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A Crisis within a Crisis: COVID-19 Knowledge and Awareness among the Syrian Population - a national survey assessment

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Abstract:

Objectives: To gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic. The aim of this study is to examine the Syrian public's awareness and knowledge regarding COVID-19.

Design: Web-based cross-sectional survey.

Setting: This study was distributed randomly in March 2020, nearly 10 years into the Syrian war crisis. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram, Instagram, and Facebook targeting various social groups.

Participants: Of 4495 total participants who completed the survey, 3942 were in Syria. 356 participants outside of Syria were females and 1142(31.8%) males. The final sample of 3586 participants (completion rate=79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males. All participants residing in Syria with no known history of COVID-19 infection were included in the study.

Primary and secondary outcome measures: The study revealed good awareness regarding COVID-19. Poor knowledge was associated with male gender, education of secondary school or lower, careers in government, private, business, military, and "other" sectors, as well as unemployment, poor and moderate economic status, and over 5 household members.

Results: Of the 3586 participants, 68.2% were females, 50.8% were unemployed, and 79.2% were at college-educated. The study revealed good awareness regarding COVID-19 (mean 75.6%, SD±9.4%). Multiple linear regression analysis correlated knowledge scores with gender, education level, occupation, economic status, and the number of household members.

Conclusion: This study revealed some potentially troubling knowledge gaps which underscore the need for a vigorous public education campaign. This campaign must reinforce the public's awareness, knowledge, and vigilance towards precautionary measures against COVID-19 and, most importantly aid in controlling the worldwide spread of the disease. A further assessment of attitudes and practice towards COVID-19 is needed.

Strengths and limitations of this study:

This is the first study to measure the awareness and general knowledge of COVID-19 among the Syrian population during a time of war. Our findings can be generalized regarding the Syrian population; however, only for well-educated Syrians of good socio-economic status. Syrians vulnerable to COVID-19 who represented a minority in the survey, such as the elderly and rural residents, are more likely to exhibit poor knowledge and awareness due to limited internet access. Even though all Syrian governorates were represented in this study, the majority of participants lived in Damascus and Rural Damascus.

. This web-based cross-sectional survey was conducted between March 3rd and April 4th.

. The survey's designed questions were modelled after existing surveys.

. Participation was voluntary and confidentiality and anonymity of responses was assured.

. The first section of the survey covered socio-demographic information,

. The second section contained: general knowledge, transmission, symptoms, and prevention.

Keywords: Awareness; Knowledge; COVID-19; Pandemic; Syria; War; Population.

Background:

Coronavirus disease 2019 (COVID-19), previously known as 2019 novel coronavirus disease,[3] is a highly infectious respiratory disease that evolved into a worldwide pandemic threatening a prolonged economic recession. The first incidence was reported at a local seafood market in Wuhan, China (4). By April 20th 2020, the virus had reached 214 different countries and territories and resulted in 3,517,345 cases and 243,401 deaths worldwide.[5] On January 30th 2020, the World Health Organization (WHO) declared for the sixth time that COVID-19 outbreak is a public health emergency of international concern (PHEIC), prompting the organization to adopt and stipulate drastic global measures to stem the tide of the pandemic.[6]

The battle against COVID-19 in Syria is still in its infancy. The first confirmed case was announced on March 22,[7] and there had only been 44 cases and 3 death to date. These figure are significantly lower than neighbouring countries such as Turkey (127,659 and 3,461), Iran (98,647 and 6,277), Iraq (2,346 and 98), Lebanon (740 and 25), and Jordan (465 and 9).[5] The Syrian healthcare system is severely under-equipped and lacks the capacity to contain such a crisis. The estimated number of intensive care unit (ICU) beds with ventilators is mere 325, and the theoretical maximum number of cases that can be adequately treated is only 6,500.[8] Once this maximum threshold capacity is exceeded, drastic rationing decisions will have to be made. Therefore, cooperation with and response to guidance from the WHO are of utmost importance. Unprecedented measures have been adopted to control the spread of COVID-19 in Syria including: partial closure of borders; suspension of public transportation; closure of mosques, shops, parks, restaurants universities, and schools; isolation and care of suspected and infected individuals; curfews to limit social contact; and awareness campaigns. The public's adherence to these control measures- which is largely affected by their awareness, knowledge, and attitudes, towards COVID-19- is crucial to mitigating the further spread of the disease.[9, 10]

The Syrian conflict, now in its 10th year, has resulted in the worst refugee crisis since World War II.[11] The devastating impact of war has placed the public health system under constant strain; the numbers of casualties continues to rise, 70% of health care workers have fled the country, the annihilation of healthcare facilities, and the "weaponization" of the healthcare are ongoing challenges.[8, 12] These challenges along with dense residential areas, the growing prevalence of chronic illness, and 83% of the population living under the poverty line make Syria highly vulnerable to a severe outbreak.[8, 13]

While some studies have been conducted to assess the knowledge, attitude, and practices among populations during this pandemic, none have done so in Syria.[1, 2, 14-19] To our knowledge this first study that aims to measure the awareness and general knowledge of COVID-19 among the Syrian population at a time where ambiguity and misinformation are rampant. The objective of this study is to gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic.

Methods:

Study design, setting and participants:

This web-based cross-sectional survey was conducted between March 3rd and April 4th. Ethical approval was obtained from the Institutional Review Board (IRB) of the Faculty of Medicine, Syrian Private University. All participants residing in Syria with no known history of COVID-19 infection were included in the study. The authors designed questions that were modelled after existing surveys.[1, 2] We conducted a pilot study on 20 people to assess clarity, relevance, and the acceptability of the survey; these were excluded from the

final sample to avoid bias. Modifications were made based on feedback received to facilitate better comprehension before distributing the final survey to the general population. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram, Instagram, and Facebook targeting various social groups. Participants confirmed their voluntarily participation by answering a yes-no question, were informed of the option to opt-out of the survey at any time, and were assured of the confidentiality and anonymity of their responses. After confirmation, participants were directed to the first part of the survey to complete questions about socio-demographic information including, age, gender, residence, education level, occupation, and economic status. Participants under the age of 18 required informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain consent before the child was given access to the survey. The self-administered survey contained 40 questions divided into 4 sections: general knowledge (10 questions), transmission pathways (7 questions), clinical features (12 questions), and prevention methods (11 questions). The survey is available in appendix 1.

Patient and public involvement:

The public's priorities, experience, and preferences were assessed through a pilot study before administering the survey to the community. The public were involved in this study through various social-media platforms. We encouraged the public to share the survey link with family members and friends; however, participants were not involved in the conduct of the study. The results of the survey were analyzed using Statistical Package for Social Sciences version 25.0 (SPSS Inc., Chicago, IL, United States) to correlate mean knowledge scores of participants with socio-demographic factors. We also identified participants factors

associated with poor knowledge. Participant advisors including those in the pilot study were deeply thanked. Patients were not involved in this study.

Statistical analysis

Data was analyzed using the Statistical Package for Social Sciences version 25.0 (SPSS Inc., Chicago, IL, United States) and reported as frequencies and percentages (for categorical variables) or means and standard deviations (SD) (for continuous variables). One-way analysis of variance (ANOVA), t-test, or Chi-square test was applied to compare mean knowledge scores against socio-demographic variables. Multivariable linear regression analysis using the socio-demographic variables as independent variables and mean knowledge score as the outcome variable was conducted to identify factors associated with knowledge. P-values<0.05 was considered statistically significant.

Results:

Socio-demographics characteristics:

Of 4495 total participants who completed the survey, 3942 were in Syria. 356 participants outside of Syria were excluded. The final sample of 3586 participants (completion rate=79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males. Participants aged 16-30 years were the majority 2789(77.8%) while participants under 16 were the minority 59(1.6%). Participant ages ranged from 12-78 years with the majority being 19(mean=30 ±10 years), single 2279(63.6%), and unemployed 1822(50.8%). 1064(29.7%) participants were smokers, and 428(11.9%) were alcohol consumers (Table 1). The majority of participants were residents of Damascus/Rural Damascus 2019(56.3%), and had attained college/university level education (Figure1).

General Knowledge regarding COVID-19:

Participants showed a good level of awareness regarding COVID-19 (75.6%). An adequate level of basic knowledge (67.0%) was found among participants (Table 2), 3383(94.3%) knew that a virus was the causative agent of COVID-19; 2535(70.7%) correctly identified the incubation period as being between 2 days and 2 weeks. Only 1500(41.8%) knew that an infection with COVID-19 does not confer lifelong immunity. The majority of participants 3489(97.3%) were aware that COVID-19 infection in high risk groups can be fatal. There is currently insufficient evidence on whether infertility is a complication of COVID-19 infection; 461(12.9%) participants believed that COVID-19 can cause infertility while 1903(53.0%) did not. 2986(83.3%), and 2597(72.4%) correctly answered that there are currently no available vaccine or treatments; however, there were misconceptions about the efficacy of antibiotics and Ibuprofen as treatments, 1228(34.2%) and 1268(35.3%) respectively (Table 3).

Transmission and Signs and Symptoms regarding COVID-19:

There was a fair level of awareness (70.7%) regarding COVID-19 transmission pathways (Table 2). A high level of awareness was demonstrated regarding common transmission pathways: 3521(98.2%), 3387(94.4%), and 3330(92.9%) identified respiratory droplets, touching an infected person's personal belongings, and handshaking respectively. There is currently limited evidence on animal-to-human and sexual transmission; 703(19.6%) did not know if transmission occurs between animals and humans, while 899(25.1%) did not know if the virus is transmitted sexually (Table 4).

The data showed a good level of awareness (76.0%) regarding clinical features (Table 2). When asked about the main clinical features, participants correctly identified, fever 3563(99.4%), sore throat 3037(84.7%), headache 3186(88.8%), chest pain 3050(85.0%),

general pain 3019(84.2%), fatigue 3405(95.0%), and dry cough 3466(96.7%), whereas only 1972(55.0%) knew that diarrhea can be a symptom. Only 2221(61.9%) were aware that infected individuals may be asymptomatic (Table 4).

Prevention Methods regarding COVID-19:

The highest level of awareness was in the prevention section (88.8%) (Table 2). Washing hands with soap, avoiding crowded areas, remaining at home, and wearing a face mask outside are the principal preventative measures against COVID-19, 3574(99.7%), 3574(99.75%), 3554(99.1%), and 3204(89.3%), respectively. A minority 158(4.4%) believed that cleaning with a mixture of Flash and bleach is a sound preventive measure. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19 (Table 5).

Comparison Study:

A series of one way ANOVA analyses revealed that mean knowledge differed significantly across: gender (p-value=0.009) (Figure 2), age (p-value=0.003), social status (p-value=0.042), education level (p-value=0.000), economic status (p-value=0.000), number of household members (p-value=0.000) (Table 4). The data showed a significant correlation between mean knowledge and place of residence (p-value=0.000). Participants living in Lattakia (77.6%) exhibited the greatest awareness, whereas those in Ar-Raqqah (71.7%) followed by Deir-ez-Zor (71.8%) exhibited the lowest (Figure 3).

Participants acquired their information from the following source(s): Social media, 1998(55.7%); health websites, 2823(78.7%); television/radio, 1572(43.8%); family members/friends, 528(14.7%); magazines/books, 266(7.4%); and lectures, 517(14.4%). Participants with the lowest awareness acquired their information from family members/friends (74.0%), whereas those with the highest awareness acquired their

information from lectures (78.2%), (p-value=0.000), (Figure 4). When participants were asked if they were likely to share new information with friends and family, 3513(98.0%) answered "yes". There was a significant difference in mean knowledge between those who were inclined to disseminate new information about COVID-19 to friends and family (75.7%) compared with those who were not (72.3%) (p-value=0.002). On exclusive use of personal belongings, 2692(75.1%) answered "yes". We found no significant correlation between mean knowledge and participant tendency to share personal belongings with others (p-value=0.112). Participants who knew someone infected with COVID 19, 65(1.8%) answered "yes". There was no significant difference in mean knowledge between those who knew an infected individual (75.9%) compared with those who did not (75.6%) (p-value=0.816).

Multiple linear regression:

Multiple linear regression analysis results: male gender (vs. female, p=0.005); education of secondary school or lower (vs. college/university and above, p=0.000); careers in government, private, business, military, and "other" sectors, as well as unemployment (vs. health care workers, p=0.000); poor and moderate economic status (vs. good and excellent, p<0.040), and over 5 household members (vs. of 1-5, p=0.000) were associated with significantly lower knowledge scores (Table 7). Careers in health care (vs. Unemployed, p-value=0.000), and the 31-45 age group (vs. 16-30, p-value=0.005) were associated with significantly higher knowledge scores.

Discussion:

We found an overall mean knowledge score of 75.6%, indicating that most participants were relatively knowledgeable about COVID-19, though less so compared to their counterparts in China (90%).[1] This level of knowledge was unexpected given that when we carried out the survey, only 10 cases of COVID-19 had been confirmed in Syria.[20]

We found that poor knowledge was associated with males, non-post-secondary education, non-healthcare occupations, unemployment, poor and moderate economic status, and households exceeding 5 members (Table 5). Similar trends were observed in China.[1] Correlating socio-demographic variables with awareness is critical to public health efforts to mitigate the spread of COVID-19. This data obtained can be leveraged by the Syrian Ministry of Health to tailor prevention and educational campaigns to populations with the widest knowledge gaps.

In the general knowledge section (67%), the majority of the participants 3383(94.3%) knew that COVID-19 is caused by a virus, similar to a Pakistani study (93.3%).[17] Low awareness of the 2 to 14 day incubation period was found,[21] among dentists (36.1%), and health care workers (HCW) (36.4%).[2, 19] Our study showed a higher level of awareness 2535(70.7%) among the population. Syria has a relatively young population; 2018 showed that only 4.5% of the population was over 65.[22] 3489(97.3%) knew that COVID-19 infection can be severe and lead to death in elderly, chronically ill, and immunodeficient patients. This is higher than studies conducted in China (73.2%), and India (88.37%).[1, 23] 40.6% of Syrians are hypertensive, yet a staggering 79.8% of them are unaware of their condition. Diabetes is also prevalent, affecting 11.9% of the population.[24, 25] Such a rampant lack of awareness about chronic disease in the population can be fatal, and underscores the need for targeted awareness campaigns.

Only 2597(72.4%) participants knew that there is currently no available treatment; this is higher than a Kenyan study (40%) but significantly lower than a Chinese study (94%).[1, 15] A minority 103(2.9%) participants thought there was a vaccine available against COVID-19; by contrast, Coimbatore District (18.6%) and Pakistan (11.6%) were misinformed. In the absence of a vaccine or effective treatment protocol for COVID-19, controlling the spread of the disease is the best line of defense. We observed a considerable knowledge gap in 1268(35.3%) with regards to ibuprofen as a treatment option. There is no available evidence to suggest that ibuprofen is effective against COVID-19.[26]

Participants showed a fair level of awareness regarding transmission pathways (70.7%), very similar to a Pakistani study (70.8%).[17] The majority 3521(98.2%) of participants were aware that respiratory droplets are common transmission vectors this is similar to a Chinese study (97.8%), but much higher than an Indian study (29.5%).[1, 16] WHO advise on physical distancing include: using greetings that replace physical contact with a wave, nod, bow, peace sign, sign language, friendly words or smiles.[27, 28] 3330(92.9%) participants identified handshaking as a transmission pathway, higher than a study among dentists (85.6%).[2]

A good level of awareness was found regarding the clinical features of COVID-19 (76.0%), similar to a Pakistani (77.7%).[17] A very high level of awareness of the most common symptoms was found: fever 3563(99.4%), dry cough 3466(96.7%), fatigue 3405(95.0%), and myalgia 3019(84.2%), similar to findings from Chinese (96.4%) and Indian (95.4%) studies.[1, 23] When asked about sore throat, a higher level of awareness 3037(84.7%) was found compared to studies from India (15.2%) and among dentists (28.5%).[2, 16] Knowledge about diarrhea as a symptom was lacking: only 1972(55.0%); a study among dentists also showed low awareness (39.9%). [2, 16] While infected individuals are frequently asymptomatic, or present with mild symptoms, around 1 in every 5 infections

can be serious enough to require hospitalisation.[6, 29] Only 2221(61.9%) participants were aware that infected individuals can be asymptomatic, while a study among dentists (34.5%) reported much lower awareness. "Silent spreaders" may significantly contribute to the transmission of COVID-19, and so increasing public awareness of this particular point is crucial

We found a high level of awareness in the preventive methods section (88.8%), similar to a study in Pakistan (85%).[17] Hand hygiene is considered an important element of infection control dating back to the revolutionary work of Ignaz Semmelweis.[30] Implementing hand-washing techniques can break the transmission cycle and reduce the risk of infection by 6%-44%.[31] Almost all 3574(99.7%) participants were aware that washing hands with soap and water is an important preventive measure against COVID-19. This finding is in accordance with India (97.0%), and other studies (96.2%, and 87%).[2, 16, 19]

This year the WHO recommended that the following mitigation measures be implemented during the holy month of Ramadan: cancelling social and religious gatherings, holding events outdoors for adequate ventilation, physical distancing of at least 1 meter between people, and the use of technology to broadcast ceremonies on television.[27, 28] The majority 3574(99.7%) identified avoiding mass gatherings as a preventive measure; studies in China (98.6%) and Coimbatore District (97.7%) reported similar awareness.[1, 23] Cheap and efficient interventions such as N95 (filtration capacity=95%) have a 91% effectiveness of blocking pathogen transmission.[32] 3204(89.3%) participants considered wearing a face mask when leaving home as an effective prevention method, compared with a Coimbatore District study (93.02%).[23]

Since Syrian society is particularly vulnurable to COVID-19, this knowledge gap is potentially dangerous and should be addressed to mitigate disease spread. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19; this is similar to a

Coimbatore District study (67.4%), but lower than a study amongst HCWs (90.7%).[19, 23] Mixing flash with bleach is highly toxic and caustic to the respiratory tract. Only a minority of participants 158(4.4%) believed that this method of cleaning is a sound preventive measure. 3305(92.2%) were aware that individuals showing symptoms should quarantine themselves, lower than in China (98.2%) and India (95.8%).[1, 16]

North-East Syria (NES) has a population of over 4 million people, 600,000 of whom are internally displaced refugees, 100,000 of whom live in overcrowded camps: only 2 of NES's 11 hospitals are currently functioning. NES consists of 3 governorates: Ar-Raqqah, Deir-ez-Zor and Al-Hasakah. With only 22 ICU beds, (18 in Al-Hasakah, 4 in Ar-Raqqah and none in Deir-ez-Zor), the maximum capacity threshold is only 80 COVID-19 cases. Ar-Raqqa and Deir-ez-Zor, the most vulnerable governorates, also showed the lowest awareness in the study (71.7%), and (71.8%). This is a potentially catastrophic situation, and a concern to the international community, as an unmonitored, uncontrolled outbreak in NES can prolong the global pandemic.

Limitations:

Our findings can only be generalized about well-educated Syrians of good socio-economic status. Syrians vulnerable to COVID-19, such as the elderly and rural residents, are more likely to exhibit poor knowledge and awareness due to limited internet access. As such, reaching out to these populations must be prioritized. Even though all Syrian governorates were represented in this study, the majority of participants lived in Damascus and Rural Damascus. Furthermore, assessment of attitudes and practice towards COVID-19 is needed, which should be developed as either a web-based survey, or phone interviews, and constructed using multi-dimensional scaling.

Conclusion:

COVID-19 has been a dire warning to humanity about the fragility of its social, economic, and healthcare institutions. Our study revealed good public awareness of clinical features and preventive measures. However general knowledge and knowledge about transmission pathways was suboptimal. Syrians of good socio-economic status, in particular young well-educated women, have shown good knowledge. Our national response must adapt to the growing threat of COVID-19 by adopting public awareness strategies and behaviours to contain the disease both within and beyond our borders.

