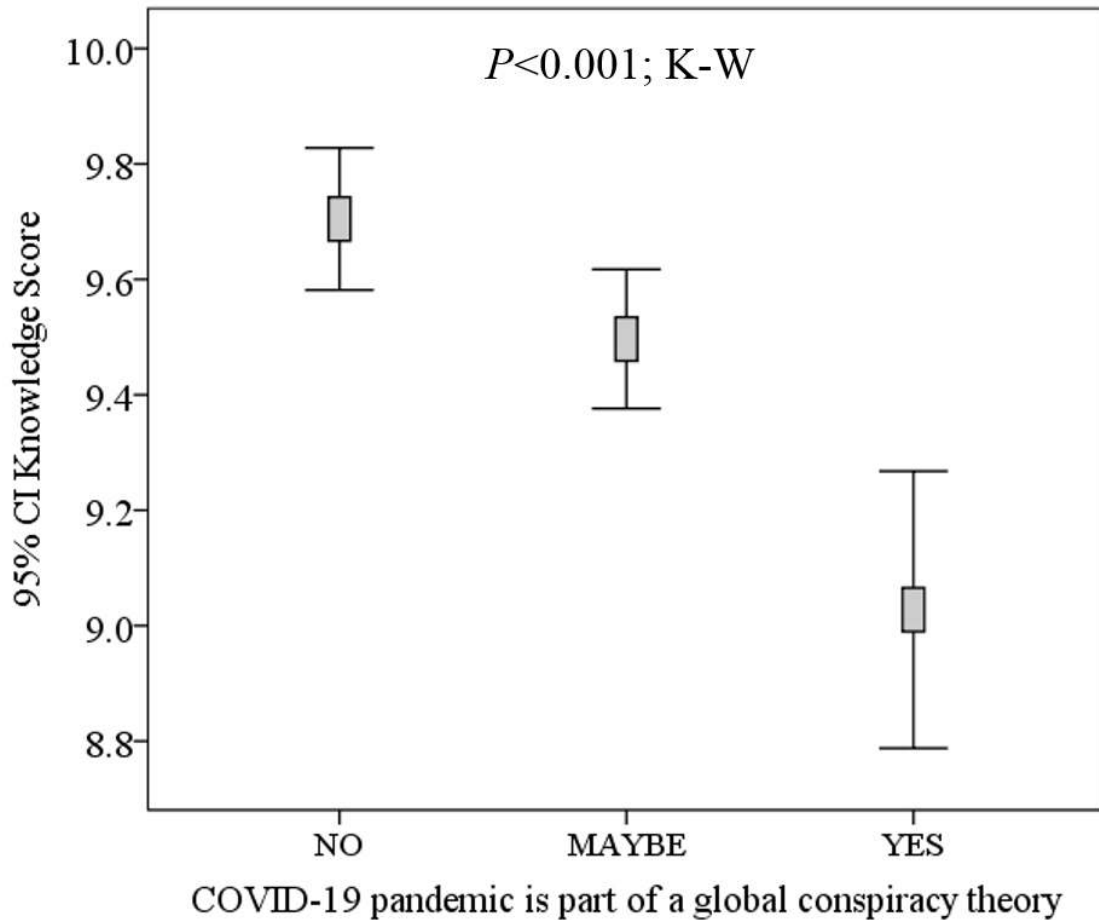
214 The overall knowledge regarding the disease and the virus among the participants was generally
215 high with 9.5 as the mean K-score. Older age was associated with higher level of knowledge (mean
216 K-score: 9.7 vs. 9.3, $p<0.001$; t-test). Postgraduate students had higher mean K-score compared to their
217 undergraduate counterparts (9.7 vs. 9.5, $p=0.035$; M-W). The highest mean K-score was found among
218 students at Health Schools followed by the Scientific Schools, while the lowest mean K-score was
219 found among the Humanities Schools (9.8 vs. 9.4 vs. 9.1, $p<0.001$; K-W). Higher mean K-score was
220 observed among those who felt that COVID-19 is very dangerous compared to those who felt that
221 the disease is moderately dangerous, however, without statistical significance ($p=0.150$; K-W). For
222 gender, marital status, nationality and family income, no statistically significant differences were
223 found as well.