Abbreviations: COVID-19: Coronavirus Disease 2019; MERS: Middle East Respiratory Syndrome; SARS: Severe Acute Respiratory Syndrome; WHO: World Health Organization; PHEIC: Public Health Emergency of International Concern; ICU: Intensive care unit; IRB: Institutional Review Board; SPSS: Statistical Package for Social Sciences; SD: Standard Deviation; HCW: Health Care Worker.

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Availability of data and materials:

All data related to this paper's conclusion are available and stored by the authors. All data are available from the corresponding author on a reasonable request.

Declarations:

Ethics approval and consent to participate:

This study was approved by the Institutional Review Board (IRB) at the Syrian Private University (SPU). All Participants confirmed their written consent by answering a yes-no question. Participants under the age of 18 required verbal informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain verbal consent before the child was given access to the survey. The verbal and written form of consent was approved by the IRB at SPU. Participation in the study was voluntary and participants were assured that anyone who was not inclined to participate or decided to withdraw after giving consent would not be victimized. All information collected from this study was kept strictly confidential.

Consent for Publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

Authors' contributions:

FM conceptualized the study, participated in the design, wrote the study protocol, performed the statistical analysis, did a literature search and drafted the manuscript. BB

participated in study design, did a literature search and drafted the manuscript. HA, and NA did a literature search, and revision of the draft. All authors read and approved the final draft.

Tables and Figures:

Table 1.

Table 1. Socio-demographic characteristics: (n=3586)

Gender (%)	Male	1142(31.8)	**Education (%)**	Primary School	25(0.7)
	Female	2444(68.2)		Intermediate School	166(4.6)
Age (%)	<16	59(1.6)		Secondary school	375(10.4)
	16-30	2789(77.8)		College/University	2839(79.2)
	31-45	503(14.0)		Master's degree	157(4.4)
	>45	235(6.6)		PhD	24(0.7)
Social Status (%)	Single	2279(63.5)	**Occupation (%)**	Health care worker	634(17.7)
	In a relationship	286(8.0)		Government institution	283(7.9)
	Married	943(26.3)		Private institution	182(5.1)
	Divorced	46(1.3)		Business	198(5.5)
	Widowed	32(0.9)		Military	32(0.9)
				Unemployed	1822(50.8)
Economic	[1]Poor	247(6.9)		Other	435(12.1)

Status (%)	[2]Moderate	1247(34.8)	**Household members (%)**	0	46(1.3)
	[3]Good	1761(49.1)		1-5	2751(76.7)
	[4]Excellent	331(9.2)		>5	789(22)

[1]Poor: income does not provide essential needs for the family. [2]Moderate: income provides essential needs for the family but no more. [3]Good: income provides essential needs and some luxury requirements. [4]Excellent: income provides luxury requirements.

Table 2.

Table 2. Mean knowledge score of participants by section

	Mean Knowledge Score (%)	± Standard Deviation (%)
General Knowledge	67.0	18.9
Transmission Pathways	70.7	16.9
Signs and Symptoms	76.0	13.6
Prevention Methods	88.8	10.2
Overall knowledge	75.6	9.4

Table 3.

Table 3. General Knowledge around COVID-19: (n= 3586)

	Virus	Bacteria	Parasite	Immune deficiency	Fungus	Inherited	Do Not Know
Causative Agent	3383(94.3)	39(1.1)	8(0.2)	46(1.3)	0(0.0)	2(0.1)	108(3.0)

N(%)							
	1 Minute to 1 Hour	1 Hour to 2 Days	2 Days to 2 Weeks		2 Weeks to 1 Month		>1 Month
Incubation period N(%)	18(0.5)	58(1.6)	2535(70.7)		958(26.7)		17(0.5)
		Yes(%)	**No(%)**		**Do Not Know(%)**		
Can infection with COVID-19 confer permanent immunity?		815(22.7)	1500(41.8)		1271(35.5)		
Can COVID-19 cause severe illness and lead to death in elderly, chronically ill, and immunodeficient patients?		3489(97.3)	28(0.8)		69(1.9)		
Can COVID-19 cause infertility?		461(12.9)	1222(34.1)		1903(53.0)		
Is COVID-19 teratogenic (i.e. cause malformations/abnormalities to an embryo/fetus)?		157(4.4)	1433(40.0)		1996(55.6)		
Treatment							
	Yes(%)		**No(%)**		**Do Not Know(%)**		
No treatment	2597(72.4)		515(14.4)		474(13.2)		

available			
Antibiotics	1228(34.3)	1790(49.9)	568(15.8)
Ibuprofen	1268(35.3)	1921(53.6)	397(11.1)
Vaccine	103(2.9)	2986(83.3)	497(13.8)

Table 4.

Table 4. Transmission, Signs, and Symptoms of COVID-19: (n=3586)			
	YES(%)	**NO(%)**	**DO NOT KNOW(%)**
Transmission Pathways			
Respiratory droplets (from coughing or sneezing)	3521(98.2)	21(0.6)	44(1.2)
Handshaking	3330(92.9)	189(5.3)	67(1.8)
Touching an infected person's personal belongings	3387(94.4)	131(3.7)	68(1.9)
Animals-to-human	910(25.4)	1973(55.0)	703(19.6)
Undercooked food	1301(36.3)	1734(48.3)	551(15.4)
Sexual contact	1210(33.7)	1477(41.2)	899(25.1)
Horizontal transmission	1130(31.5)	1160(32.4)	1296(36.1)
Signs and Symptoms			
Fever	3563(99.4)	9(0.2)	14(0.4)
Sneezing	2353(65.6)	1000(27.9)	233(6.5)

Sore throat	3037(84.7)	358(10.0)	191(5.3)
Headache	3186(88.8)	190(5.3)	210(5.9)
Chest pain	3050(85.0)	254(7.1)	282(7.9)
Body aches (generalized pain)	3019(84.2)	260(7.2)	307(8.6)
Fatigue	3405(95.0)	72(2.0)	109(3.0)
Diarrhea	1972(55.0)	971(27.1)	643(17.9)
Dry cough	3466(96.7)	44(1.2)	76(2.1)
Productive cough	458(12.8)	2586(72.1)	542(15.1)
Bleeding	130(3.6)	2613(72.9)	843(23.5)
Asymptomatic	2221(61.9)	375(10.5)	990(27.6)

Table 5.

Table 5. Prevention Methods: (n= 3586)

	YES(%)	**NO(%)**	**DO NOT KNOW(%)**
Does wearing a face mask outside the home offer protection from Covid-19?	3204(89.3)	314(8.8)	68(1.9)
Does washing hands with soap and water offer protection from Covid-19?	3574(99.7)	5(0.1)	7(0.2)

Does avoiding crowded places offer protection from Covid-19?	3574(99.7)	4(0.1)	8(0.2)
Does the flu vaccine offer protection from Covid-19?	331(9.2)	2482(69.2)	773(21.6)
Does staying at home offer protection from Covid-19?	3554(99.1)	15(0.4)	17(0.5)
Does using hand sanitizer offer protection from Covid-19?	3430(95.6)	104(2.9)	52(1.5)
Does cleaning house items with bleach offer protection from Covid-19?	3408(95.0)	110(3.1)	68(1.9)
Does cleaning fruits and vegetables with soap and water offer protection from Covid-19?	3262(90.9)	221(6.2)	103(2.9)
Does cleaning surfaces with a mixture of Flash and bleach offer protection from Covid-19?	158(4.4)	3301(92.1)	127(3.5)
Does the quarantine of symptomatic individuals protect others from Covid-19?	3305(92.2)	241(6.7)	40(1.1)
Do cumin, anise, and mint offer protection from Covid-19?	1041(29.0)	1934(53.9)	611(17.1)

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392 **Table 6.**

Table 6. Mean knowledge score of participants by demographic variables (one way ANOVA), (n= 3586)

Characteristics		Number of participants (%)	Knowledge Score (%)	F-test	P-value
Gender	Male	1142(31.8)	75.0	-2.625	0.009*
	Female	2444(68.2)	75.9		
Age-group (years)	<16	59(1.6)	71.5	4.770	0.003*
	16-30	2789(77.8)	75.8		
	31-45	503(14.0)	75.7		
	>45	23(6.6)	74.8		
Social status	Single	2279(63.5)	75.8	2.485	0.042*

	In a relationship	286(8.0)	76.6		
	Married	943(26.3)	75.1		
	Divorced	46(1.3)	73.9		
	Widowed	32(0.9)	73.4		
Residence	Urban	2426(67.7)	75.8	1.652	0.099
	Rural	1160(32.3)	75.3		
Education	Primary school	25(0.7)	66.5	26.176	0.000*
	Intermediate school	166(4.6)	73.2		
	Secondary school	375(10.4)	70.0		
	College/University	2839(79.2)	76.3		
	Master's degree	157(4.4)	77.2		

	PhD	24(0.7)	76.6		
Occupation	Health care worker	634(17.7)	78.6	16.379	0.000*
	Government institution	283(7.9)	75.7		
	Private institution	182(5.1)	75.5		
	Business	198(5.5)	73.4		
	Military	32(0.9)	71.2		
	Unemployed	1822(50.8)	75.3		
	Other	435(12.1)	74.0		

Economic status	Excellent	331(9.2)	76.6	7.108	0.000*
	Good	1761(49.1)	76.2		
	Moderate	1247(34.8)	74.9		
	Poor	247(6.9)	74.3		
Household members	0	46(1.3)	74.4	15.451	0.000*
	1-5	2751(76.7)	76.1		
	>5	789(22.0)	74.0		

Table 7.

Table 7. Multiple linear regression on variables associated with poor COVID-19 knowledge

Variable	Coefficient	Standard error	t	P
Gender (male vs. female)	-0.933	0.334	-2.794	0.005*

Education (primary, intermediate, secondary school vs. college/university, master, PhD)	-3.782	0.466	-8.125	0.000*
Occupation (government, private sector, business, military, unemployed, other vs. health care worker)	-3.592	0.474	-7.579	0.000*
Economic status (moderate, poor vs. excellent, good)	-0.669	0.325	-2.057	0.040*
Household members(>5 vs. 1-5)	-1.737	0.374	-4.648	0.000*

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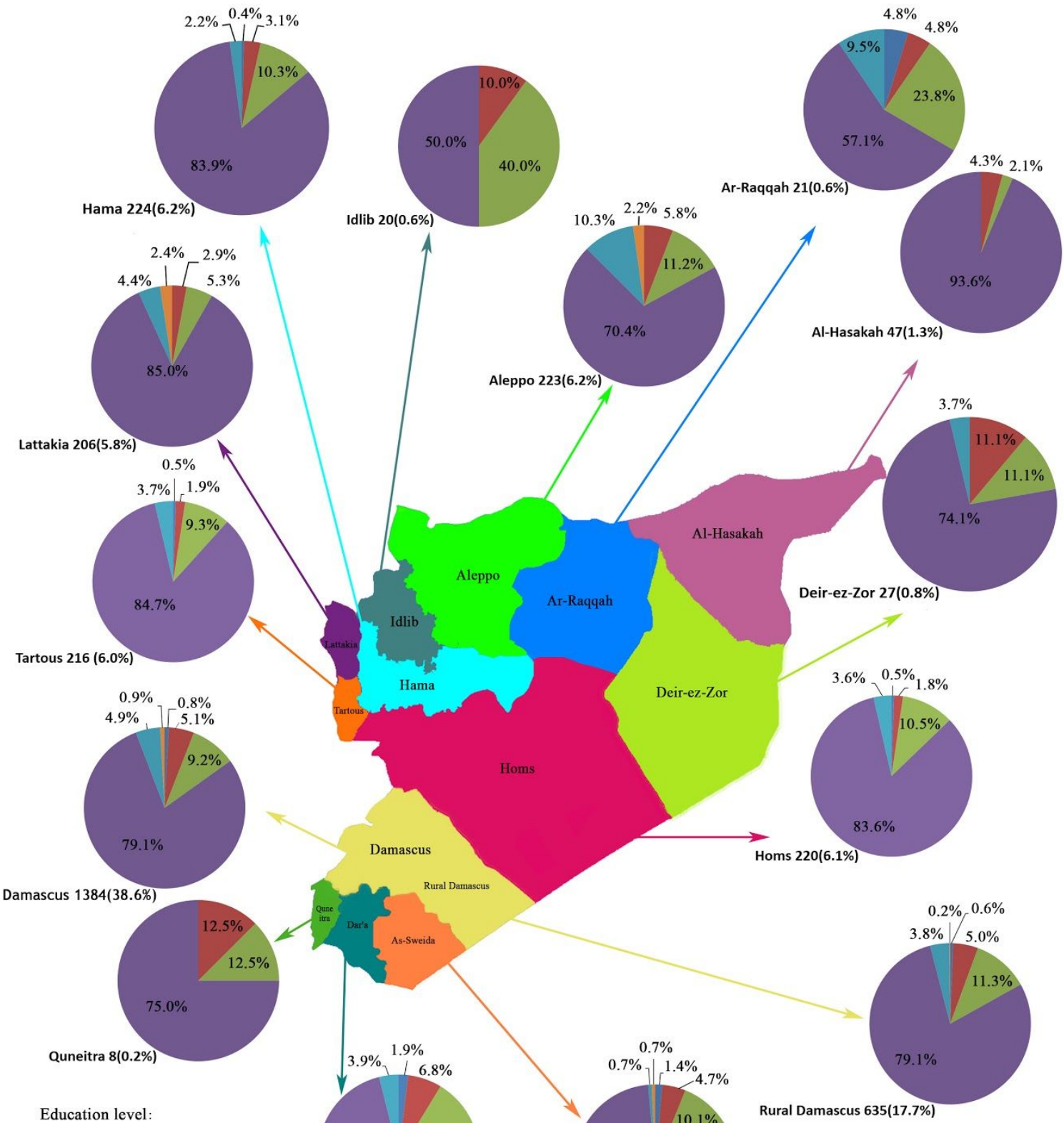

Figure 1. Distribution of participants according to governorates and education level

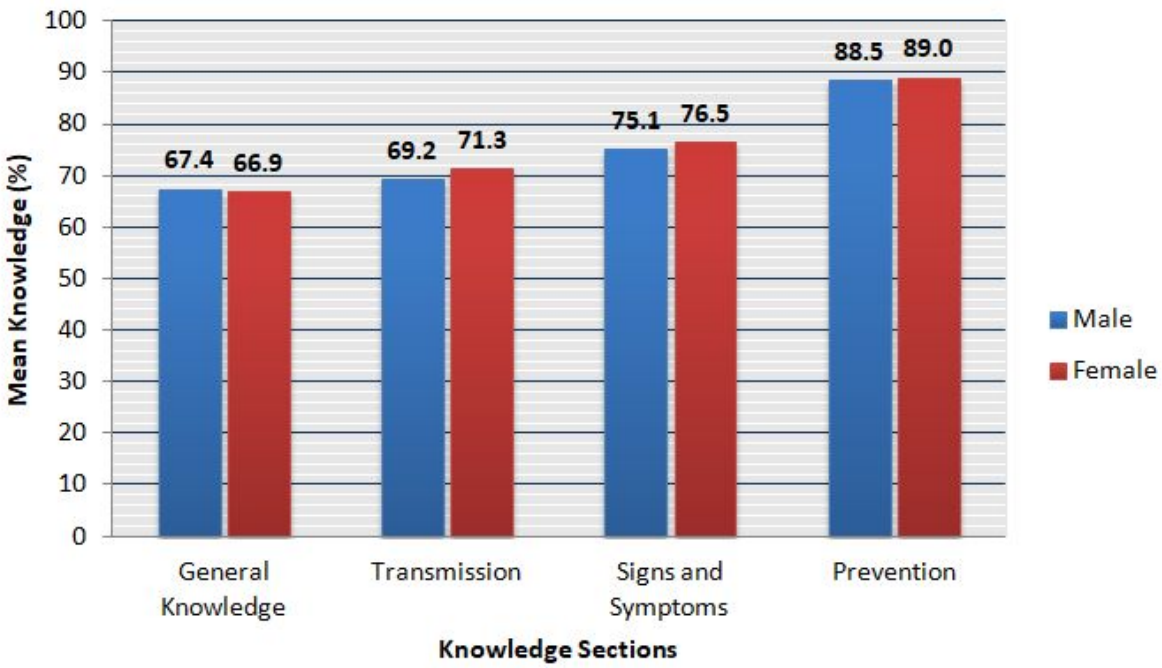

Figure 2. Relationship between both genders and mean knowledge.

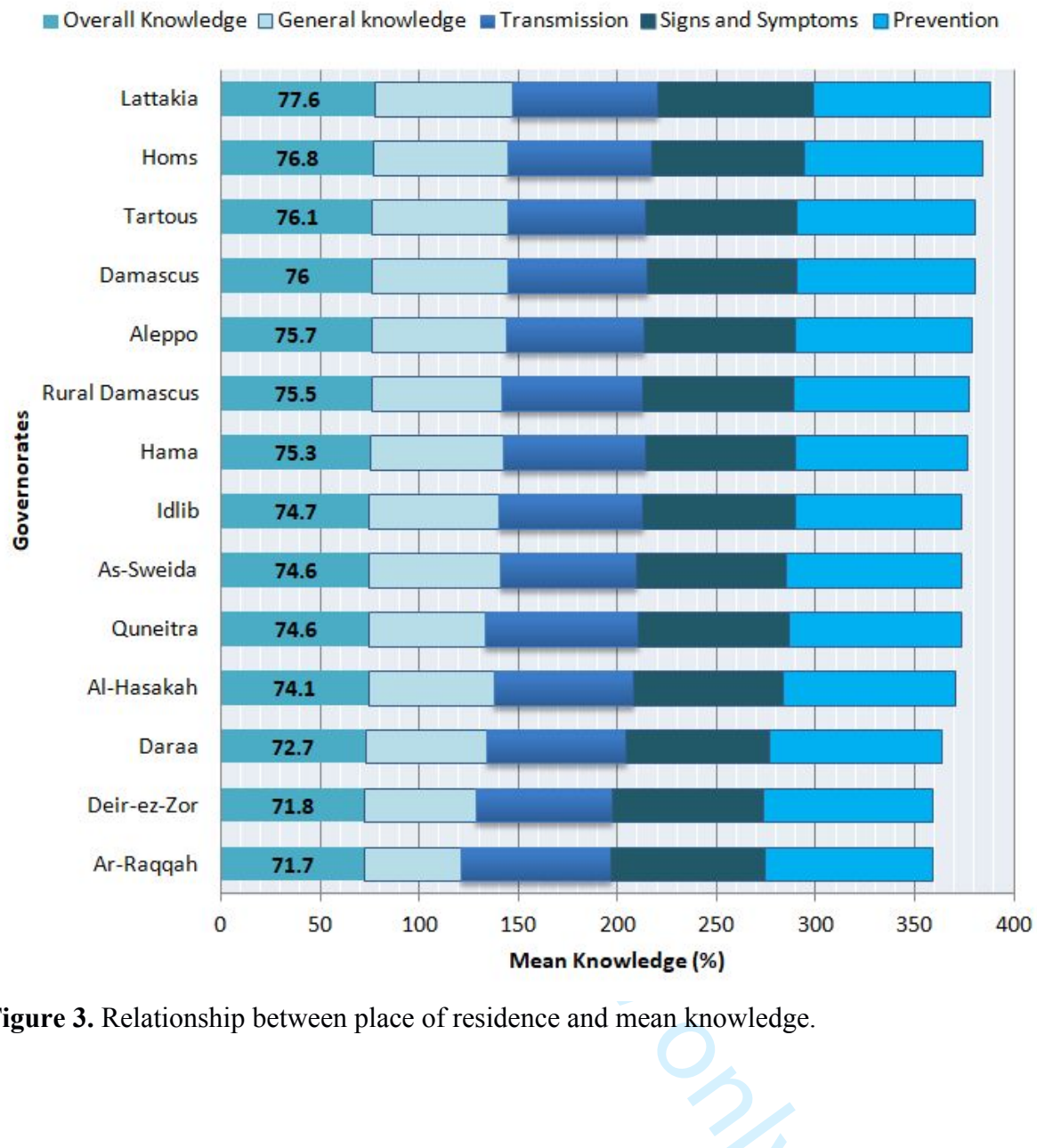

Figure 3. Relationship between place of residence and mean knowledge.

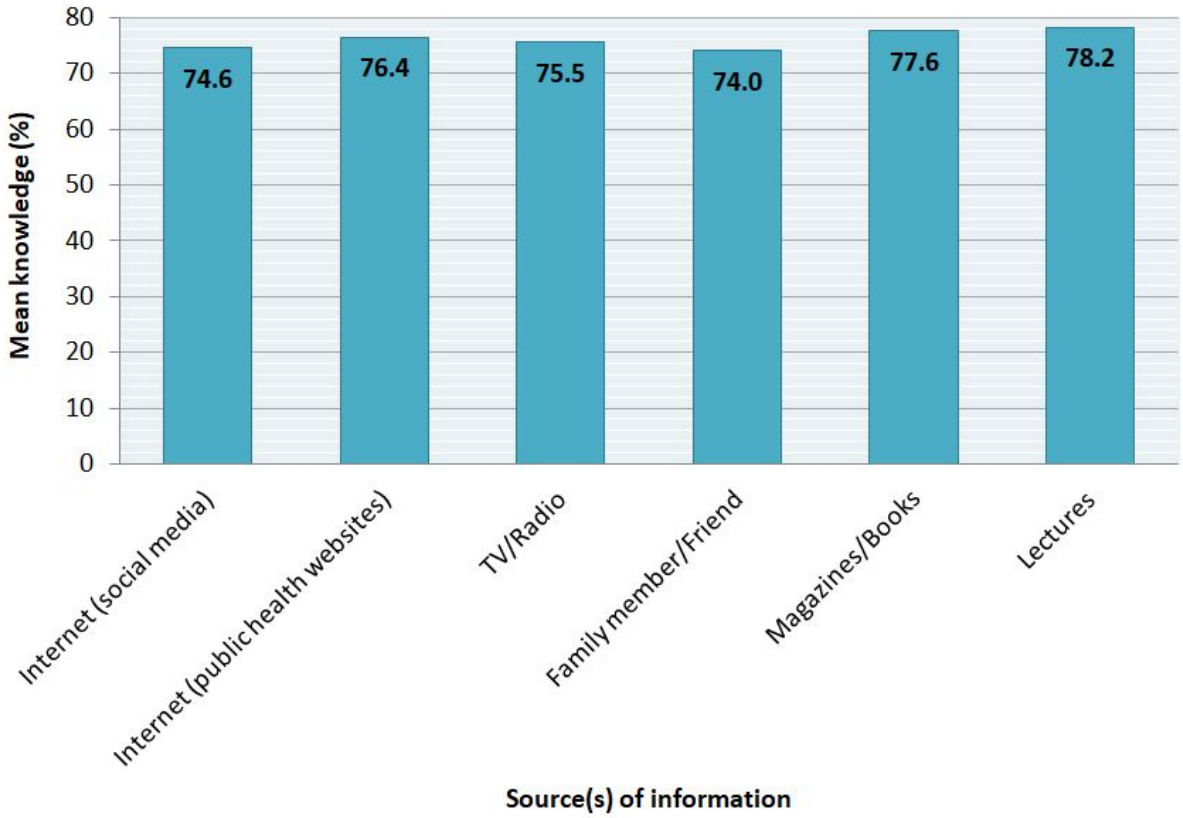

Figure 4. Relationship between different sources of information and mean knowledge.

Figures and tables legends:

Table 1. Sociodemographic characteristics

Table 2. Mean knowledge score of participants by section

Table 3. General Knowledge around COVID-19

Table 4. Transmission, Signs, and Symptoms of COVID-19

Table 5. Prevention Methods

Table 6. Mean knowledge score of participants by demographic variables

Table 7. Multiple linear regression on variables associated with poor COVID-19 knowledge

Figure 1. Distribution of participants according to governorates and education level

Figure 2. Relationships between both genders and mean knowledge.

Figure 3. Relationship between place of residence and mean knowledge.

Figure 4. The relationship between different sources of information and mean knowledge.

References:

1. Zhong B-L, Luo W, Li H-M, Zhang Q-Q, Liu X-G, Li W-T, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. International Journal of Biological Sciences. 2020;16(10):1745.
2. Khader Y, Al Nsour M, Al-Batayneh OB, Saadeh R, Bashier H, Alfaqih M, et al. Dentists' Awareness, Perception, and Attitude Regarding COVID-19 and Infection Control: Cross-Sectional Study Among Jordanian Dentists. JMIR Public Health and Surveillance. 2020;6(2):e18798.
3. Naming the coronavirus disease (COVID-19) and the virus that causes it. World Health Organization. 2020.
4. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet. 2020;395(10223):497-506.
5. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 106. 2020.
6. Organization WH. Getting your workplace ready for COVID-19: How COVID-19 spreads, 19 March 2020. World Health Organization; 2020.
7. McKernan B. Syria confirms first Covid-19 case amid fears of catastrophic spread. The Guardian. 2020.
8. Gharibah M, Mehchy Z. COVID-19 pandemic: Syria's response and healthcare capacity. 2020.
9. Ajilore K, Atakiti I, Onyenankeya K. College students' knowledge, attitudes and adherence to public service announcements on Ebola in Nigeria: Suggestions for improving future Ebola prevention education programmes. Health Education Journal. 2017;76(6):648-60.
10. Tachfouti N, Slama K, Berraho M, Nejjari C. The impact of knowledge and attitudes on adherence to tuberculosis treatment: a case-control study in a Moroccan region. Pan African Medical Journal. 2012;12(1).
11. McNatt Z, Boothby NG, Al-Shannaq H, Chandler H, Freels P, Mahmoud AS, et al. Impact of Separation on Refugee Families: Syrian Refugees in Jordan. 2018.
12. Syria anniversary press release. United Nations Office for the Coordination of Humanitarian Affairs (OCHA). 2020.
13. UNICEF Syria Crisis Situation Report 2019.
14. Qarawi A, Ng SJ, Gad A, Luu M, Al-Ahdal T, Sharma A, et al. Awareness and Preparedness of Hospital Staff against Novel Coronavirus (COVID-2019): A Global Survey - Study Protocol. SSRN Electronic Journal. 2020.
15. Austrian K, Pinchoff J, Tidwell JB, White C, Abuya T, Kangwana B, et al. COVID-19 related knowledge, attitudes, practices and needs of households in informal settlements in Nairobi, Kenya. 2020.
16. Roy D, Tripathy S, Kar SK, Sharma N, Verma SK, Kaushal V. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. Asian Journal of Psychiatry. 2020:102083.
17. Hussain T, Khan S, Gilani U, Raza S. Evaluation of General Awareness Among Professionals Regarding COVID-19: A Survey Based Study from Pakistan. 2020.
18. Zhou M, Tang F, Wang Y, Nie H, Zhang L, You G, et al. Knowledge, attitude and practice regarding COVID-19 among health care workers in Henan, China. Journal of Hospital Infection. 2020.
19. Bhagavathula AS, Aldhaleei WA, Rahmani J, Mahabadi MA, Bandari DK. Novel Coronavirus (COVID-19) Knowledge and Perceptions: A Survey on Healthcare workers. medRxiv. 2020.
20. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 71. 2020.

21. Backer J, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. Eurosurveillance. 2020;25.
22. Plecher H. Age structure in Syria 2018. Statista. 2020.
23. Vadivu TS, Annamuthu P. An Awareness and Perception of COVID-19 among General Public–A Cross Sectional Analysis. 2014.
24. Organization WH. Web World Health Organization–Diabetes country profiles. Diakses; 2016.
25. Tailakh A, Evangelista LS, Mentes JC, Pike NA, Phillips LR, Morisky DE. Hypertension prevalence, awareness, and control in A rab countries: A systematic review. Nursing & health sciences. 2014;16(1):126-30.
26. The use of non-steroidal anti-inflammatory drugs (NSAIDs) in patients with COVID-19. World Health Organization. 2020.
27. Practical considerations and recommendations for religious leaders and faith-based communities in the context of COVID-19. World Health Organization. 2020.
28. Safe Ramadan practices in the context of the COVID-19 World Health Organization. 2020.
29. Surveillances V. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)—China, 2020. China CDC Weekly. 2020;2(8):113-22.
30. Best M, Neuhauser D. Ignaz Semmelweis and the birth of infection control. Quality & safety in health care. 2004;13:233-4.
31. Rabie T, Curtis V. Handwashing and Risk of Respiratory Infections: A Quantitative Systematic Review. Tropical medicine & international health : TM & IH. 2006;11:258-67.
32. Jefferson T, Foxlee R, Del Mar C, Dooley L, Ferroni E, Hewak B, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses: systematic review. Bmj. 2008;336(7635):77-80.

Attached Survey:

Appendix 1

Socio-demographic Characteristics	
Age (years): ☐Below 15 ☐15-20 ☐20-30 ☐30-50 ☐40-50 ☐50-60 ☐60-70 ☐Above 70	**Gender:** ☐Male ☐Female
Marital status: ☐Single ☐Relationship ☐Married ☐Divorced ☐Widowed	**Educational level:** ☐Primary school ☐Intermediate school ☐Secondary school ☐University/College ☐Master's Degree ☐PHD Degree
Occupation: ☐Health care worker ☐Government institution ☐Private institution ☐Business ☐Military ☐Unemployed ☐Other	**Residence:** ☐Damascus/Rural Damascus ☐Hama ☐Aleppo ☐Homs ☐Tartous ☐Lattakia ☐Dara'a ☐As-Sweida ☐Al Hasakah ☐Deir-ez-Zor ☐Idlib ☐Ar-Raqqah ☐Quneitra
Area: ☐Rural ☐Urban	**Economic Status:** ☐Excellent ☐Good ☐Moderate ☐Poor
Do you smoke? ☐Yes ☐No	**Do you drink alcohol?** ☐Yes ☐No
How many people do you live with? ☐Alone ☐1-5 ☐6-10 ☐11-15 ☐16-20 ☐Above 20	
Do you share toiletries/personal care products with others? ☐Yes ☐No	
Do you know anyone infected with COVID-19? ☐Yes ☐No	

Table 2. General Knowledge about COVID-19	
What is COVID-19? ☐Virus ☐Bacteria ☐Parasite ☐Fungus	**Do you know how long after being infected with COVID-19 can a person suffer from signs and symptoms?** ☐1 Minute to 1 Hour ☐1 Hour to 2 Days

☐Immunodeficiency ☐Inherited ☐Do not know	☐2 Days to 2 weeks ☐2 Weeks to 1Month ☐Over a 1 month
Can an infection with COVID-19 confer permanent immunity (once infected with COVID-19 you cannot contract another infection)? ☐Yes ☐No ☐Do not know	
Can COVID-19 cause severe illness and lead to death in elderly, chronically ill (hypertension, diabetes, asthma . . .), and those who have compromised immune systems? ☐Yes ☐No ☐Do not know	
Can COVID-19 cause infertility? ☐Yes ☐No ☐Do not know	
Is COVID-19 teratogenic (i.e. cause malformations/abnormalities to an embryo/fetus)? ☐Yes ☐No ☐Do not know	

Treatment for COVID-19

	Yes	No	Do Not Know
No treatment available			
Antibiotics			
Ibuprofen			

Is there an available vaccine for COVID-19?
☐Yes ☐No ☐Do not know

Table 3. Transmission Pathways

	Yes	No	Do Not Know
Can COVID-19 be transmitted via respiratory droplets (coughing or sneezing) of infected individuals?			
Can COVID-19 be transmitted after shaking-hands with an infected individual?			
Can COVID-19 be transmitted after touching an infected individual's personal belongings?			
Can COVID-19 be transmitted from animals to humans?			
Can COVID-19 be transmitted via undercooked food?			

Can COVID-19 be transmitted via sexual contact?			
Can COVID-19 be transmitted via vertical transmission (mother to fetus)?			

Table 4. Signs and Symptoms of COVID-19

	True	False	Do Not Know
Is fever/temperature among the signs and symptoms of COVID-19?			
Is sneezing among the signs and symptoms of COVID-19?			
Is sore throat among the signs and symptoms of COVID-19?			
Is headache among the signs and symptoms of COVID-19?			
Is Chest pain among the signs and symptoms of COVID-19?			
Is body aches (generalized pain) among the signs and symptoms of COVID-19?			
Is fatigue among the signs and symptoms of COVID-19?			
Is diarrhea among the signs and symptoms of COVID-19?			
Is a runny nose among the signs and symptoms of COVID-19?			
Is dry cough among the signs and symptoms of COVID-19?			
Is productive cough among the signs and symptoms of COVID-19?			
Is bleeding among the signs and symptoms of COVID-19?			
Can a person be infected with COVID-19 and have no signs and symptoms?			

Table 5. Prevention Methods

	True	False	Do Not Know
Does wearing a face mask outside the home offer protection from Covid-19?			

Does washing hands with soap and water offer protection from COVID-19?			
Do avoiding crowded places offer protection from Covid-19?			
Does the flu vaccine offer protection from Covid-19?			
Does staying at home offer protection from Covid-19?			
Does using hand sanitizer offer protection from Covid-19?			
Does using bleach to clean household surfaces prevent COVID-19 infection?			
Does cleaning surfaces with a mixture of Flash and bleach offer protection from Covid-19?			
Does the quarantine of symptomatic individuals protect others from Covid-19?			
Do cumin, anise, and mint offer protection from Covid-19?			

What is your main source of information about COVID-19? (You may choose more than one option)

☐Internet (social media platforms)

☐Internet (Official websites like world health organization)

☐TV/Radio

☐Friends/Member of family

☐Magazines/Books

☐Lectures

If you had new information about COVID-19 would you share it with friends and family to raise awareness?

☐Yes ☐No

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BMJ Open

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A Crisis Within a Crisis: COVID-19 Knowledge and Awareness among the Syrian Population - a cross-sectional study

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Abstract:

Objectives: To gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic.

Design: Web-based cross-sectional survey.

Setting: This study was conducted in March 2020, nearly 10 years into the Syrian war crisis. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram, Instagram, and Facebook targeting various social groups.

Participants: Of 4495 total participants who completed the survey, participants with no known history of Covid-19 infection, residing outside Syria, and who did not fully complete the survey were excluded. The final sample of 3586 participants (completion rate=79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males.

Primary and secondary outcome measures: The First, knowledge of COVID-19 in 4 areas (1. General knowledge 2. Transmission pathways 3. Signs and symptoms 4. Prevention methods). The second, factors associated with poor knowledge.

Results: Of the 3586 participants, 2444(68.2%) were female, 1822(50.8%) were unemployed, and 2839(79.2%) were college-educated. The study revealed good awareness regarding COVID-19 (mean 75.6%, SD±9.4%). Multiple linear regression analysis correlated knowledge scores with female gender (β=-0.933, p=0.005), education level (β=-3.782, p<0.001), occupation (β=-3.592, p<0.001), economic status (β=-0.669, p<0.040), and the number of household members (β=-1.737, p<0.001).

Conclusion: This study revealed some potentially troubling knowledge gaps which underscore the need for a vigorous public education campaign. This campaign must reinforce the public's awareness, knowledge, and vigilance towards precautionary measures against COVID-19, and most importantly aid in controlling the worldwide spread of the disease.

Strengths and limitations of this study:

. This study assesses COVID-19 knowledge and identifies poor knowledge factors

. Data are derived from a large, national survey across Syria, during the lockdown period.

. The survey covered socio-demographic information, general knowledge, transmission, symptoms, and prevention.

. Results have broad implications for public health programming and response to COVID-19 in Syria.

. This web-based cross-sectional study cannot be generalized towards the Syrian population.

Keywords: Awareness; Knowledge; COVID-19; Pandemic; Syria; War; Population.

Background:

Coronavirus disease 2019 (COVID-19)is a highly infectious respiratory disease that evolved into a worldwide pandemic threatening a prolonged economic recession. The first incidence was reported at a local seafood market in Wuhan, China.[1] The virus continues to spread resulting in growing morbidity and mortality cases, hitting the poorest and most

vulnerable in the world. Many studies have assessed symptom clusters, transmission pathways, and prevention methods; however, many aspects have yet to be proven.[2 3] Sexual transmission, horizontal transmission, animal to human transmission, permanent immunity, and fetal abnormalities as a result of maternal infection are unproven.

The battle against COVID-19 in Syria is still in its infancy. The first confirmed case was announced on March 22,[4] and there had only been 44 cases and 3 deaths to date. These figures are significantly lower than neighbouring countries such as Turkey (127,659 and 3,461), Iran (98,647 and 6,277), Iraq (2,346 and 98), Lebanon (740 and 25), and Jordan (465 and 9).[5] The Syrian healthcare system is severely under-equipped and lacks the capacity to contain such a crisis. The estimated number of intensive care unit (ICU) beds with ventilators is a mere 325, and the theoretical maximum number of cases that can be adequately treated is only 6,500.[6] Once this maximum threshold capacity is exceeded, drastic rationing decisions will have to be made. Therefore, cooperation with and response to guidance from the WHO are of utmost importance. Unprecedented measures have been adopted to control the spread of COVID-19 in Syria.[6] The public's adherence to these control measures- is largely affected by their awareness, knowledge, and attitudes towards pandemics.[7 8]

The Syrian conflict, now in its 10th year, has resulted in the worst refugee crisis since World War II.[9] The devastating impact of war has placed the public health system under constant strain; the numbers of casualties continue to rise, 70% of health care workers have fled the country, the annihilation of healthcare facilities, and the "weaponization" of the healthcare are ongoing challenges.[6 10] These challenges along with dense residential areas, the growing prevalence of chronic illness, and 83% of the population living under the poverty line make Syria highly vulnerable to a severe outbreak.[6 11]

While some studies have been conducted to assess the knowledge, attitude, and practices among populations during this pandemic, including one done in China, none have

done so in Syria.[12-19] To our knowledge this first study that aims to measure the awareness and general knowledge of COVID-19 among the Syrian population at a time where ambiguity and misinformation are rampant. The objective of this study is to gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic. The information gleaned from this research will help with public health programming and response to COVID-19 in Syria as the pandemic continues to unfold.

Methods:

Study design, setting and, participants:

This web-based cross-sectional survey was conducted between March 31st and April 4th, during the lockdown period. Ethical approval was obtained from the Institutional Review Board (IRB) of the Faculty of Medicine, Syrian Private University. All participants, who completed the survey, and residing in Syria with no known history of COVID-19 infection were included in the study. The authors designed questions that were modelled after existing surveys.[12 13] The survey was translated to Arabic and was reviewed by two dialectologists and two infectious disease specialists, who evaluated whether the survey questions effectively assessed COVID-19 knowledge, and checked for double-barrelled and confusing questions, to ascertain the validity. We conducted a pilot study on 20 people to assess reliability clarity, relevance, and the acceptability of the survey; these were excluded from the final sample to avoid bias. Modifications were made based on feedback received to facilitate better comprehension before distributing the final survey to the general population. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram,

Instagram, and Facebook targeting various social groups. To avoid non-response bias the survey was distributed during lockdown where the majority of the population were out of work and at home, GIFs and posts were adapted to appeal to each social group, the questions were made short and in the form of multiple choice questions that required no typing, and the ability for viewers to comment on the link increased the popularity of the survey. Participants confirmed their voluntary participation by answering a yes-no question, were informed of the option to opt-out of the survey at any time, and were assured of the confidentiality and anonymity of their responses. After confirmation, participants were directed to the first part of the survey to complete questions about socio-demographic information including, age, gender, residence, education level, occupation, and economic status. Participants under the age of 18 required informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain consent before the child was given access to the survey. The sample size calculated was 2401 participants based on an error margin of 2%, and a confidence level of 95%, for a population of 18284423 people using a sample size calculator (website: https://www.surveysystem.com/sscalc.htm). The self-administered survey contained 40 questions divided into 4 sections: general knowledge (10 questions), transmission pathways (7 questions), clinical features (12 questions), and prevention methods (11 questions). The survey is available in appendix 1.