224

225 **Figure 1.** Anxiety score distribution among the study participants stratified by attitude towards
 226 COVID-19 perceived danger. Gradual increase in anxiety was seen among students at the University
 227 of Jordan in relation to their perception of coronavirus disease 2019 (COVID-19) danger. The
 228 difference was statistically significant ($p < 0.001$, Kruskal Wallis test).

229 The level of knowledge about COVID-19 was lower among participants who believed that the
 230 disease is part of a conspiracy, compared to those who did not have such a belief (mean K-score: 9.0
 231 vs. 9.7, $p < 0.001$; M-W). In addition, the mean K-score showed a gradual decrease going from those
 232 who denied the existence of conspiracy to those who answered maybe, and ending in participants
 233 who had such a belief (mean K-score: 9.0 vs. 9.5 vs. 9.7; $p < 0.001$; K-W, Figure 2).



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Figure 2. Correlation between students' knowledge about COVID-19 and their belief in conspiracy role in the disease. Participants were students at the University of Jordan. K-W: Kruskal Wallis test. **CI: confidence interval.**

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3.5. Anxiety level in relation to other variables

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For the whole study population, the mean anxiety score was 8.4 (median=8.0, IQR (5.0-12.0)). Males showed lower level of anxiety compared to females (mean anxiety scores: 7.7 vs. 8.6, $p=0.002$; M-W). Higher level of anxiety was found among participants with the lowest monthly income as compared to the other two groups (8.9 vs. 8.3 vs. 8.1, $p=0.043$; K-W, Supplementary File 2). In addition, higher level of anxiety was also noticed among non-Jordanians, however, without statistical significance (mean anxiety score: 9.2 vs. 8.3, $p=0.068$; M-W). Nevertheless, significantly higher level of anxiety was found among non-Jordanian females compared to their Jordanian counterparts (mean anxiety score: 10.0 vs. 8.5; $p=0.011$; M-W, Supplementary File 2).

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Anxiety scores were significantly higher among the study participants who believed that COVID-19 is the result of a global conspiracy compared to those who denied such a belief (mean anxiety score: 9.0 vs. 7.7, $p=0.004$; M-W). In addition, a gradual increase in the level of anxiety was observed moving from a mean score of 7.7 among those who did not believe in the role of conspiracy, to a mean score of 8.6 among those who answered maybe, and reaching the highest mean score of 9.0 among those who had such a belief ($p=0.001$; K-W, Figure 3). On the other hand, no significant differences in anxiety scores were observed for study level, Schools, nationalities and conditions of living during the quarantine.

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3.6. Association of belief in conspiracy with other variables