Patient and public involvement:

The public were not involved in the study design, conduct of the study, or plans to disseminate the results to study participants.

Statistical analysis

A scoring system was used to analyse the participants' knowledge: a score of "1" was given for a correct answer and a score of "0" was given for an incorrect answer. The percentage score for mean knowledge was calculated as follows: sum of scores obtained/maximum scores that could be obtained × 100. Participants' total mean knowledge in all the subsections, and mean knowledge of each subsection were calculated. Data were analysed using the Statistical Package for Social Sciences version 25.0 (SPSS Inc., Chicago, IL, United States) and reported as frequencies and percentages (for categorical variables) or means and standard deviations (SD) (for continuous variables). The t-test was applied to compare mean knowledge scores against both genders, and 3 questions (knowing an infected individual, use of personal belongings and dissemination of knowledge). The t-test was applied to compare mean knowledge scores against age. One-way analysis of variance (ANOVA) was applied using f-test to compare mean knowledge scores against socio-demographic variables (age, social status, residence, education level, occupation, economic status, and number of household members), and source of information. Multivariable linear regression analysis using the socio-demographic variables as independent variables (categorical) and mean knowledge score as the outcome variable (continuous) was conducted to identify factors associated with knowledge. Factors were selected with a backward method and were analysed using unstandardized coefficient (β), odds ratio (OR), and 95% confidence interval. P-values<0.05 were considered statistically significant.

Results:

Socio-demographics characteristics:

Of 4495 total participants who completed the survey, participants with no known history of Covid-19 infection, residing outside Syria, and who did not fully complete the survey were excluded. The final sample of 3586 participants (completion rate= 79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males. Participants aged >20 years were the majority 1204(33.6%) while participants between 35 and 39 were the minority 186(5.2). Participant ages ranged from 12-78 years with a mean of 30 (±10) years). 2279(63.6%) participants were single, 1822(50.8%) were unemployed, 1064(29.7%) were smokers, and 428(11.9%) were alcohol consumers (Table 1). The majority of participants were residents of Damascus/ Rural Damascus 2019(56.3%) and had attained college/university level education (Figure1).

General Knowledge regarding COVID-19:

Participants showed a good level of awareness regarding COVID-19 (75.6 ±9.4%). An adequate level of basic knowledge (67.0 ±18.9%) was found among participants, 3383(94.3%) knew that a virus was the causative agent of COVID-19; 2535(70.7%) correctly identified the incubation period as being between 2 days and 2 weeks. Only 1500(41.8%) knew that an infection with COVID-19 does not confer lifelong immunity. The majority of participants 3489(97.3%) were aware that COVID-19 infection in high-risk groups can be fatal. There is currently insufficient evidence on whether infertility is a complication of COVID-19 infection; 461(12.9%) participants believed that COVID-19 can cause infertility while 1903(53.0%) did not. 2986(83.3%), and 2597(72.4%) correctly answered that there are currently no available vaccine or treatments; however, there were misconceptions about the efficacy of antibiotics and Ibuprofen as treatments, 1228(34.2%) and 1268(35.3%) respectively (Table 2).

Transmission and Signs and Symptoms regarding COVID-19:

There was a fair level of awareness (70.7 ±16.9%) regarding COVID-19 transmission pathways. A high level of awareness was demonstrated regarding common transmission pathways: 3521(98.2%), 3387(94.4%), and 3330(92.9%) identified respiratory droplets, touching an infected person's personal belongings, and handshaking respectively. There is currently limited evidence on animal-to-human and sexual transmission; 703(19.6%) did not know if transmission occurs between animals and humans, while 899(25.1%) did not know if the virus is transmitted sexually (Table 2).

The data showed a good level of awareness (76.0 ±13.6%) regarding clinical features. When asked about the main clinical features, participants correctly identified, fever 3563(99.4%), sore throat 3037(84.7%), headache 3186(88.8%), chest pain 3050(85.0%), general pain 3019(84.2%), fatigue 3405(95.0%), and dry cough 3466(96.7%), whereas only 1972(55.0%) knew that diarrhea can be a symptom. Only 2221(61.9%) were aware that infected individuals may be asymptomatic (Table 2).

Prevention Methods regarding COVID-19:

The highest level of awareness was in the prevention section (88.8 ±10.2%). Washing hands with soap, avoiding crowded areas, remaining at home, and wearing a face mask outside are the principal preventative measures against COVID-19, 3574(99.7%), 3574(99.75%), 3554(99.1%), and 3204(89.3%), respectively. A minority 158(4.4%) believed that cleaning with a mixture of Flash and bleach is a sound preventive measure. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19 (Table 2).

Statistical Analysis of the Data:

A series of one way ANOVA analyses revealed that mean knowledge differed significantly across: gender (p-value=0.009), age (p-value=0.003), social status (p-

value=0.042), education level (p-value<0.001<0.001), economic status (p-value<0.001<0.001), number of household members (p-value<0.001<0.001), place of residence (p-value<0.001), and source of information (p-value<0.001) (Table 3). Participants living in Lattakia (77.6%) exhibited the greatest awareness, whereas those in Ar-Raqqah (71.7%) followed by Deir-ez-Zor (71.8%) exhibited the lowest. The mean knowledge differed across groups that acquired information from different sources, the lowest awareness was among participants who chose family members/friends as one of their source(s) (74.0%), whereas those with the highest awareness acquired their information from lectures as one of their source(s) (78.2%) , (Table 3).

When participants were asked if they were likely to share new information with friends and family, 3513(98.0%) answered "yes". There was a significant difference in mean knowledge between those who were inclined to disseminate new information about COVID-19 to friends and family (75.7%) compared with those who were not (72.3%) (p-value=0.002). On exclusive use of personal belongings, 2692(75.1%) answered "yes". We found no significant correlation between mean knowledge and participant tendency to share personal belongings with others (p-value=0.112). Of participants who knew someone infected with COVID-19, 65(1.8%) answered "yes". There was no significant difference in mean knowledge between those who knew an infected individual (75.9%) compared with those who did not (75.6%) (p-value=0.816).

Multiple linear regression:

Multiple linear regression analysis results: male gender (vs. female, β=-0.933, p=0.005); education of secondary school or lower (vs. college/university and above, β=-3.782, p<0.001); careers in government, private, business, military, and "other" sectors, as well as unemployment (vs. health care workers, β=-3.592, p<0.001); poor and moderate economic

status (vs. good and excellent, β=-0.669, p<0.040); and over 5 household members (vs. of 1-5, β=-1.737, p<0.001) were associated with significantly lower knowledge scores (Table 4). Careers in health care (vs. Unemployed, β=3.592, p-value=<0.001), and the 31-45 age group (vs. 16-30, β=1.511, p-value=0.005) were associated with significantly higher knowledge scores.

Discussion:

During this time of Covid-19, the amount of ambiguity is larger than normal, we cannot know for sure when there will be vaccines or treatments, neither provide sufficient evidence to support Sexual transmission, horizontal transmission, animal to human transmission, permanent immunity, and fetal abnormalities as a result of maternal infection. We found an overall mean knowledge score of 75.6%, indicating that most participants were relatively knowledgeable about COVID-19, though less so compared to their counterparts in China (90%).[12] This level of knowledge was unexpected given that when we carried out the survey, only 10 cases of COVID-19 had been confirmed in Syria.[20]

We found that poor knowledge was associated with males, non-post-secondary education, non-healthcare occupations, unemployment, poor and moderate economic status, and households exceeding 5 members. Similar trends were observed in China.[12] Correlating socio-demographic variables with awareness is critical to public health efforts to mitigate the spread of COVID-19. This data obtained can be leveraged by the Syrian Ministry of Health to tailor prevention and educational campaigns to populations with the widest knowledge gaps.

In the general knowledge section (67%), the majority of the participants 3383(94.3%) knew that COVID-19 is caused by a virus, similar to a Pakistani study (93.3%).[17] Low

awareness of the 2 to 14 day incubation period was found,[21] among dentists (36.1%), and health care workers (HCW) (36.4%).[13 19] Our study showed a higher level of awareness 2535(70.7%) among the population. Syria has a relatively young population; 2018 showed that only 4.5% of the population was over 65.[22] 3489(97.3%) knew that COVID-19 infection can be severe and lead to death in elderly, chronically ill, and immunodeficient patients. This is higher than studies conducted in China (73.2%), and India (88.37%).[12 23] 40.6% of Syrians are hypertensive, yet a staggering 79.8% of them are unaware of their condition. Diabetes is also prevalent, affecting 11.9% of the population.[24 25] Such a rampant lack of awareness about chronic disease in the population can be fatal and underscores the need for targeted awareness campaigns.

Only 2597(72.4%) participants knew that there is currently no available treatment; this is higher than a Kenyan study (40%) but significantly lower than a Chinese study (94%).[12 15] A minority 103(2.9%) participants thought there was a vaccine available against COVID-19; by contrast, Coimbatore District (18.6%) and Pakistan (11.6%) were misinformed. In the absence of a vaccine or effective treatment protocol for COVID-19, controlling the spread of the disease is the best line of defence. We observed a considerable knowledge gap in 1268(35.3%) with regards to ibuprofen as a treatment option. There is no available evidence to suggest that ibuprofen is effective against COVID-19.[26]

Participants showed a fair level of awareness regarding transmission pathways (70.7%), very similar to a Pakistani study (70.8%).[17] The majority 3521(98.2%) of participants were aware that respiratory droplets are common transmission vectors this is similar to a Chinese study (97.8%), but much higher than an Indian study (29.5%).[12 16] WHO advice on physical distancing include: using greetings that replace physical contact with a wave, nod, bow, peace sign, sign language, friendly words or smiles.[27 28] 3330(92.9%) participants identified handshaking as a transmission pathway, higher than a study among dentists (85.6%).[13]

A good level of awareness was found regarding the clinical features of COVID-19 (76.0%), similar to a Pakistani (77.7%).[17] A very high level of awareness of the most common symptoms was found: fever 3563(99.4%), dry cough 3466(96.7%), fatigue 3405(95.0%), and myalgia 3019(84.2%), similar to findings from Chinese (96.4%) and Indian (95.4%) studies.[12 23] When asked about sore throat, a higher level of awareness 3037(84.7%) was found compared to studies from India (15.2%) and among dentists (28.5%).[13 16] Knowledge about diarrhea as a symptom was lacking: only 1972(55.0%); a study among dentists also showed low awareness (39.9%). [13 16] While infected individuals are frequently asymptomatic, or present with mild symptoms, around 1 in every 5 infections can be serious enough to require hospitalisation.[29 30] Only 2221(61.9%) participants were aware that infected individuals can be asymptomatic, while a study among dentists (34.5%) reported much lower awareness. "Silent spreaders" may significantly contribute to the transmission of COVID-19, and so increasing public awareness of this particular point is crucial

We found a high level of awareness in the preventive methods section (88.8%), similar to a study in Pakistan (85%).[17] Hand hygiene is considered an important element of infection control dating back to the revolutionary work of Ignaz Semmelweis.[31] Implementing hand-washing techniques can break the transmission cycle and reduce the risk of infection by 6%-44%.[32] Almost all 3574(99.7%) participants were aware that washing hands with soap and water is an important preventive measure against COVID-19. This finding is in accordance with India (97.0%), and other studies (96.2%, and 87%).[13 16 19]

This year the WHO recommended that the following mitigation measures be implemented during the holy month of Ramadan: cancelling social and religious gatherings, holding events outdoors for adequate ventilation, physical distancing of at least 1 meter between people, and the use of technology to broadcast ceremonies on television.[27 28] The majority 3574(99.7%) identified avoiding mass gatherings as a preventive measure; studies in

China (98.6%) and Coimbatore District (97.7%) reported similar awareness.[12 23] Cheap and efficient interventions such as N95 (filtration capacity=95%) have a 91% effectiveness of blocking pathogen transmission.[33] 3204(89.3%) participants considered wearing a face mask when leaving home as an effective prevention method, compared with a Coimbatore District study (93.02%).[23]

Since Syrian society is particularly vulnerable to COVID-19, this knowledge gap is potentially dangerous and should be addressed to mitigate disease spread. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19; this is similar to a Coimbatore District study (67.4%), but lower than a study amongst HCWs (90.7%).[19 23] Mixing flash with bleach is highly toxic and caustic to the respiratory tract. Only a minority of participants 158(4.4%) believed that this method of cleaning is a sound preventive measure. 3305(92.2%) were aware that individuals showing symptoms should quarantine themselves, lower than in China (98.2%) and India (95.8%).[12 16]

North-East Syria (NES) has a population of over 4 million people, 600,000 of whom are internally displaced refugees, 100,000 of whom live in overcrowded camps: only 2 of NES's 11 hospitals are currently functioning. NES consists of 3 governorates: Ar-Raqqah, Deir-ez-Zor, and Al-Hasakah. With only 22 ICU beds, (18 in Al-Hasakah, 4 in Ar-Raqqah, and none in Deir-ez-Zor), the maximum capacity threshold is only 80 COVID-19 cases. Ar-Raqqa and Deir-ez-Zor, the most vulnerable governorates, also showed the lowest awareness in the study (71.7%), and (71.8%). This is a potentially catastrophic situation, and a concern to the international community, as an unmonitored, uncontrolled outbreak in NES can prolong the global pandemic.

Limitations:

Our findings can only be generalized about online users of well-educated Syrians of good socio-economic status. Syrians vulnerable to COVID-19, such as the elderly and rural residents, are more likely to exhibit poor knowledge and awareness due to limited internet access. As such, reaching out to these populations must be prioritized. Even though all Syrian governorates were represented in this study, most participants lived in Damascus and Rural Damascus. Furthermore, an assessment of attitudes and practice towards COVID-19 is needed.

Conclusion:

COVID-19 has been a dire warning to humanity about the fragility of its social, economic, and healthcare institutions. Our study revealed good public awareness of clinical features and preventive measures. However general knowledge and knowledge about transmission pathways was suboptimal. Syrians of good socio-economic status, in particular young well-educated women, have shown good knowledge. Our national response must adapt to the growing threat of COVID-19 by adopting public awareness strategies and behaviours to contain the disease both within and beyond our borders.

Abbreviations: COVID-19: Coronavirus Disease 2019; MERS: Middle East Respiratory Syndrome; SARS: Severe Acute Respiratory Syndrome; WHO: World Health Organization; PHEIC: Public Health Emergency of International Concern; ICU: Intensive care unit; IRB: Institutional Review Board; SPSS: Statistical Package for Social Sciences; SD: Standard Deviation; HCW: Health Care Worker.

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Availability of data and materials:

All data related to this paper's conclusion are available and stored by the authors. All data are available from the corresponding author on a reasonable request.

Declarations:

Ethics approval and consent to participate:

This study was approved by the Institutional Review Board (IRB) at the Syrian Private University (SPU). All Participants confirmed their written consent by answering a yes-no question. Participants under the age of 18 required verbal informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain verbal consent before the child was given access to the survey. The verbal and written form of consent was approved by the IRB at SPU. Participation in the study was voluntary and participants were assured that anyone who was not inclined to participate or decided to withdraw after giving consent would not be victimized. All information collected from this study was kept strictly confidential.

Consent for Publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

Authors' contributions:

FM conceptualized the study, participated in the design, wrote the study protocol, performed the statistical analysis, did a literature search, and drafted the manuscript. BB participated in study design, did a literature search, and drafted the manuscript. HA, and ND did a literature search, and revision of the draft. All authors read and approved the final draft.

Tables and Figures:

Table 1.

Table 1. Socio-demographic characteristics: (n=3586)

Gender (%)	**Male**	**1142(31.8)**	**Education (%)**	**Primary School**	**25(0.7)**
	Female	**2444(68.2)**		**Intermediate School**	**166(4.6)**
Age (%)	**<20**	**1204(33.6)**		**Secondary school**	**375(10.4)**
	20-24	**1104(30.8)**		**College/University**	**2839(79.2)**
	25-29	**446(12.4)**		**Master's degree**	**157(4.4)**
	30-34	**266(7.4)**		**PhD**	**24(0.7)**

	35-39	186(5.2)	Occupation (%)	Health care worker	634(17.7)
	>39	380(10.6)		Government institution	283(7.9)
Social Status (%)	Single	2279(63.5)		Private institution	182(5.1)
	In a relationship	286(8.0)		Business	198(5.5)
	Married	943(26.3)		Military	32(0.9)
	Divorced	46(1.3)		Unemployed	1822(50.8)
	Widowed	32(0.9)		Other	435(12.1)
Economic Status (%)	[1]Poor	247(6.9)	Household members (%)	0	46(1.3)
	[2]Moderate	1247(34.8)		1-5	2751(76.7)
	[3]Good	1761(49.1)		>5	789(22)
	[4]Excellent	331(9.2)			

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[1]Poor: income does not provide essential needs for the family. [2]Moderate: income provides essential needs for the family but no more. [3]Good: income provides essential needs and some luxury requirements. [4]Excellent: income provides luxury requirements.

Table 2.