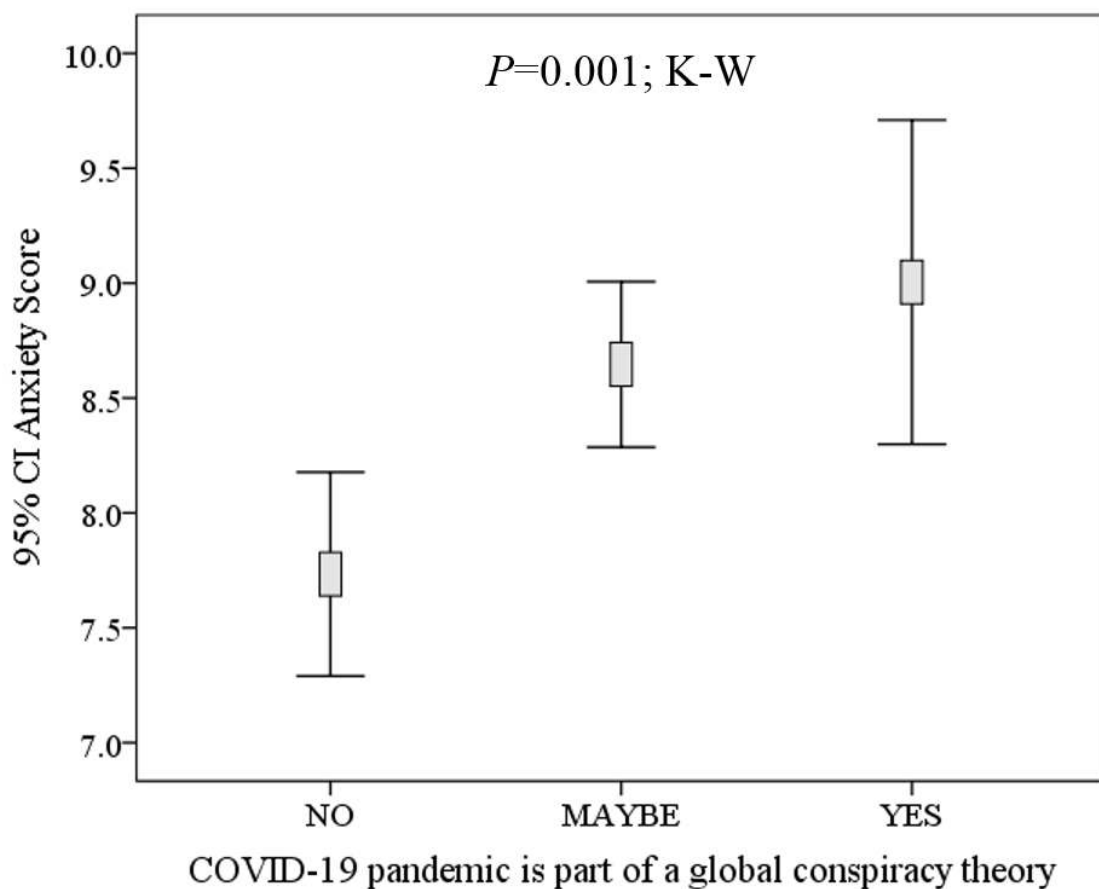
256

257

The total number of participants who stated that COVID-19 is not part of a conspiracy was 518 representing 33.6% of the study population. On the other hand, 16.4% of the participants stated that

258 they believe in the role of conspiracy in the origin of the disease (n=253), and those who answered
259 maybe represented 49.9% of the study population (n=769).

260 Upon comparing different variables depending on whether the participants had a belief that
261 COVID-19 is part of a global conspiracy or not, we found that females were more inclined to have
262 such a belief compared to males (36.3% vs. 23.8%; $p=0.001$; χ^2 test). Those with lower income had
263 higher likelihood to believe that the disease is the result of a global conspiracy (74.6% answered yes
264 or maybe among participants with income <500 JD, compared to 59.0% who answered yes or maybe
265 among participants with income >1000 JD, $p<0.001$; χ^2 test). In addition, the participants who believed
266 in conspiracy had higher tendency to believe that there is a vaccine for COVID-19 (8.2% vs. 4.4%,
267 $p=0.001$; χ^2 test), and to believe that the disease can be treated with antibiotics (13.7% vs. 6.8%, $p<0.001$;
268 χ^2 test). Also, those who believed either entirely or indicated a possibility of conspiracy had the
269 doubtful belief that summer heat will inactivate SARS-CoV-2 (45.8% vs. 29.5%, $p<0.001$; χ^2 test). Level
270 of study, nationality and living conditions during the quarantine did not have statistically significant
271 differences in relation to belief in conspiracy.



272

273 **Figure 3.** Correlation between students' anxiety about COVID-19 and their belief in conspiracy role
274 in the disease. Participants were students at the University of Jordan. K-W: Kruskal Wallis
275 test. CI: confidence interval.

276 3.7. Sources of information regarding COVID-19

277 Regarding the most frequent sources of information about the disease and the virus that were
278 reported by the students, the Jordanian Ministry of Health (MoH) website was the most frequent one
279 (n=1018), followed by television programs and news releases (n=918), social media (n=913), medical
280 doctors (n=684), scientific journals (n=462) and the UJ websites (n=362). The WHO website was the
281 most frequent reported source of information mentioned in the "others" option (n=18). The majority
282 of students reported more than one source of information about the pandemic (n=1238). For social

283 media platforms, Facebook was the most frequent source of information (n=911), followed by
284 Instagram (n=283), WhatsApp (n=270) and Twitter (n=209).

285 4. Discussion

286 Knowledge and attitude surveys can be used as an asset to identify gaps in knowledge, certain
287 misbeliefs and patterns of behavior. Such gathered information can be helpful to plan for better action
288 especially in the current time where public appears vulnerable to media littered with piles of
289 misinformation that lacks accuracy at times [16]. This misinformation can create a response that
290 varies from full-fledged terror and panic to complete negligence, which can impede a successful
291 response to the current pandemic in both ways [15, 19]. The response to COVID-19 requires
292 cooperation of the public through following government-issued strict quarantine and social
293 distancing measures, which are the best strategies to lessen the effects of the pandemic and to prevent
294 collapse of health care system [14]. This also applies to university students where the conditions that
295 accompanied the pandemic have resulted in psychological and educational difficulties [30]. The swift
296 spread of COVID-19 pandemic was met initially by alertness of the public in some countries,
297 confusion and panic in others. Panic could particularly be related to lack of accurate information
298 about the pandemic [4, 31, 32].

299 One of the main misconceptions is the presence of conspiracy theories regarding the origin of
300 the virus itself [15, 33]. The interplay between virus evolution and dynamics of virus emergence,
301 diversification and spread has been reviewed by Pybus and Rambaut [34]. Virus evolution by itself
302 is not the sole factor for the increased incidence of infectious disease. Increased human mobility with
303 ease of travel and growth of the global population resulted in increased contact with virus reservoirs
304 and vectors for transmission of human infectious agents and rapid global spread of these novel
305 pathogens [35]. Obvious examples to illustrate this phenomenon include the spread of West Nile
306 fever from the Middle East into New York in 1999 and the emergence of Severe Acute Respiratory
307 Syndrome (SARS) coronavirus in 2003, Middle East Respiratory Syndrome coronavirus (MERS) in
308 2012, Ebola in 2014, and Zika fever in 2015 [36-39]. Thus, conspiracy theories regarding origins of
309 viral diseases, including COVID-19 are not plausible on any scientific level. Currently, there is
310 sufficient conclusive evidence that explains the origin of SARS-CoV-2 from bat reservoir [40, 41].
311 Other currently circulating misconceptions include the presence of effective treatment of COVID-19
312 using antibiotics (azithromycin) and antimalarial (hydroxychloroquine) that have not been proven as
313 effective treatment yet, with variable and conflicting results [42]. In addition, a widespread belief that
314 the pandemic will die out in summer, despite the absence of a clear cut evidence of such a notion. On
315 the contrary, the spread of SARS-CoV-2 in the Southern hemisphere might hint to the fallacy of such
316 a claim. Thus, discernable effect of summer heat on the virus needs further scientific investigation to
317 reach valid and conclusive evidence about this issue.