Table 2. General Knowledge, Transmission, Signs and Symptoms, and Prevention of COVID-19: (n=3586)

General Knowledge					
Causative Agent N(%)	Virus	3383(94.3)	**Incubation period N(%)**	1 Minute to 1 Hour	18(0.5)
	Bacteria	39(1.1)		1 Hour to 2 Days	58(1.6)
	Parasite	8(0.2)		2 Days to 2 Weeks	2535(70.7)
	Immune deficiency	46(1.3)			
	Fungus	0(0.0)		2 Weeks to 1 Month	958(26.7)
	Inherited	2(0.1)			
	Do Not Know	108(3.0)		>1 Month	17(0.5)
		YES(%)	**NO(%)**	**DO NOT KNOW(%)**	

Can infection with COVID-19 confer permanent immunity?	815(22.7)	1500(41.8)	1271(35.5)
Can COVID-19 cause severe illness and lead to death in elderly, chronically ill, and immunodeficient patients?	3489(97.3)	28(0.8)	69(1.9)
Can COVID-19 cause infertility?	461(12.9)	1222(34.1)	1903(53.0)
Is COVID-19 teratogenic (i.e. cause malformations/ abnormalities to an embryo/fetus)?	157(4.4)	1433(40.0)	1996(55.6)
Is there no available treatment against COVID-19?	2597(72.4)	515(14.4)	474(13.2)
Can COVID-19 be treated with antibiotics?	1228(34.3)	1790(49.9)	568(15.8)
Can COVID-19 be treated with Ibuprofen?	1268(35.3)	1921(53.6)	397(11.1)
Are there available COVID-19 vaccines?	103(2.9)	2986(83.3)	497(13.8)
Transmission Pathways			
Respiratory droplets (from coughing or sneezing)	3521(98.2)	21(0.6)	44(1.2)

Handshaking	3330(92.9)	189(5.3)	67(1.8)
Touching an infected person's personal belongings	3387(94.4)	131(3.7)	68(1.9)
Animals-to-human	910(25.4)	1973(55.0)	703(19.6)
Undercooked food	1301(36.3)	1734(48.3)	551(15.4)
Sexual contact	1210(33.7)	1477(41.2)	899(25.1)
Horizontal transmission	1130(31.5)	1160(32.4)	1296(36.1)
Signs and Symptoms			
Fever	3563(99.4)	9(0.2)	14(0.4)
Sneezing	2353(65.6)	1000(27.9)	233(6.5)
Sore throat	3037(84.7)	358(10.0)	191(5.3)
Headache	3186(88.8)	190(5.3)	210(5.9)
Chest pain	3050(85.0)	254(7.1)	282(7.9)
Body aches (generalized pain)	3019(84.2)	260(7.2)	307(8.6)
Fatigue	3405(95.0)	72(2.0)	109(3.0)
Diarrhea	1972(55.0)	971(27.1)	643(17.9)
Dry cough	3466(96.7)	44(1.2)	76(2.1)
Productive cough	458(12.8)	2586(72.1)	542(15.1)
Bleeding	130(3.6)	2613(72.9)	843(23.5)

Asymptomatic	2221(61.9)	375(10.5)	990(27.6)
Prevention Methods			
Does wearing a face mask outside the home offer protection from COVID-19?	3204(89.3)	314(8.8)	68(1.9)
Does washing hands with soap and water offer protection from COVID-19?	3574(99.7)	5(0.1)	7(0.2)
Does avoiding crowded places offer protection from COVID-19?	3574(99.7)	4(0.1)	8(0.2)
Does the flu vaccine offer protection from COVID-19?	331(9.2)	2482(69.2)	773(21.6)
Does staying at home offer protection from COVID-19?	3554(99.1)	15(0.4)	17(0.5)
Does using hand sanitizer offer protection from COVID-19?	3430(95.6)	104(2.9)	52(1.5)
Does cleaning house items with bleach offer protection from COVID-19?	3408(95.0)	110(3.1)	68(1.9)
Does cleaning fruits and vegetables with soap and water offer protection from COVID-19?	3262(90.9)	221(6.2)	103(2.9)

Does cleaning surfaces with a mixture of Flash and bleach offer a safe protection from COVID-19?	158(4.4)	3301(92.1)	127(3.5)
Does the quarantine of symptomatic individuals protect others from COVID-19?	3305(92.2)	241(6.7)	40(1.1)
Do cumin, anise, and mint offer protection from COVID-19?	1041(29.0)	1934(53.9)	611(17.1)

389 **Table 3.**

Table 3. Mean knowledge score of participants by demographic variables, and source of information (one way ANOVA), (n= 3586)

Characteristics		Number of participants (%)	Mean Knowledge Score (±SD%)	F-test/ T-test	P-value
Gender	Male	1142(31.8)	75.0(±10.1)	-2.625	0.009*
	Female	2444(68.2)	75.9(±9)		
Age-group	**<20**	1204(33.6)	75.0(±9.9)	2.990	0.011*

(years)	**20-24**	1104(30.8)	76.4(±9.3)		
	25-29	446(12.4)	76.0(±9.4)		
	30-34	266(7.4)	75.4(±9.4)		
	35-39	186(5.2)	76.1(±7.6)		
	>39	380(10.6)	75.1(±8.6)		
Social status	Single	2279(63.5)	75.8(±9.3)	2.485	0.042*
	In a relationship	286(8.0)	76.6(±8.6)		
	Married	943(26.3)	75.1(±9.4)		
	Divorced	46(1.3)	73.9(±8.8)		
	Widowed	32(0.9)	73.4(±15.9)		
Residence	Urban	2426(67.7)	75.8(±9.3)	1.652	0.099

	Rural	1160(32.3)	75.3(±9.6)		
Education	Primary school	25(0.7)	66.5(±12.4)	26.176	<0.001*
	Intermediate school	166(4.6)	73.2(±9.3)		
	Secondary school	375(10.4)	70.0(±13)		
	College/University	2839(79.2)	76.3(±8.9)		
	Master's degree	157(4.4)	77.2(±9.7)		
	PhD	24(0.7)	76.6(±8.5)		
Occupation	Health care worker	634(17.7)	78.6(±8.6)	16.379	<0.001*
	Government institution	283(7.9)	75.7(±7.9)		

	Private institution	182(5.1)	75.5(±9)		
	Business	198(5.5)	73.4(±10.2)		
	Military	32(0.9)	71.2(±15.6)		
	Unemployed	1822(50.8)	75.3(±9.2)		
	Other	435(12.1)	74.0(±10.2)		
Economic status	Excellent	331(9.2)	76.6(±11.1)	7.108	<0.001*
	Good	1761(49.1)	76.2(±9.4)		
	Moderate	1247(34.8)	74.9(±9)		

	Poor	247(6.9)	74.3(±9.3)		
Household members	0	46(1.3)	74.4(±10.6)	15.451	<0.001*
	1-5	2751(76.7)	76.1(±9)		
	>5	789(22.0)	74.0(±10.2)		
Source of information	Health websites	2823(78.7%)	76.4(±8.7)	24.523	<0.001*
	Social media	1998(55.7%)	74.6(±9.6)		
	Television/ radio	1572(43.8%)	75.5(±9)		
	Family members/ friends	528(14.7%)	74.0(±10.3)		
	Lectures	517(14.4%)	78.2(±7.5)		
	Magazines/ books	266(7.4%)	77.6(±8.8)		

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391 **Table 4.**

Table 4. Multiple linear regression on variables associated with poor COVID-19 knowledge

Variable	Coefficient	Standard error	t	P
Male gender (reference: female)	-0.933	0.334	-2.794	0.005*
education of secondary school or lower (reference: college/university and above)	-3.782	0.466	-8.125	<0.001*
careers in government, private, business, military, and "other" sectors, as well as unemployment (reference: health care workers)	-3.592	0.474	-7.579	<0.001*
poor and moderate economic status (reference: good and excellent)	-0.669	0.325	-2.057	0.040*
>5 household members (reference: of 1-5)	-1.737	0.374	-4.648	<0.001*

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Figures and tables legends:

Table 1. Sociodemographic characteristics

Table 2. General Knowledge, Transmission, Signs and Symptoms, and Prevention around COVID-19**Table 3.** Mean knowledge score of participants by demographic variables

Table 4. Multiple linear regression on variables associated with poor COVID-19 knowledge

Figure 1. Distribution of participants according to governorates and education level

References:

1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet* 2020;395(10223):497-506. doi: 10.1016/s0140-6736(20)30183-5
2. Viner RM, Ward JL, Hudson LD, et al. Systematic review of reviews of symptoms and signs of COVID-19 in children and adolescents. 2020
3. Rahman HS, Aziz MS, Hussein RH, et al. The transmission modes and sources of COVID-19: A systematic review. 2020
4. McKernan B. Syria confirms first Covid-19 case amid fears of catastrophic spread. *The Guardian* 2020
5. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 106. 2020
6. Gharibah M, Mehchy Z. COVID-19 pandemic: Syria's response and healthcare capacity. 2020
7. Ajilore K, Atakiti I, Onyenankeya K. College students' knowledge, attitudes and adherence to public service announcements on Ebola in Nigeria: Suggestions for improving future Ebola prevention education programmes. *Health Education Journal* 2017;76(6):648-60.
8. Tachfouti N, Slama K, Berraho M, et al. The impact of knowledge and attitudes on adherence to tuberculosis treatment: a case-control study in a Moroccan region. *Pan African Medical Journal* 2012;12(1)
9. McNatt Z, Boothby NG, Al-Shannaq H, et al. Impact of Separation on Refugee Families: Syrian Refugees in Jordan. 2018
10. Syria anniversary press release. *United Nations Office for the Coordination of Humanitarian Affairs (OCHA)* 2020
11. UNICEF Syria Crisis Situation Report 2019
12. Zhong B-L, Luo W, Li H-M, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *International Journal of Biological Sciences* 2020;16(10):1745.
13. Khader Y, Al Nsour M, Al-Batayneh OB, et al. Dentists' Awareness, Perception, and Attitude Regarding COVID-19 and Infection Control: Cross-Sectional Study Among Jordanian Dentists. *JMIR Public Health and Surveillance* 2020;6(2):e18798.
14. Qarawi A, Ng SJ, Gad A, et al. Awareness and Preparedness of Hospital Staff against Novel Coronavirus (COVID-2019): A Global Survey - Study Protocol. *SSRN Electronic Journal* 2020 doi: 10.2139/ssrn.3550294
15. Austrian K, Pinchoff J, Tidwell JB, et al. COVID-19 related knowledge, attitudes, practices and needs of households in informal settlements in Nairobi, Kenya. 2020
16. Roy D, Tripathy S, Kar SK, et al. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian Journal of Psychiatry* 2020:102083.
17. Hussain T, Khan S, Gilani U, et al. Evaluation of General Awareness Among Professionals Regarding COVID-19: A Survey Based Study from Pakistan. 2020

18. Zhou M, Tang F, Wang Y, et al. Knowledge, attitude and practice regarding COVID-19 among health care workers in Henan, China. *Journal of Hospital Infection* 2020
19. Bhagavathula AS, Aldhaleei WA, Rahmani J, et al. Novel Coronavirus (COVID-19) Knowledge and Perceptions: A Survey on Healthcare workers. *medRxiv* 2020
20. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 71. 2020
21. Backer J, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. *Eurosurveillance* 2020;25 doi: 10.2807/1560-7917.ES.2020.25.5.2000062
22. Plecher H. Age structure in Syria 2018. *Statista* 2020
23. Vadivu TS, Annamuthu P. An Awareness and Perception of COVID-19 among General Public–A Cross Sectional Analysis. 2014
24. Organization WH. Web World Health Organization–Diabetes country profiles: Diakses, 2016.
25. Tailakh A, Evangelista LS, Mentes JC, et al. Hypertension prevalence, awareness, and control in A rab countries: A systematic review. *Nursing & health sciences* 2014;16(1):126-30.
26. The use of non-steroidal anti-inflammatory drugs (NSAIDs) in patients with COVID-19. *World Health Organization* 2020
27. Practical considerations and recommendations for religious leaders and faith-based communities in the context of COVID-19. *World Health Organization* 2020
28. Safe Ramadan practices in the context of the COVID-19 *World Health Organization* 2020
29. Surveillances V. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)—China, 2020. *China CDC Weekly* 2020;2(8):113-22.
30. Organization WH. Getting your workplace ready for COVID-19: How COVID-19 spreads, 19 March 2020: World Health Organization, 2020.
31. Best M, Neuhauser D. Ignaz Semmelweis and the birth of infection control. *Quality & safety in health care* 2004;13:233-4. doi: 10.1136/qhc.13.3.233
32. Rabie T, Curtis V. Handwashing and Risk of Respiratory Infections: A Quantitative Systematic Review. *Tropical medicine & international health : TM & IH* 2006;11:258-67. doi: 10.1111/j.1365-3156.2006.01568.x
33. Jefferson T, Foxlee R, Del Mar C, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses: systematic review. *Bmj* 2008;336(7635):77-80.

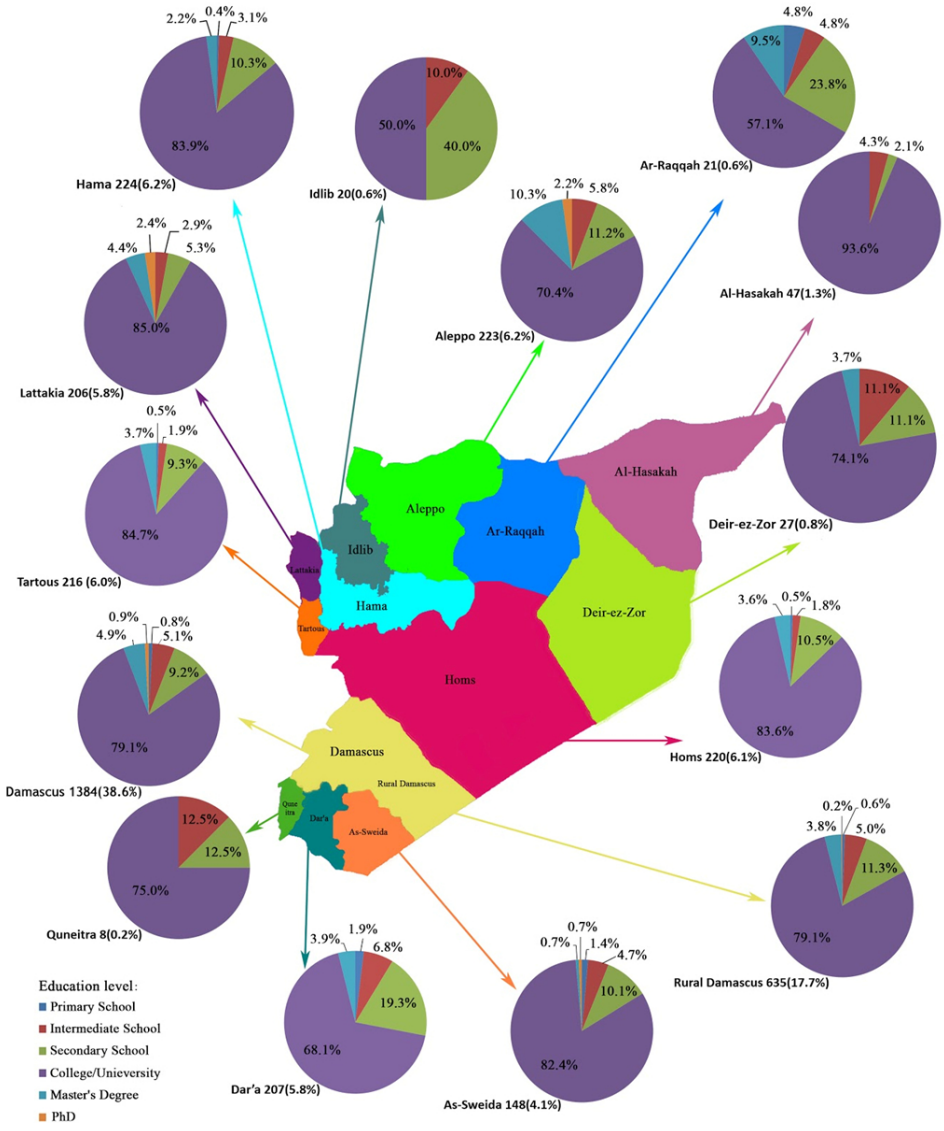

Figure 1. Distribution of participants according to governorates and education level

Attached Survey:

Appendix 1

Socio-demographic Characteristics	
Age (years): ☐ Below 15 ☐ 15-20 ☐ 20-30 ☐ 30-50 ☐ 40-50 ☐ 50-60 ☐ 60-70 ☐ Above 70	**Gender:** ☐ Male ☐ Female
Marital status: ☐ Single ☐ Relationship ☐ Married ☐ Divorced ☐ Widowed	**Educational level:** ☐ Primary school ☐ Intermediate school ☐ Secondary school ☐ University/College ☐ Master's Degree ☐ PHD Degree
Occupation: ☐ Health care worker ☐ Government institution ☐ Private institution ☐ Business ☐ Military ☐ Unemployed ☐ Other	**Residence:** ☐ Damascus/Rural Damascus ☐ Hama ☐ Aleppo ☐ Homs ☐ Tartous ☐ Lattakia ☐ Dar'a ☐ As-Sweida ☐ Al Hasakah ☐ Deir-ez-Zor ☐ Idlib ☐ Ar-Raqqah ☐ Quneitra
Area: ☐ Rural ☐ Urban	**Economic Status:** ☐ Excellent ☐ Good ☐ Moderate ☐ Poor
Do you smoke? ☐ Yes ☐ No	**Do you drink alcohol?** ☐ Yes ☐ No
How many people do you live with? ☐ Alone ☐ 1-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ Above 20	
Do you share toiletries/personal care products with others? ☐ Yes ☐ No	
Do you know anyone infected with COVID-19? ☐ Yes ☐ No	

Table 2. General Knowledge about COVID-19

What is COVID-19?

☐ Virus ☐ Bacteria
☐ Parasite ☐ Fungus
☐ Immunodeficiency ☐ Inherited
☐ Do not know

Do you know how long after being infected with COVID-19 can a person suffer from signs and symptoms?

☐ 1 Minute to 1 Hour ☐ 1 Hour to 2 Days
☐ 2 Days to 2 weeks ☐ 2 Weeks to 1Month
☐ Over a 1 month

Can an infection with COVID-19 confer permanent immunity (once infected with COVID-19 you cannot contract another infection)?

☐ Yes ☐ No ☐ Do not know

Can COVID-19 cause severe illness and lead to death in elderly, chronically ill (hypertension, diabetes, asthma . . .), and those who have compromised immune systems?

☐ Yes ☐ No ☐ Do not know

Can COVID-19 cause infertility?

☐ Yes ☐ No ☐ Do not know

Is COVID-19 teratogenic (i.e. cause malformations/abnormalities to an embryo/fetus)?

☐ Yes ☐ No ☐ Do not know

Treatment for COVID-19

	Yes	No	Do Not Know
No treatment available			
Antibiotics			
Ibuprofen			

Is there an available vaccine for COVID-19?

☐ Yes ☐ No ☐ Do not know

Table 3. Transmission Pathways			
	Yes	**No**	**Do Not Know**
Can COVID-19 be transmitted via respiratory droplets (coughing or sneezing) of infected individuals?			
Can COVID-19 be transmitted after shaking-hands with an infected individual?			
Can COVID-19 be transmitted after touching an infected individual's personal belongings?			
Can COVID-19 be transmitted from animals to humans?			
Can COVID-19 be transmitted via undercooked food?			
Can COVID-19 be transmitted via sexual contact?			
Can COVID-19 be transmitted via vertical transmission (mother to fetus)?			

Table 4. Signs and Symptoms of COVID-19			
	True	**False**	**Do Not Know**
Is fever/temperature among the signs and symptoms of COVID-19?			
Is sneezing among the signs and symptoms of COVID-19?			
Is sore throat among the signs and symptoms of COVID-19?			
Is headache among the signs and symptoms of COVID-19?			
Is Chest pain among the signs and symptoms of COVID-19?			
Is body aches (generalized pain) among the signs and symptoms of COVID-19?			
Is fatigue among the signs and symptoms of COVID-19?			
Is diarrhea among the signs and symptoms of COVID-19?			
Is a runny nose among the signs and symptoms of COVID-19?			
Is dry cough among the signs and symptoms of COVID-19?			
Is productive cough among the signs and symptoms of COVID-19?			
Is bleeding among the signs and symptoms of COVID-19?			
Can a person be infected with COVID-19 and have no signs and symptoms?			

Table 5. Prevention Methods			
	True	**False**	**Do Not Know**
Does wearing a face mask outside the home offer protection from Covid-19?			
Does washing hands with soap and water offer protection from COVID-19?			
Do avoiding crowded places offer protection from Covid-19?			
Does the flu vaccine offer protection from Covid-19?			
Does staying at home offer protection from Covid-19?			
Does using hand sanitizer offer protection from Covid-19?			
Does using bleach to clean household surfaces prevent COVID-19 infection?			
Does cleaning surfaces with a mixture of Flash and bleach offer protection from Covid-19?			
Does the quarantine of symptomatic individuals protect others from Covid-19?			
Do cumin, anise, and mint offer protection from Covid-19?			

What is your main source of information about COVID-19? (You may choose more than one option)

- ☐ Internet (social media platforms)
- ☐ Internet (Official websites like world health organization)
- ☐ TV/Radio
- ☐ Friends/Member of family
- ☐ Magazines/Books
- ☐ Lectures

If you had new information about COVID-19 would you share it with friends and family to raise awareness?

☐ Yes ☐ No

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2,3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6,7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Not applicable
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	Not applicable (no missing data)
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up	8

	was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
€	Describe any sensitivity analyses	-

Continued on next page

Results			**Page No.**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		© *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	-
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	-
		Cross-sectional study—Report numbers of outcome events or summary measures	29-35
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	34,35
		(*b*) Report category boundaries when continuous variables were categorized	29-33
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A Crisis Within a Crisis: COVID-19 Knowledge and Awareness among the Syrian Population - a cross-sectional study

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Abstract:

Objectives: To gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic.

Design: Web-based cross-sectional survey.

Setting: This study was conducted in March 2020, nearly 10 years into the Syrian war crisis. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram, Instagram, and Facebook targeting various social groups.

Participants: A total of 4495 participants completed the survey. Participants with a history of COVID-19 infection, residing outside Syria, or who did not fully complete the survey were excluded from the study. The final sample of 3586 participants (completion rate=79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males.

Primary and secondary outcome measures: The first, knowledge of COVID-19 in 4 areas (1. general knowledge 2. transmission pathways 3. signs and symptoms 4. prevention methods). The second, factors associated with poor knowledge.