318 The main study findings are the following: students at the UJ displayed relatively high level of
319 knowledge about COVID-19, which was shown by high mean K-score. More than 80% of the
320 participants correctly identified the commonly reported signs and symptoms of COVID-19 (fever,
321 cough and shortness of breath). In addition, the students showed high level of knowledge regarding
322 the transmission routes (fomites and droplet transmission through sneezing or coughing) and the
323 preventive methods. This level of knowledge might be attributed to mass awareness campaigns via
324 different media channels including the UJ, MoH, and news websites and their social media pages
325 and accounts, besides the massive awareness campaigns on TV and the internet. Also, this result can
326 stem from the desire of the students to actively seek knowledge about this disease that strongly
327 affected their lives including educational, social and mental aspects. However, important gaps in
328 knowledge regarding other possible modes of transmission were identified. This included about one-
329 fifth of the participants missing the importance of crowded places as a possible setting for virus
330 transmission. Such places can increase the chance of exposure to respiratory droplets, with the
331 possibility of transmission from infected people lacking symptoms [13, 43, 44]. In addition,
332 transmission via blood was incorrectly identified by 17.8% of the students. Despite concerns related
333 to infrequent detection of SARS-CoV-2 in blood, no evidence of confirmed or even suspected blood-

334 borne cases of COVID-19 were reported. This pattern was also seen in SARS and MERS, the two other
335 recent emerging coronavirus epidemics [45, 46]. In addition, the participants had sufficient
336 knowledge regarding the unavailability of an effective vaccine and the uselessness of antibiotics for
337 COVID-19.

338 Regarding the attitude towards COVID-19 danger, males were more likely to perceive the
339 disease as very dangerous compared to females. This perception can be ascribed to the financial and
340 economic by-products of the pandemic and the quarantine, and their fear of what is at stake from the
341 mandatory unemployment. Similarly, lower monthly family income was associated with higher
342 perception of danger. As expected, participants who perceived the virus as very dangerous had
343 higher levels of anxiety.

344 The vast majority of participants showed positive attitude towards the quarantine through
345 following the government-issued rules. However, a minority (1.8%) stated that they broke the
346 quarantine. Those were more likely to be males, married and postgraduate participants, and a
347 possible explanation for their attitude is that they are the ones who venture outside to buy groceries
348 or in case of emergencies.

349 Participants from Health schools had higher COVID-19 knowledge, compared to participants
350 from the Science and Humanities Schools, which might be related to the possibility of having similar
351 subjects in their curriculum, and their general understanding of diseases. Moreover, the mean K-
352 score was also higher among the older and the postgraduate students, which seems plausible.

353 Based on the previous explanation in the Methods section, the results indicated that the study
354 population had mild anxiety with an 8.4 mean anxiety score. Keeping in mind that a score of 10 and
355 above warrants further psychological assessment and in some cases therapy, the UJ is advised to take
356 an active reassuring approach towards the students, together with providing accurate and timely
357 information about the disease. In addition, females had higher anxiety levels; females tend to worry
358 and overthink more, leading to anxiety, as opposed to males who use distractions as a coping
359 mechanism [47, 48]. Additionally, non-Jordanian females had significantly higher anxiety levels, and
360 this can be the result of being abroad and probably spending the quarantine away from their families,
361 causing them to be more anxious.

362 Participants with lower monthly income had higher anxiety level. This can be partially explained
363 by the fact that the aforementioned group mostly depends on day-to-day income, with obvious
364 financial impediments during the quarantine period.

365 Regarding the overall belief in the conspiracy in relation to the current pandemic, only a third
366 of the participants rejected such a claim, whereas the majority of the students either believed entirely
367 or at least had an inclination to believe in this dubious and even harmful notion. This harmful way
368 of thinking might have negative consequences on people's psychological, social and health status.
369 Examples of these negative impacts may include the possibility of racial abuse through distrustful
370 view of other people and anti-vaccination campaigns [49].

371 In general, those who believed in the conspiracy and even those who were skeptical about it,
372 had lower knowledge about SARS-CoV-2. A tangible explanation for the belief in these conspiracies
373 is the lack of proper knowledge about the disease. The results of the study also showed a clear relation
374 between the belief in the conspiracies and the elevated levels of anxiety.

375 The majority of students who believed in the conspiracy were female participants and those with
376 lower income. Participants who believed in the conspiracy were also more likely to believe that a
377 vaccine is available and the disease can be treated using antibiotics. They also thought that summer
378 heat is capable of inactivating the virus.