Results: Of the 3586 participants, 2444(68.2%) were female, 1822(50.8%) were unemployed, and 2839(79.2%) were college-educated. The study revealed good awareness regarding COVID-19 (mean 75.6%, SD±9.4%). Multiple linear regression analysis correlated poor mean knowledge scores with male gender (β=-0.933, p=0.005), secondary school or lower education level (β=-3.782, p<0.001), non-healthcare occupation (β=-3.592, p<0.001), low economic status (β=-0.669, p<0.040), and >5 household members (β=-1.737, p<0.001).

Conclusion: This study revealed some potentially troubling knowledge gaps which underscore the need for a vigorous public education campaign. This campaign must reinforce the public's awareness, knowledge, and vigilance towards precautionary measures against COVID-19, and most importantly aid in controlling the worldwide spread of the disease.

Strengths and limitations of this study:

. Data are derived from a large, national survey across Syria, during the lockdown period.

. The survey covered socio-demographic information, general knowledge, transmission, symptoms, and prevention.

. Results have broad implications for public health programming and response to COVID-19 in Syria.

. This web-based cross-sectional study cannot be generalized towards the Syrian population.

Keywords: Awareness; Knowledge; COVID-19; Pandemic; Syria; War; Population.

Background:

Coronavirus disease 2019 (COVID-19) is a highly infectious respiratory disease that evolved into a worldwide pandemic threatening a prolonged economic recession. The first incidence was reported at a local seafood market in Wuhan, China.[1] The virus continues to spread, with steadily increasing morbidity and mortality cases, hitting the poorest and most vulnerable in the world. Many studies have assessed symptom clusters, transmission pathways, and prevention methods; however, many aspects have yet to be studied.[2] [3] Sexual

transmissions, horizontal transmission, animal to human transmission, permanent immunity, and fetal abnormalities as a result of maternal infection are as yet unproven.

The battle against COVID-19 in Syria has just entered its third wave. The first confirmed case was announced on 22 March 2020,[4] and there had only been 44 cases and 3 deaths at the time of the study. These figures are significantly lower than neighbouring countries such as Turkey (127,659 and 3,461), Iran (98,647 and 6,277), Iraq (2,346 and 98), Lebanon (740 and 25), and Jordan (465 and 9).[5] The Syrian healthcare system is severely under-equipped and lacks the capacity to contain such a crisis. The estimated number of intensive care unit (ICU) beds with ventilators is a mere 325, and the theoretical maximum number of cases that can be adequately treated is only 6,500.[6] Once this maximum threshold capacity is exceeded, drastic rationing decisions will have to be made. Therefore, cooperation with and response to guidance from the WHO are of utmost importance. Unprecedented measures have been adopted to control the spread of COVID-19 in Syria.[6] The public's adherence to these control measures is largely affected by their awareness, knowledge, and attitudes towards disease and outbreaks.[7 8]

The Syrian conflict, now in its 10th year, has resulted in the worst refugee crisis since World War II.[9] The devastating impact of war has placed the public health system under constant strain; the numbers of casualties continue to rise, 70% of health care workers (HCW) have fled the country, the annihilation of healthcare facilities, and the "weaponization" of healthcare are ongoing challenges.[6 10] These challenges along with dense residential areas, the growing prevalence of chronic illness, and 83% of the population living under the poverty line make Syria highly vulnerable to a severe outbreak.[6 11]

While some studies have been conducted to assess the knowledge, attitude, and practices among populations during this pandemic, including one done in China, none have done so in Syria.[12-19] To our knowledge this first study that aims to measure the awareness and

general knowledge of COVID-19 among the Syrian population at a time where ambiguity and misinformation are rampant. The objective of this study is to gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic. The information gleaned from this research will help with public health programming and response to COVID-19 in Syria as the pandemic continues to unfold.

Methods:

Study design, setting, and participants:

This web-based cross-sectional survey was conducted between March 31st and April 4th of 2020, during the lockdown period. Ethical approval was obtained from the Institutional Review Board (IRB) of the Faculty of Medicine, Syrian Private University. The inclusion criteria for this study were participants residing in Syria who completed the survey and had no known history of COVID-19 infection. The authors designed questions that were modelled after existing awareness surveys, WHO course materials, technical briefs, and question and answer bank on COVID-19 related topics.[12 13 20-23] Questions from existing awareness surveys that did not target community awareness regarding COVID-19 were excluded from the study. [12 13] The survey was translated to Arabic and was reviewed by two dialectologists and two infectious disease specialists, who evaluated whether the survey questions effectively assessed COVID-19 knowledge, and checked for double-barrelled and confusing questions, to ascertain the validity. We conducted a pilot study on 20 volunteers to assess reliability clarity, relevance, and the acceptability of the survey. These volunteers were excluded from the final sample to avoid bias. Modifications were made based on feedback received to facilitate better

comprehension before distributing the final survey to the general population. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram, Instagram, and Facebook targeting various social groups. To avoid non-response bias the survey was distributed during lockdown where the majority of the population were out of work and at home, GIFs and posts were adapted to appeal to each social group, the questions were made short and in the form of multiple choice questions that required no typing, and the ability for viewers to comment on the link increased the popularity of the survey. Participants confirmed their voluntary participation by answering a yes-no question, were informed of the option to opt-out of the survey at any time, and were assured of the confidentiality and anonymity of their responses. After confirmation, participants were directed to the first part of the survey to complete questions about socio-demographic information including, age, gender, residence, education level, occupation, and economic status. Participants under the age of 18 required informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain consent before the child was given access to the survey. The sample size calculated was 2401 participants based on a margin of error of 2%, and a confidence interval of 95%, for a population of 18,284,423 people using a sample size calculator (website: https://www.surveysystem.com/sscalc.htm). The self-administered survey contained 40 questions divided into 4 sections: general knowledge (10 questions), transmission pathways (7 questions), clinical features (12 questions), and prevention methods (11 questions). The survey is available in appendix 1.

Patient and public involvement:

The public were not involved in the study design, conduct of the study, or plans to disseminate the results to study participants.

Statistical analysis

A scoring system was used to analyse the participants' knowledge: a score of "1" was given for a correct answer and a score of "0" was given for an incorrect answer. The correct answers to the survey were determined from previous surveys and available WHO resources. [12 13 20-23] The percentage score for mean knowledge was calculated as follows: sum of scores obtained/maximum scores that could be obtained × 100. Participants' total mean knowledge in all the subsections, and mean knowledge of each subsection were calculated. Data were analysed using the Statistical Package for Social Sciences version 25.0 (SPSS Inc., Chicago, IL, United States) and reported as frequencies and percentages (for categorical variables) or means and standard deviations (SD) (for continuous variables). The t-test was applied to compare mean knowledge scores against both genders, and 3 questions (knowing an infected individual, use of personal belongings, and dissemination of knowledge). The t-test was applied to compare mean knowledge scores against gender. One-way analysis of variance (ANOVA) was applied using f-test to compare mean knowledge scores against socio-demographic variables (age, social status, residence, education level, occupation, economic status, and number of household members), and source of information. Multivariable linear regression analysis using the socio-demographic variables as independent variables (categorical) and mean knowledge score as the outcome variable (continuous) was conducted to identify factors associated with knowledge. Factors were selected with a backward method and were analysed using the unstandardized coefficient (β), and 95% confidence interval. P-values<0.05 were considered statistically significant.

Results:

Socio-demographics characteristics:

Of 4495 total participants who completed the survey, participants with a known history of COVID-19 infection, residing outside Syria, and who did not fully complete the survey were excluded. The final sample of 3586 participants (completion rate= 79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males. Participants aged >20 years were the majority 1204(33.6%) while participants between 35 and 39 were the minority 186(5.2%). Participant ages ranged from 12-78 years with a mean of 30 (±10) years). 2279(63.6%) participants were single, 1822(50.8%) were unemployed, 1064(29.7%) were smokers, and 428(11.9%) were alcohol consumers (Table 1). The majority of participants were residents of Damascus/ Rural Damascus 2019(56.3%) and had attained college/university level education (Figure1).

General Knowledge regarding COVID-19:

Participants showed a good level of awareness regarding COVID-19 (75.6 ±9.4%). An adequate level of basic knowledge (67.0 ±18.9%) was found among participants, 3383(94.3%) knew that a virus was the causative agent of COVID-19; 2535(70.7%) correctly identified the incubation period as being between 2 days and 2 weeks. Only 1500(41.8%) believed that an infection with COVID-19 does not confer lifelong immunity. The majority of participants 3489(97.3%) were aware that COVID-19 infection in high-risk groups can be fatal. There is currently insufficient evidence on whether infertility is a complication of COVID-19 infection; 461(12.9%) participants believed that COVID-19 can cause infertility while 1903(53.0%) did not. 2986(83.3%), and 2597(72.4%) correctly answered that there are currently no available vaccine or treatments respectively; however, there were misconceptions about the efficacy of antibiotics and Ibuprofen as treatments, 1228(34.2%) and 1268(35.3%) respectively (Table 2).

Transmission, and Signs and Symptoms regarding COVID-19:

There was a fair level of awareness (70.7 ±16.9%) regarding COVID-19 transmission pathways. A high level of awareness was demonstrated regarding common transmission pathways: 3521(98.2%), 3387(94.4%), and 3330(92.9%) identified respiratory droplets, touching an infected person's personal belongings, and handshaking respectively. There is currently limited evidence on animal-to-human and sexual transmission; 703(19.6%) did not know if transmission occurs between animals and humans, while 899(25.1%) did not know if the virus is transmitted sexually (Table 2).

The data showed a good level of awareness (76.0 ±13.6%) regarding clinical features. When asked about the main clinical features, participants correctly identified, fever 3563(99.4%), sore throat 3037(84.7%), headache 3186(88.8%), chest pain 3050(85.0%), general pain 3019(84.2%), fatigue 3405(95.0%), and dry cough 3466(96.7%), whereas only 1972(55.0%) knew that diarrhea can be a symptom. Only 2221(61.9%) were aware that infected individuals may be asymptomatic (Table 2).

Prevention Methods regarding COVID-19:

The highest level of awareness was in the prevention section (88.8 ±10.2%). Washing hands with soap, avoiding crowded areas, remaining at home, and wearing a face mask outside are the principal preventative measures against COVID-19, 3574(99.7%), 3574(99.75%), 3554(99.1%), and 3204(89.3%), respectively. A minority of 158(4.4%) believed that cleaning with a mixture of Flash and bleach is a sound preventive measure. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19 (Table 2).

Statistical Analysis of the Data:

A series of one way ANOVA analyses revealed that mean knowledge differed significantly across: gender (p-value=0.009), age (p-value=0.003), social status (p-

value=0.042), education level (p-value<0.001), economic status (p-value<0.001), number of household members (p-value<0.001), place of residence (p-value<0.001), and source of information (p-value<0.001) (Table 3). Participants living in Lattakia (77.6%) exhibited the greatest awareness, whereas those in Ar-Raqqah (71.7%) followed by Deir-ez-Zor (71.8%) exhibited the lowest. The mean knowledge differed across groups that acquired information from different sources, the lowest awareness was among participants who chose family members/friends as one of their source(s) (74.0%), whereas those with the highest awareness acquired their information from lectures as one of their source(s) (78.2%), (Table 3).

When participants were asked if they were likely to share new information with friends and family, 3513(98.0%) answered "yes". There was a significant difference in mean knowledge between those who were inclined to disseminate new information about COVID-19 to friends and family (75.7%) compared with those who were not (72.3%) (p-value=0.002). On exclusive use of personal belongings, 2692(75.1%) answered "yes". We found no significant correlation between mean knowledge and participant tendency to share personal belongings with others (p-value=0.112). Of participants who knew someone infected with COVID-19, 65(1.8%) answered "yes". There was no significant difference in mean knowledge between those who knew an infected individual (75.9%) compared with those who did not (75.6%) (p-value=0.816).

Multiple linear regression:

Multiple linear regression analysis results: male gender (vs. female, β=-0.933, p=0.005); education of secondary school or lower (vs. college/university and above, β=-3.782, p<0.001); careers in government, private, business, military, and "other" sectors, as well as unemployment (vs. health care workers, β=-3.592, p<0.001); poor and moderate economic status (vs. good and excellent, β=-0.669, p<0.040); and over 5 household members (vs. of 1-5,

β=-1.737, p<0.001) were associated with significantly poorer knowledge scores (Table 4). Careers in health care (vs. Unemployed, β=3.592, p-value=<0.001), and the 31-45 age group (vs. 16-30, β=1.511, p-value=0.005) were associated with significantly higher knowledge scores.

Discussion:

We found an overall mean knowledge score of 75.6%, indicating that most participants were relatively knowledgeable about COVID-19, though less so compared to their counterparts in China (90%).[12] This level of knowledge was unexpected given that only 10 cases of COVID-19 had been confirmed in Syria at the time of the survey.[24]

Poor knowledge was associated with males, non-post-secondary education, non-healthcare occupations, unemployment, poor and moderate economic status, and households with more than 5 members; similar trends were observed in China.[12] Correlating socio-demographic variables with awareness is critical to public health efforts to mitigate the spread of COVID-19. The data obtained from this study can be leveraged by the Syrian Ministry of Health to tailor prevention and educational campaigns to populations with the widest knowledge gaps.

Our study showed a relatively high level of awareness 2535(70.7%) among the population. In the general knowledge section (mean knowledge score 67%), the majority of the participants 3383(94.3%) knew that COVID-19 is caused by a virus, similar to a Pakistani study (93.3%).[17] Low awareness of the 2-to-14 day incubation period was found[25] among dentists (36.1%) and HCW (36.4%) in similar studies.[13] [19] Syria has a relatively young population; statistical data from 2018 showed that only an estimated 4.5% of the population

was over the age of 65.[26] 3489(97.3%) knew that COVID-19 infection can be severe and potentially fatal in elderly, chronically ill, and immunodeficient patients. This is higher than in studies conducted in China (73.2%) and India (88.37%).[12 27] 40.6% of Syrians are hypertensive, yet a staggering 79.8% of them are unaware of their condition. Diabetes is also prevalent, affecting 11.9% of the population.[28 29] Such a rampant lack of awareness about chronic diseases associated with high mortality in COVID-19 patients underscores the need for targeted awareness campaigns.

At the time of the survey, no standardized evidence-based protocols had yet been developed to treat COVID-19 infections; only 2597(72.4%) participants knew that there was no available treatment at that time; this is higher than a Kenyan study (40%) but significantly lower than a Chinese study (94%).[12 15] A minority 103(2.9%) of participants thought there was a vaccine available against COVID-19, even though vaccines have only become commercially available in the past few months; by contrast, Coimbatore District and Pakistan were less informed, with (18.6%) and (11.6%) respectively believing that such a vaccine was available at the time. In the absence of a vaccine or effective treatment protocol for COVID-19 at the time of the survey, controlling the spread of the disease was the best line of defence, and remains so given the dire shortage of medication, ventilators, ICU capacity, and the continued lack of a vaccine widely available to the Syrian people. We observed a considerable knowledge gap in 1268(35.3%) with regards to ibuprofen as a treatment option. There is no available evidence to suggest that ibuprofen is effective against COVID-19.[30]

Participants showed a fair level of awareness regarding transmission pathways (70.7%), very similar to a Pakistani study (70.8%).[17] The majority 3521(98.2%) of participants were aware that respiratory droplets are common transmission vectors; this is similar to a Chinese study (97.8%), but much higher than an Indian study (29.5%).[12 16] 3330(92.9%) participants

identified handshaking as a transmission pathway, higher than a study among Jordanian dentists (85.6%).[13]

The majority of survey participants were sufficiently aware of the clinical features of COVID-19 (76.0%), similar to a Pakistani study (77.7%).[17] A very high level of awareness of the most common symptoms was found: fever 3563(99.4%), dry cough 3466(96.7%), fatigue 3405(95.0%), and myalgia 3019(84.2%), similar to findings from Chinese (96.4%) and Indian (95.4%) studies.[12 27] When asked about sore throat, a high level of awareness 3037(84.7%) was found compared to studies from India (15.2%) and among dentists in Jordan (28.5%).[13 16] Knowledge about diarrhea as a symptom was lacking: only 1972(55.0%); a study among dentists also showed low awareness (39.9%). [13 16] While infected individuals are frequently asymptomatic, or present with mild symptoms, around 1 in every 5 infections can be serious enough to require hospitalisation.[31 32] Only 2221(61.9%) participants were aware that infected individuals can be asymptomatic, while a study among dentists (34.5%) reported much lower awareness. Increasing public awareness about the variability of symptoms is particularly important since those with mild or unreported symptoms may significantly contribute to the transmission of COVID-19; the lack of health insurance, paid sick leave, telecommuting, or other social and professional safety nets increase the likelihood that these "silent spreaders" will underreport symptoms for fear of being forced to miss work.

We found a high level of awareness in the preventive methods section (88.8%), similar to a Pakistani study (85%).[17] Hand hygiene has been known to be an important element of infection control since the 14th century.[33] Implementing hand-washing techniques can break the transmission cycle and reduce the risk of infection by 6%-44%.[34] Almost all 3574(99.7%) participants were aware that washing hands with soap and water is an important preventive measure against COVID-19. This finding is in accordance with studies from Joran (97.0%), and India (96.2%, and 87%).[13 16 19]

This year the WHO recommended that the following mitigation measures be implemented during the holy month of Ramadan: cancelling social and religious gatherings, holding events outdoors for adequate ventilation, physical distancing of at least 1 meter between people, and the use of technology to broadcast ceremonies on television.[35 36] The majority 3574(99.7%) identified avoiding mass gatherings as a preventive measure; studies in China (98.6%) and Coimbatore District (97.7%) reported similar awareness.[12 27] Cheap and efficient interventions such as N95 (filtration capacity=95%) have a 91% effectiveness of blocking pathogen transmission.[37] 3204(89.3%) participants considered wearing a face mask when leaving home as an effective prevention method, compared with a Coimbatore District study (93.02%).[27]

Since Syrian society is particularly vulnerable to COVID-19, this knowledge gap is potentially dangerous and should be addressed to mitigate disease spread. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19; this is similar to a Coimbatore District study (67.4%), but lower than a study amongst HCWs (90.7%).[19 27] 3305(92.2%) were aware that individuals showing symptoms should quarantine themselves, lower than in China (98.2%) and India (95.8%).[12 16]

North-East Syria (NES) has a population of over 4 million people, 600,000 of whom are internally displaced refugees, 100,000 of whom live in overcrowded camps: only 2 of NES's 11 hospitals are currently functioning. NES consists of 3 governorates: Ar-Raqqah, Deir-ez-Zor, and Al-Hasakah. With only 22 ICU beds, (18 in Al-Hasakah, 4 in Ar-Raqqah, and none in Deir-ez-Zor), the maximum capacity threshold is only 80 COVID-19 cases. Ar-Raqqa and Deir-ez-Zor, the most vulnerable governorates, also showed the lowest awareness in the study (71.7%), and (71.8%). This is a potentially catastrophic situation, and a concern to the international community, as an unmonitored, uncontrolled outbreak in NES can prolong the global pandemic.

Since storming the international stage two years ago, COVID-19 caught the whole world off guard; ambiguity and uncertainly have been and continue to be defining features of this pandemic. Despite the emergence of effective vaccines and treatment protocols, timely global availability is a continuing challenge. We have yet to achieve a critical mass of vaccinations and herd immunity, as evidenced by the emergence of wave after wave of infection in both developed and developing countries.

Further research is necessary to study transmission through sexual contact (body fluids other than respiratory droplets) and undercooked food. Numerous cases of animal infection, including house pets, apes, and even tigers, highlight the need for extensive studies into horizontal transmission.[38 39] Long-term studies into permanent immunity, and fetal abnormalities as a result of maternal infection are also necessary.

Limitations:

Our findings can only be generalized about online users of well-educated Syrians of good socio-economic status. Syrians vulnerable to COVID-19, such as the elderly and rural residents, are more likely to exhibit poor knowledge and awareness due to limited internet access. As such, reaching out to these populations must be prioritized. Even though all Syrian governorates were represented in this study, most participants lived in Damascus and Rural Damascus. Credible published national data regarding the socio-demographic characteristics of Syrians are not available to evaluate the representativeness of our sample. Furthermore, an assessment of the Syrian population's practices relating to COVID-19 and the attitudes driving them is necessary to complete the picture.