379 Finally, our results showed that the main sources of information for the students were the MoH
380 website on COVID-19, TV, news releases and Facebook [50]. Thus, these media outlets should take a
381 meticulous approach in rigorously reviewing the accuracy of information they provide about the
382 disease, taking into account the reliance of public in general and students in particular on these
383 sources to get knowledge about the current pandemic.

384 This study had several important limitations. First, an inevitable caveat in all surveys is the
385 tendency of some participants to respond in a way they believe to be suitable for the researchers.

386 Second, during sharing of the survey, it was emphasized to answer to the best of participants'
387 knowledge, however there is never a guarantee that they followed such an instruction. Furthermore,
388 willingness to participate, especially on an online-based survey, may have been limited. Another
389 shortcoming was the female predominance in the sample and higher number of participants that
390 were affiliated to Health and Scientific Schools. One important point should be clarified, which is
391 related to the scoring system that was used to assess the level of knowledge among participants
392 regarding COVID-19. This assessment tool might be arbitrary and subjective. In addition, the weight
393 of each item can be criticized considering the difficulty in assessing the contribution of each item to
394 overall COVID-19 knowledge. Thus, generalizability of our results in relation to this issue, should be
395 made with extreme caution.

396 5. Conclusions

397 The impact of COVID-19 pandemic is not merely related to health issues, but also involves social
398 and psychological effects. The results of this study highlight the negative effect of misinformation
399 that is conveyed by media teeming with fallacies and assumptions that lack substantial evidence,
400 particularly the belief in conspiracy role in the pandemic. The negative impact on UJ students was
401 revealed by significantly higher level of anxiety and lower knowledge about COVID-19 in those who
402 believed in these claims of conspiracy. This must be addressed by the main sources of knowledge
403 that were identified by the participants (e.g. MoH, TV, social media outlets), which are encouraged
404 to have robust fact-checking processes, before conveying information about this unprecedented
405 pandemic.

406 This study identified gaps in knowledge among UJ students about COVID-19, particularly
407 among those studying at Humanities Schools. Thus, it is crucial to sustain and intensify the awareness
408 and education of the students with evidence-based knowledge.

409 6. DECLARATIONS

410 **Ethics approval and consent to participate:** The study was approved by the Department of Pathology,
411 Microbiology and Forensic Medicine and by the Scientific Research Committee at the School of Medicine/UJ
412 (Meeting #2 of the week 14, 2020 using WhatsApp conference call). Participation in the study was voluntary and
413 anonymous. An informed consent was ensured by the presence of an introductory section of the questionnaire,
414 with submission of responses implying the agreement to participate. All collected data were treated
415 confidentially.

416 **Consent for publication:** Not applicable.

417 **Availability of data and material:** Data sharing not applicable to this article as no datasets were generated or
418 analysed during the current study.

419 **Competing interests:** We declare that we have no competing interests nor conflicts of interests.

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422 **Author Contributions:** Conceptualization: MS, DD, AM; Formal Analysis: MS, DD, AY, AH, NAA;
423 Investigation: MS, DD, AY, AH, NAA, FGB, AM; Methodology: MS, DD, AY, AH, NAA, FGB, AM; Project
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429 List of abbreviations:

430 COVID-19: Coronavirus disease 2019
431 GAD-7 : 7-item Generalized Anxiety Disorder Scale
432 JD: Jordanian dinar
433 K-score: COVID-19 knowledge score
434 K-W: Kruskal-Wallis test

435	MERS:	Middle East respiratory syndrome coronavirus
436	MoH:	Jordanian Ministry of Health
437	M-W:	Mann-Whitney <i>U</i> test
438	SARS:	Severe acute respiratory syndrome
439	SARS-CoV-2:	Severe acute respiratory syndrome coronavirus 2
440	UJ:	University of Jordan
441	WHO:	World Health Organization
442	χ^2 :	Chi-squared test

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