Conclusion:

COVID-19 has been a dire warning to humanity about the fragility of its social, economic, and healthcare institutions. Our study revealed good public awareness of clinical features and preventive measures. However general knowledge and knowledge about transmission pathways was suboptimal. Syrians of good socio-economic status, in particular young well-educated women, have shown good knowledge. Our national response must adapt to the growing threat of COVID-19 by adopting public awareness strategies and behaviours to contain the disease both within and beyond our borders.

Abbreviations: COVID-19: Coronavirus Disease 2019; MERS: Middle East Respiratory Syndrome; SARS: Severe Acute Respiratory Syndrome; WHO: World Health Organization; PHEIC: Public Health Emergency of International Concern; ICU: Intensive care unit; IRB: Institutional Review Board; SPSS: Statistical Package for Social Sciences; SD: Standard Deviation; HCW: Health Care Worker.

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Availability of data and materials:

All data related to this paper's conclusion are available and stored by the authors. All data are available from the corresponding author on a reasonable request.

Declarations:

Ethics approval and consent to participate:

This study was approved by the Institutional Review Board (IRB) at the Syrian Private University (SPU). All Participants confirmed their written consent by answering a yes-no question. Participants under the age of 18 required verbal informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain verbal consent before the child was given access to the survey. The verbal and written form of consent was approved by the IRB at SPU. Participation in the study was voluntary and participants were assured that anyone who was not inclined to participate or decided to withdraw after giving consent would not be victimized. All information collected from this study was kept strictly confidential.

Consent for Publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

Authors' contributions:

FM conceptualized the study, participated in the design, wrote the study protocol, performed the statistical analysis, did a literature search, and drafted the manuscript. BB participated in study design, did a literature search, and drafted the manuscript. HA, and NA did a literature search and revision of the draft. All authors read and approved the final draft.

Tables and Figures:

Table 1.

Table 1. Socio-demographic characteristics: (n=3586)

Gender (%)	**Male**	**1142(31.8)**	**Education (%)**	**Primary School**	**25(0.7)**
	Female	**2444(68.2)**		**Intermediate School**	**166(4.6)**
Age (%)	**<20**	**1204(33.6)**		**Secondary school**	**375(10.4)**
	20-24	**1104(30.8)**		**College/University**	**2839(79.2)**
	25-29	**446(12.4)**		**Master's degree**	**157(4.4)**
	30-34	**266(7.4)**		**PhD**	**24(0.7)**
	35-39	**186(5.2)**	**Occupation (%)**	**Health care worker**	**634(17.7)**
	>39	**380(10.6)**		**Government institution**	**283(7.9)**
Social	**Single**	**2279(63.5)**		**Private institution**	**182(5.1)**

Status (%)	**In a relationship**	**286(8.0)**		**Business**	**198(5.5)**
	Married	**943(26.3)**		**Military**	**32(0.9)**
	Divorced	**46(1.3)**		**Unemployed**	**1822(50.8)**
	Widowed	**32(0.9)**		**Other**	**435(12.1)**
Economic Status (%)	**[1]Poor**	**247(6.9)**	**Household members (%)**	**0**	**46(1.3)**
	[2]Moderate	**1247(34.8)**		**1-5**	**2751(76.7)**
	[3]Good	**1761(49.1)**		**>5**	**789(22)**
	[4]Excellent	**331(9.2)**			

[1]Poor: income does not provide essential needs for the family. [2]Moderate: income provides essential needs for the family but no more. [3]Good: income provides essential needs and some luxury requirements. [4]Excellent: income provides luxury requirements.

Table 2.

Table 2. General Knowledge, Transmission, Signs and Symptoms, and Prevention of COVID-19: (n=3586)

General Knowledge					
Causative Agent N(%)	Virus	3383(94.3)	**Incubation period N(%)**	1 Minute to 1 Hour	18(0.5)
	Bacteria	39(1.1)		1 Hour to 2 Days	58(1.6)
	Parasite	8(0.2)		2 Days to 2 Weeks	2535(70.7)
	Immune deficiency	46(1.3)			
	Fungus	0(0.0)		2 Weeks to 1 Month	958(26.7)
	Inherited	2(0.1)			
	Do Not Know	108(3.0)		>1 Month	17(0.5)

	YES(%)	**NO(%)**	**DO NOT KNOW(%)**
Can infection with COVID-19 confer permanent immunity?	815(22.7)	1500(41.8)	1271(35.5)
Can COVID-19 cause severe illness and lead to death in elderly, chronically ill, and immunodeficient patients?	3489(97.3)	28(0.8)	69(1.9)
Can COVID-19 cause infertility?	461(12.9)	1222(34.1)	1903(53.0)

Is COVID-19 teratogenic (i.e. cause malformations/ abnormalities to an embryo/fetus)?	157(4.4)	1433(40.0)	1996(55.6)
Is there no available treatment against COVID-19?	2597(72.4)	515(14.4)	474(13.2)
Can COVID-19 be treated with antibiotics?	1228(34.3)	1790(49.9)	568(15.8)
Can COVID-19 be treated with Ibuprofen?	1268(35.3)	1921(53.6)	397(11.1)
Are there available COVID-19 vaccines?	103(2.9)	2986(83.3)	497(13.8)
Transmission Pathways			
Respiratory droplets (from coughing or sneezing)	3521(98.2)	21(0.6)	44(1.2)
Handshaking	3330(92.9)	189(5.3)	67(1.8)
Touching an infected person's personal belongings	3387(94.4)	131(3.7)	68(1.9)
Animals-to-human	910(25.4)	1973(55.0)	703(19.6)
Undercooked food	1301(36.3)	1734(48.3)	551(15.4)
Sexual contact	1210(33.7)	1477(41.2)	899(25.1)
Horizontal transmission	1130(31.5)	1160(32.4)	1296(36.1)

Signs and Symptoms			
Fever	3563(99.4)	9(0.2)	14(0.4)
Sneezing	2353(65.6)	1000(27.9)	233(6.5)
Sore throat	3037(84.7)	358(10.0)	191(5.3)
Headache	3186(88.8)	190(5.3)	210(5.9)
Chest pain	3050(85.0)	254(7.1)	282(7.9)
Body aches (generalized pain)	3019(84.2)	260(7.2)	307(8.6)
Fatigue	3405(95.0)	72(2.0)	109(3.0)
Diarrhea	1972(55.0)	971(27.1)	643(17.9)
Dry cough	3466(96.7)	44(1.2)	76(2.1)
Productive cough	458(12.8)	2586(72.1)	542(15.1)
Bleeding	130(3.6)	2613(72.9)	843(23.5)
Asymptomatic	2221(61.9)	375(10.5)	990(27.6)
Prevention Methods			
Does wearing a face mask outside the home offer protection from COVID-19?	3204(89.3)	314(8.8)	68(1.9)
Does washing hands with soap and water offer protection from COVID-19?	3574(99.7)	5(0.1)	7(0.2)

Does avoiding crowded places offer protection from COVID-19?	3574(99.7)	4(0.1)	8(0.2)
Does the flu vaccine offer protection from COVID-19?	331(9.2)	2482(69.2)	773(21.6)
Does staying at home offer protection from COVID-19?	3554(99.1)	15(0.4)	17(0.5)
Does using hand sanitizer offer protection from COVID-19?	3430(95.6)	104(2.9)	52(1.5)
Does cleaning household surfaces with bleach offer protection from COVID-19?	3408(95.0)	110(3.1)	68(1.9)
Does cleaning fruits and vegetables with soap and water offer protection from COVID-19?	3262(90.9)	221(6.2)	103(2.9)
Does cleaning surfaces with a mixture of Flash and bleach offer a safe protection from COVID-19?	158(4.4)	3301(92.1)	127(3.5)
Does the quarantine of symptomatic individuals protect others from COVID-19?	3305(92.2)	241(6.7)	40(1.1)
Do cumin, anise, and mint offer protection from COVID-19?	1041(29.0)	1934(53.9)	611(17.1)

409 **Table 3.**

Table 3. Mean knowledge score of participants by demographic variables, and source of information (one way ANOVA), (n= 3586)

Characteristics		Number of participants (%)	Mean Knowledge Score (±SD%)	F-test/ T-test	P-value
Gender	Male	1142(31.8)	75.0(±10.1)	-2.625	0.009*
	Female	2444(68.2)	75.9(±9)		
Age-group (years)	**<20**	1204(33.6)	75.0(±9.9)	2.990	0.011*
	20-24	1104(30.8)	76.4(±9.3)		
	25-29	446(12.4)	76.0(±9.4)		
	30-34	266(7.4)	75.4(±9.4)		
	35-39	186(5.2)	76.1(±7.6)		

	>39	380(10.6)	75.1(±8.6)		
Social status	Single	2279(63.5)	75.8(±9.3)	2.485	0.042*
	In a relationship	286(8.0)	76.6(±8.6)		
	Married	943(26.3)	75.1(±9.4)		
	Divorced	46(1.3)	73.9(±8.8)		
	Widowed	32(0.9)	73.4(±15.9)		
Residence	Urban	2426(67.7)	75.8(±9.3)	1.652	0.099
	Rural	1160(32.3)	75.3(±9.6)		
Education	Primary school	25(0.7)	66.5(±12.4)	26.176	<0.001*
	Intermediate school	166(4.6)	73.2(±9.3)		
	Secondary school	375(10.4)	70.0(±13)		

	College/University	2839(79.2)	76.3(±8.9)		
	Master's degree	157(4.4)	77.2(±9.7)		
	PhD	24(0.7)	76.6(±8.5)		
Occupation	Health care worker	634(17.7)	78.6(±8.6)	16.379	<0.001*
	Government institution	283(7.9)	75.7(±7.9)		
	Private institution	182(5.1)	75.5(±9)		
	Business	198(5.5)	73.4(±10.2)		

	Military	32(0.9)	71.2(±15.6)		
	Unemployed	1822(50.8)	75.3(±9.2)		
	Other	435(12.1)	74.0(±10.2)		
Economic status	Excellent	331(9.2)	76.6(±11.1)	7.108	<0.001*
	Good	1761(49.1)	76.2(±9.4)		
	Moderate	1247(34.8)	74.9(±9)		
	Poor	247(6.9)	74.3(±9.3)		
Household members	0	46(1.3)	74.4(±10.6)	15.451	<0.001*
	1-5	2751(76.7)	76.1(±9)		
	>5	789(22.0)	74.0(±10.2)		

Source of information	Health websites	2823(78.7%)	76.4(±8.7)	24.523	<0.001*
	Social media	1998(55.7%)	74.6(±9.6)		
	Television/ radio	1572(43.8%)	75.5(±9)		
	Family members/ friends	528(14.7%)	74.0(±10.3)		
	Lectures	517(14.4%)	78.2(±7.5)		
	Magazines/ books	266(7.4%)	77.6(±8.8)		

Table 4.

Table 4. Multiple linear regression on variables associated with poor COVID-19 knowledge

Variable	Coefficient	Standard error	t	P
Male gender (reference: female)	-0.933	0.334	-2.794	0.005*

education of secondary school or lower (reference: college/university and above)	-3.782	0.466	-8.125	<0.001*
careers in government, private, business, military, and "other" sectors, as well as unemployment (reference: health care workers)	-3.592	0.474	-7.579	<0.001*
poor and moderate economic status (reference: good and excellent)	-0.669	0.325	-2.057	0.040*
>5 household members (reference: of 1-5)	-1.737	0.374	-4.648	<0.001*

Figures and tables legends:

Table 1. Sociodemographic characteristics

Table 2. General Knowledge, Transmission, Signs and Symptoms, and Prevention around COVID-19

Table 3. Mean knowledge score of participants by demographic variables

Table 4. Multiple linear regression on variables associated with poor COVID-19 knowledge

Figure 1. Distribution of participants according to governorates and education level

References:

1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet* 2020;395(10223):497-506. doi: 10.1016/s0140-6736(20)30183-5
2. Viner RM, Ward JL, Hudson LD, et al. Systematic review of reviews of symptoms and signs of COVID-19 in children and adolescents. 2020
3. Rahman HS, Aziz MS, Hussein RH, et al. The transmission modes and sources of COVID-19: A systematic review. 2020
4. McKernan B. Syria confirms first Covid-19 case amid fears of catastrophic spread. *The Guardian* 2020
5. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 106. 2020
6. Gharibah M, Mehchy Z. COVID-19 pandemic: Syria's response and healthcare capacity. 2020
7. Ajilore K, Atakiti I, Onyenankeya K. College students' knowledge, attitudes and adherence to public service announcements on Ebola in Nigeria: Suggestions for improving future Ebola prevention education programmes. *Health Education Journal* 2017;76(6):648-60.
8. Tachfouti N, Slama K, Berraho M, et al. The impact of knowledge and attitudes on adherence to tuberculosis treatment: a case-control study in a Moroccan region. *Pan African Medical Journal* 2012;12(1)
9. McNatt Z, Boothby NG, Al-Shannaq H, et al. Impact of Separation on Refugee Families: Syrian Refugees in Jordan. 2018
10. Syria anniversary press release. *United Nations Office for the Coordination of Humanitarian Affairs (OCHA)* 2020
11. UNICEF Syria Crisis Situation Report 2019
12. Zhong B-L, Luo W, Li H-M, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *International Journal of Biological Sciences* 2020;16(10):1745.
13. Khader Y, Al Nsour M, Al-Batayneh OB, et al. Dentists' Awareness, Perception, and Attitude Regarding COVID-19 and Infection Control: Cross-Sectional Study Among Jordanian Dentists. *JMIR Public Health and Surveillance* 2020;6(2):e18798.
14. Qarawi A, Ng SJ, Gad A, et al. Awareness and Preparedness of Hospital Staff against Novel Coronavirus (COVID-2019): A Global Survey - Study Protocol. *SSRN Electronic Journal* 2020 doi: 10.2139/ssrn.3550294
15. Austrian K, Pinchoff J, Tidwell JB, et al. COVID-19 related knowledge, attitudes, practices and needs of households in informal settlements in Nairobi, Kenya. 2020
16. Roy D, Tripathy S, Kar SK, et al. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian Journal of Psychiatry* 2020:102083.
17. Hussain T, Khan S, Gilani U, et al. Evaluation of General Awareness Among Professionals Regarding COVID-19: A Survey Based Study from Pakistan. 2020
18. Zhou M, Tang F, Wang Y, et al. Knowledge, attitude and practice regarding COVID-19 among health care workers in Henan, China. *Journal of Hospital Infection* 2020
19. Bhagavathula AS, Aldhaleei WA, Rahmani J, et al. Novel Coronavirus (COVID-19) Knowledge and Perceptions: A Survey on Healthcare workers. *medRxiv* 2020
20. Organization WH. Introduction to COVID-19: methods for detection, prevention, response and control. 2020
21. Organization WH. Q&As on COVID-19 and related health topics.
22. Organization WH. Water, sanitation, hygiene and waste management for COVID-19: technical brief, 03 March 2020: World Health Organization, 2020.
23. Organization WH. Key planning recommendations for mass gatherings in the context of COVID-19: interim guidance, 19 March 2020: World Health Organization, 2020.

24. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 71. 2020
25. Backer J, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. *Eurosurveillance* 2020;25 doi: 10.2807/1560-7917.ES.2020.25.5.2000062
26. Plecher H. Age structure in Syria 2018. *Statista* 2020
27. Vadivu TS, Annamuthu P. An Awareness and Perception of COVID-19 among General Public–A Cross Sectional Analysis. 2014
28. Organization WH. Web World Health Organization–Diabetes country profiles: Diakses, 2016.
29. Tailakh A, Evangelista LS, Mentes JC, et al. Hypertension prevalence, awareness, and control in A rab countries: A systematic review. *Nursing & health sciences* 2014;16(1):126-30.
30. The use of non-steroidal anti-inflammatory drugs (NSAIDs) in patients with COVID-19. *World Health Organization* 2020
31. Surveillances V. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)—China, 2020. *China CDC Weekly* 2020;2(8):113-22.
32. Organization WH. Getting your workplace ready for COVID-19: How COVID-19 spreads, 19 March 2020: World Health Organization, 2020.
33. Best M, Neuhauser D. Ignaz Semmelweis and the birth of infection control. *Quality & safety in health care* 2004;13:233-4. doi: 10.1136/qhc.13.3.233
34. Rabie T, Curtis V. Handwashing and Risk of Respiratory Infections: A Quantitative Systematic Review. *Tropical medicine & international health : TM & IH* 2006;11:258-67. doi: 10.1111/j.1365-3156.2006.01568.x
35. Practical considerations and recommendations for religious leaders and faith-based communities in the context of COVID-19. *World Health Organization* 2020
36. Safe Ramadan practices in the context of the COVID-19 *World Health Organization* 2020
37. Jefferson T, Foxlee R, Del Mar C, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses: systematic review. *Bmj* 2008;336(7635):77-80.
38. COVID-19 and Animals. *Centers for Disease Control and Prevention* 2021
39. Daly N. First great apes at U.S. zoo receive COVID-19 vaccine made for animals. *National Geographic* 2021

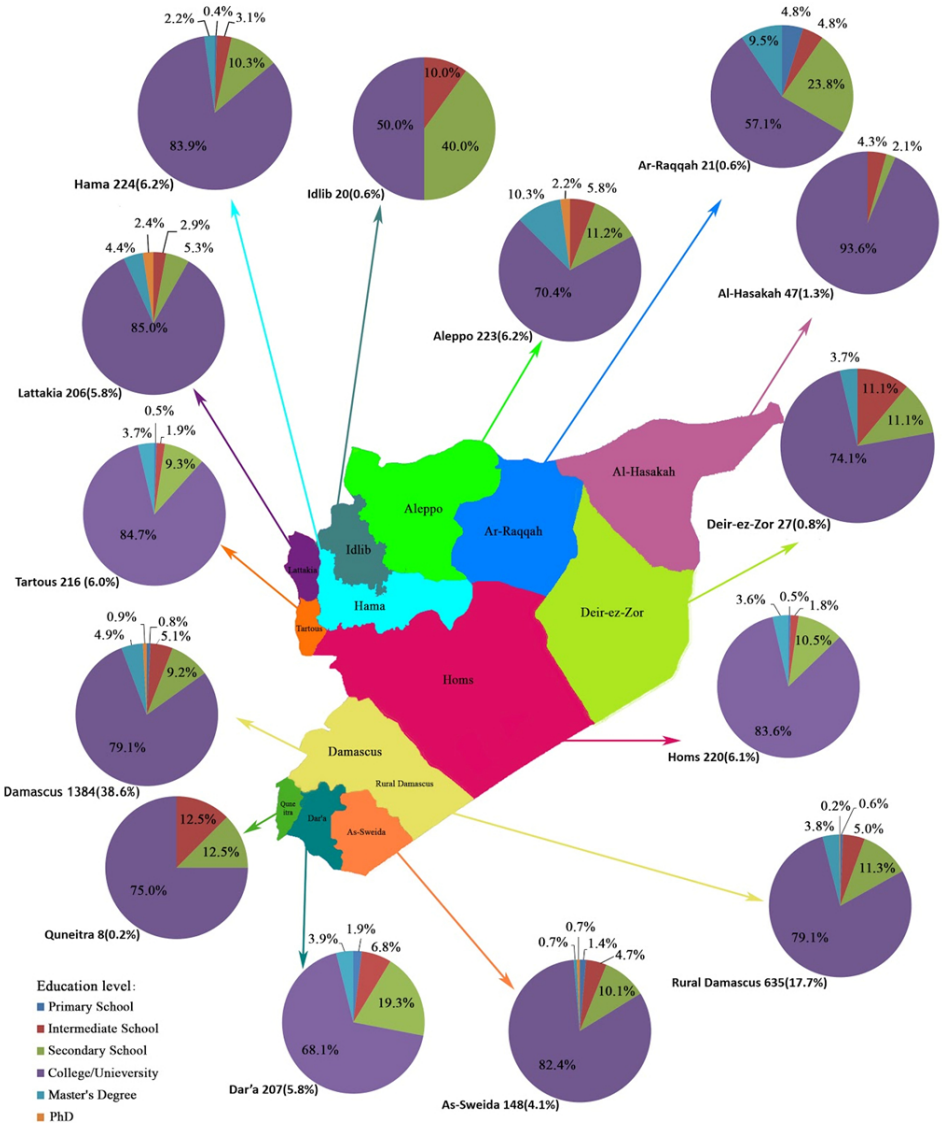

Figure 1. Distribution of participants according to governorates and education level

Attached Survey:

Appendix 1

Socio-demographic Characteristics	
Age (years): ☐ Below 15 ☐ 15-20 ☐ 20-30 ☐ 30-50 ☐ 40-50 ☐ 50-60 ☐ 60-70 ☐ Above 70	**Gender:** ☐ Male ☐ Female
Marital status: ☐ Single ☐ Relationship ☐ Married ☐ Divorced ☐ Widowed	**Educational level:** ☐ Primary school ☐ Intermediate school ☐ Secondary school ☐ University/College ☐ Master's Degree ☐ PHD Degree
Occupation: ☐ Health care worker ☐ Government institution ☐ Private institution ☐ Business ☐ Military ☐ Unemployed ☐ Other	**Residence:** ☐ Damascus/Rural Damascus ☐ Hama ☐ Aleppo ☐ Homs ☐ Tartous ☐ Lattakia ☐ Dara'a ☐ As-Sweida ☐ Al Hasakah ☐ Deir-ez-Zor ☐ Idlib ☐ Ar-Raqqah ☐ Quneitra
Area: ☐ Rural ☐ Urban	**Economic Status:** ☐ Excellent ☐ Good ☐ Moderate ☐ Poor
Do you smoke? ☐ Yes ☐ No	**Do you drink alcohol?** ☐ Yes ☐ No
How many people do you live with? ☐ Alone ☐ 1-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ Above 20	
Do you share toiletries/personal care products with others? ☐ Yes ☐ No	
Do you know anyone infected with COVID-19? ☐ Yes ☐ No	

Table 2. General Knowledge about COVID-19

What is COVID-19? ☑ Virus ☐ Bacteria ☐ Parasite ☐ Fungus ☐ Immunodeficiency ☐ Inherited ☐ Do not know	**Do you know how long after being infected with COVID-19 can a person suffer from signs and symptoms?** ☐ 1 Minute to 1 Hour ☐ 1 Hour to 2 Days ☑ 2 Days to 2 weeks ☐ 2 Weeks to 1Month ☐ Over a 1 month
Can an infection with COVID-19 confer permanent immunity (once infected with COVID-19 you cannot contract another infection)? ☐ Yes ☑ No ☐ Do not know	
Can COVID-19 cause severe illness and lead to death in elderly, chronically ill (hypertension, diabetes, asthma . . .), and those who have compromised immune systems? ☑ Yes ☐ No ☐ Do not know	
Can COVID-19 cause infertility? ☐ Yes ☐ No ☑ Do not know	
Is COVID-19 teratogenic (i.e. cause malformations/abnormalities to an embryo/fetus)? ☐ Yes ☑ No ☐ Do not know	

Treatment for COVID-19

	Yes	No	Do Not Know
No treatment available	✓		
Antibiotics		✓	
Ibuprofen		✓	

Is there an available vaccine for COVID-19?
☐ Yes ☑ No ☐ Do not know

Table 3. Transmission Pathways

	Yes	No	Do Not Know
Can COVID-19 be transmitted via respiratory droplets (coughing or sneezing) of infected individuals?	✓		
Can COVID-19 be transmitted after shaking-hands with an infected individual?	✓		

Can COVID-19 be transmitted after touching an infected individual's personal belongings?	✓		
Can COVID-19 be transmitted from animals to humans?			✓
Can COVID-19 be transmitted via undercooked food?			✓
Can COVID-19 be transmitted via sexual contact?			✓
Can COVID-19 be transmitted via vertical transmission (mother to fetus)?	✓		

Table 4. Signs and Symptoms of COVID-19

	True	False	Do Not Know
Is fever/temperature among the signs and symptoms of COVID-19?	✓		
Is sneezing among the signs and symptoms of COVID-19?	✓		
Is sore throat among the signs and symptoms of COVID-19?	✓		
Is headache among the signs and symptoms of COVID-19?	✓		
Is Chest pain among the signs and symptoms of COVID-19?	✓		
Is body aches (generalized pain) among the signs and symptoms of COVID-19?	✓		
Is fatigue among the signs and symptoms of COVID-19?	✓		
Is diarrhea among the signs and symptoms of COVID-19?	✓		
Is a runny nose among the signs and symptoms of COVID-19?	✓		
Is dry cough among the signs and symptoms of COVID-19?	✓		
Is productive cough among the signs and symptoms of COVID-19?	✓		
Is bleeding among the signs and symptoms of COVID-19?		✓	
Can a person be infected with COVID-19 and have no signs and symptoms?	✓		

Table 5. Prevention Methods			
	True	**False**	**Do Not Know**
Does wearing a face mask outside the home offer protection from COVID -19?	✓		
Does washing hands with soap and water offer protection from COVID-19?	✓		
Does avoiding crowded places offer protection from COVID -19?	✓		
Does the flu vaccine offer protection from COVID -19?		✓	
Does staying at home offer protection from COVID -19?	✓		
Does using hand sanitizer offer protection from COVID -19?	✓		
Does using bleach to clean household surfaces prevent COVID-19 infection?	✓		
Does cleaning fruits and vegetables with soap and water offer protection from COVID-19?	✓		
Does cleaning surfaces with a mixture of Flash and bleach offer protection from COVID -19?		✓	
Does the quarantine of symptomatic individuals protect others from COVID -19?	✓		
Do cumin, anise, and mint offer protection from COVID -19?		✓	

What is your main source of information about COVID-19? (You may choose more than one option)

☐ Internet (social media platforms)
☐ Internet (Official websites like world health organization)
☐ TV/Radio
☐ Friends/Member of family
☐ Magazines/Books
☐ Lectures

If you had new information about COVID-19 would you share it with friends and family to raise awareness?

☐ Yes ☐ No

12

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2,3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6,7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Not applicable
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	Not applicable (no missing data)
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up	8

	was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
€	Describe any sensitivity analyses	-

Continued on next page

Results			**Page No.**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		© *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	-
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	-
		Cross-sectional study—Report numbers of outcome events or summary measures	29-35
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	34,35
		(*b*) Report category boundaries when continuous variables were categorized	29-33
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A Crisis Within a Crisis: COVID-19 Knowledge and Awareness among the Syrian Population - a cross-sectional study

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A Crisis Within a Crisis: COVID-19 Knowledge and Awareness among the Syrian Population - a cross-sectional study

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Abstract:

Objectives: To gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic.

Design: Web-based cross-sectional survey.

Setting: This study was conducted in March 2020, nearly 10 years into the Syrian war crisis. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram, Instagram, and Facebook targeting various social groups.

Participants: A total of 4495 participants completed the survey. Participants with a history of COVID-19 infection, residing outside Syria, or who did not fully complete the survey were excluded from the study. The final sample of 3586 participants (completion rate=79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males.

Primary and secondary outcome measures: The first, knowledge of COVID-19 in 4 areas (1. general knowledge 2. transmission pathways 3. signs and symptoms 4. prevention methods). The second, factors associated with poor knowledge.

Results: Of the 3586 participants, 2444(68.2%) were female, 1822(50.8%) were unemployed, and 2839(79.2%) were college-educated. The study revealed good awareness regarding COVID-19 (mean 75.6%, SD±9.4%). Multiple linear regression analysis correlated poor mean knowledge scores with male gender (β=-0.933, p=0.005), secondary school or lower education level (β=-3.782, p<0.001), non-healthcare occupation (β=-3.592, p<0.001), low economic status (β=-0.669, p<0.040), and >5 household members (β=-1.737, p<0.001).

Conclusion: This study revealed some potentially troubling knowledge gaps which underscore the need for a vigorous public education campaign in Syria. This campaign must reinforce the public's awareness, knowledge, and vigilance towards precautionary measures against COVID-19, and most importantly aid in controlling the worldwide spread of the disease.

Strengths and limitations of this study:

. Data are derived from a large, national survey across Syria, during the lockdown period.

. The survey covered socio-demographic information, general knowledge, transmission, symptoms, and prevention.

. Results have broad implications for public health programming and response to COVID-19 in Syria.

. This web-based cross-sectional study cannot be generalized towards the Syrian population.

Keywords: Awareness; Knowledge; COVID-19; Pandemic; Syria; War; Population.

Background:

Coronavirus disease 2019 (COVID-19) is a highly infectious respiratory disease that evolved into a worldwide pandemic, threatening a prolonged economic recession. The first incidence was reported at a local seafood market in Wuhan, China.[1] The virus continues to spread, with steadily increasing morbidity and mortality cases, hitting the poorest and most vulnerable in the world. Many studies have assessed symptomatic clusters, transmission pathways, and prevention methods; however, many aspects have yet to be studied.[2 3] Sexual

transmissions, horizontal transmission, animal to human transmission, permanent immunity, and fetal abnormalities as a result of maternal infection are as yet unproven.

The battle against COVID-19 in Syria has just entered its third wave.[4 5] The first confirmed case was announced on 22 March 2020,[6] and there had only been 44 cases and 3 deaths at the time of the study. These figures are significantly lower than neighbouring countries such as Turkey (127,659 cases and 3,461 deaths), Iran (98,647 and 6,277), Iraq (2,346 and 98), Lebanon (740 and 25), and Jordan (465 and 9).[7] The Syrian healthcare system is severely under-equipped and lacks the capacity to contain such a crisis. The estimated number of intensive care unit (ICU) beds with ventilators is a mere 325, and the theoretical maximum number of cases that can be adequately treated is only 6,500.[8] Once this maximum threshold (capacity) is exceeded, drastic rationing decisions will have to be made. Therefore, cooperation with and response to guidance from the WHO are of utmost importance. Unprecedented measures have been adopted to control the spread of COVID-19 in Syria.[8] The public's adherence to these control measures is largely affected by their awareness, knowledge, and attitudes towards disease and outbreaks.[9 10]

The Syrian conflict, now in its 10th year, has resulted in the worst refugee crisis since World War II.[11] The devastating impact of war has placed the public health system under constant strain; the numbers of casualties continue to rise, 70% of health care workers (HCW) have fled the country, the annihilation of healthcare facilities, and the "weaponization" of healthcare are ongoing challenges.[8 12] These challenges along with dense residential areas, the growing prevalence of chronic illness, and 83% of the population living below the poverty line make Syria highly vulnerable to a severe outbreak.[8 13]

While some studies have been conducted to assess the knowledge, attitude, and practices among populations during this pandemic, including one done in China, none have been undertaken in Syria.[14-21] To our knowledge this first study which aims to measure the

awareness and general knowledge of COVID-19 among the Syrian population at a time where ambiguity and misinformation are rampant. The objective of this study is to gauge specific knowledge around clinical features, transmission pathways, and prevention methods, and to identify factors associated with poor knowledge to help facilitate outbreak management in Syria during this rapid global rise of the COVID-19 pandemic. The information gleaned from this research will help with public health programming and response to COVID-19 in Syria as the pandemic continues to unfold.

Methods:

Study design, setting, and participants:

This web-based cross-sectional survey was conducted between March 31st and April 4th of 2020, during the lockdown period. Ethical approval was obtained from the Institutional Review Board (IRB) of the Faculty of Medicine, Syrian Private University. The inclusion criteria for this study were participants residing in Syria who completed the survey and had no known history of COVID-19 infection. The authors designed questions were modelled after existing awareness surveys, WHO course materials, technical briefs, and question and answer bank on COVID-19 related topics.[14 15 22-25] Questions from existing awareness surveys that did not target community awareness regarding COVID-19 were excluded from the study. [14 15] The survey was translated into Arabic and was reviewed by two dialectologists and two infectious disease specialists, who evaluated whether the survey questions effectively assessed COVID-19 knowledge, and checked for double-barrelled and confusing questions, to ascertain validity. We conducted a pilot study on 20 volunteers to assess reliability, clarity, relevance, and the acceptability of the survey. These volunteers were excluded from the final sample to avoid bias. Modifications were made based on feedback received to facilitate better comprehension

before distributing the final survey to the general population. The Arabic-language survey was posted on various social media platforms including WhatsApp, Telegram, Instagram, and Facebook targeting various social groups. To avoid non-response bias the survey was distributed during lockdown where the majority of the population were out of work and at home. GIFs and posts were adapted to appeal to each social group; the questions were made short and in the form of multiple choice questions that required no typing. The ability for viewers to comment on the link increased the popularity of the survey. Participants confirmed their voluntary participation by answering a yes-no question, were informed of the option to opt-out of the survey at any time, and were assured of the confidentiality and anonymity of their responses. After confirmation, participants were directed to the first part of the survey to complete questions about socio-demographic information including; age, gender, residence, education level, occupation, and economic status. Participants under the age of 18 required informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain consent before the child was given access to the survey. The sample size calculated was 2401 participants based on a margin of error of 2%, and a confidence interval of 95%, for a population of 18,284,423 people using a sample size calculator (website: https://www.surveysystem.com/sscalc.htm). The self-administered survey contained 40 questions divided into 4 sections: general knowledge (10 questions), transmission pathways (7 questions), clinical features (12 questions), and prevention methods (11 questions). The survey is available in appendix 1.

Patient and public involvement:

The public were not involved in the study design, conduct of the study, or plans to disseminate the results to study participants.

Statistical analysis

A scoring system was used to analyse the participants' knowledge: a score of "1" was given for a correct answer and a score of "0" was given for an incorrect answer. The correct answers to the survey were determined from previous surveys and available WHO resources.[14 15 22-25] The percentage score for mean knowledge was calculated as follows: sum of scores obtained/maximum scores that could be obtained × 100. Participants' total mean knowledge in all the subsections, and mean knowledge of each subsection were calculated. Data were analysed using the Statistical Package for Social Sciences version 25.0 (SPSS Inc., Chicago, IL, United States) and reported as frequencies and percentages (for categorical variables) or means and standard deviations (SD) (for continuous variables). The t-test was applied to compare mean knowledge scores against both genders, and 3 questions (knowing an infected individual, use of personal belongings, and dissemination of knowledge). The t-test was applied to compare mean knowledge scores against gender. One-way analysis of variance (ANOVA) was applied using f-test to compare mean knowledge scores against socio-demographic variables (age, social status, residence, education level, occupation, economic status, and number of household members), and source of information. Multivariable linear regression analysis using the socio-demographic variables as independent variables (categorical) and mean knowledge score as the outcome variable (continuous) was conducted to identify factors associated with knowledge. Factors were selected with a backward method and were analysed using the unstandardized coefficient (β), and 95% confidence interval. P-values<0.05 were considered statistically significant.

Results:

Socio-demographics characteristics:

Of 4495 total participants who completed the survey, participants with a known history of COVID-19 infection, residing outside Syria, and who did not fully complete the survey were excluded. The final sample of 3586 participants (completion rate= 79.8%) consisted of 2444(68.2%) females and 1142(31.8%) males. Participants aged >20 years were the majority 1204(33.6%) while participants between 35 and 39 were the minority 186(5.2%). Participant ages ranged from 12-78 years with a mean of 30 (±10) years). 2279(63.6%) participants were single, 1822(50.8%) were unemployed, 1064(29.7%) were smokers, and 428(11.9%) were alcohol consumers (Table 1). The majority of participants were residents of Damascus/ Rural Damascus 2019(56.3%) and had attained college/university level education (Figure1).

General Knowledge regarding COVID-19:

Participants showed a good level of awareness regarding COVID-19 (75.6 ±9.4%). An adequate level of basic knowledge (67.0 ±18.9%) was found among participants, 3383(94.3%) knew that a virus was the causative agent of COVID-19; 2535(70.7%) correctly identified the incubation period as being between 2 days and 2 weeks. Only 1500(41.8%) believed that an infection with COVID-19 does not confer lifelong immunity. The majority of participants 3489(97.3%) were aware that COVID-19 infection in high-risk groups can be fatal. There is currently insufficient evidence on whether infertility is a complication of COVID-19 infection; 461(12.9%) participants believed that COVID-19 can cause infertility while 1903(53.0%) did not. 2986(83.3%), and 2597(72.4%) correctly answered that there are currently no available vaccine or treatments respectively; however, there were misconceptions about the efficacy of antibiotics and Ibuprofen as treatments, 1228(34.2%) and 1268(35.3%) respectively (Table 2).

Transmission, and Signs and Symptoms regarding COVID-19:

There was a fair level of awareness (70.7 ±16.9%) regarding COVID-19 transmission pathways. A high level of awareness was demonstrated regarding common transmission pathways: 3521(98.2%), 3387(94.4%), and 3330(92.9%) identified respiratory droplets, touching an infected person's personal belongings, and handshaking respectively. There is currently limited evidence of animal-to-human and sexual transmission; 703(19.6%) did not know if transmission occurs between animals and humans, while 899(25.1%) did not know if the virus is transmitted sexually (Table 2).

The data showed a good level of awareness (76.0 ±13.6%) regarding clinical features. When asked about the main clinical features, participants correctly identified, fever 3563(99.4%), sore throat 3037(84.7%), headache 3186(88.8%), chest pain 3050(85.0%), general pain 3019(84.2%), fatigue 3405(95.0%), and dry cough 3466(96.7%), whereas only 1972(55.0%) knew that diarrhea can be a symptom. Only 2221(61.9%) were aware that infected individuals may be asymptomatic (Table 2).

Prevention Methods regarding COVID-19:

The highest level of awareness was in the prevention section (88.8 ±10.2%). Washing hands with soap, avoiding crowded areas, remaining at home, and wearing a face mask outside are the principal preventative measures against COVID-19, 3574(99.7%), 3574(99.75%), 3554(99.1%), and 3204(89.3%), respectively. A minority of 158(4.4%) believed that cleaning with a mixture of Flash and bleach is a sound preventive measure. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19 (Table 2).

Statistical Analysis of the Data:

A series of one way ANOVA analyses revealed that mean knowledge differed significantly across: gender (p-value=0.009), age (p-value=0.003), social status (p-

value=0.042), education level (p-value<0.001), economic status (p-value<0.001), number of household members (p-value<0.001), place of residence (p-value<0.001), and source of information (p-value<0.001) (Table 3). Participants living in Lattakia (77.6%) exhibited the greatest awareness, whereas those in Ar-Raqqah (71.7%) followed by Deir-ez-Zor (71.8%) exhibited the lowest. The mean knowledge differed across groups that acquired information from different sources, the lowest awareness was among participants who chose family members/friends as one of their source(s) (74.0%), whereas those with the highest awareness acquired their information from lectures as one of their source(s) (78.2%), (Table 3).

When participants were asked if they were likely to share new information with friends and family, 3513(98.0%) answered "yes". There was a significant difference in mean knowledge between those who were inclined to disseminate new information about COVID-19 to friends and family (75.7%) compared with those who were not (72.3%) (p-value=0.002). On exclusive use of personal belongings, 2692(75.1%) answered "yes". We found no significant correlation between mean knowledge and participant tendency to share personal belongings with others (p-value=0.112). Of participants who knew someone infected with COVID-19, 65(1.8%) answered "yes". There was no significant difference in mean knowledge between those who knew an infected individual (75.9%) compared with those who did not (75.6%) (p-value=0.816).

Multiple linear regression:

Multiple linear regression analysis results: male gender (vs. female, β=-0.933, p=0.005); education of secondary school or lower (vs. college/university and above, β=-3.782, p<0.001); careers in government, private, business, military, and "other" sectors, as well as unemployment (vs. health care workers, β=-3.592, p<0.001); poor and moderate economic status (vs. good and excellent, β=-0.669, p<0.040); and over 5 household members (vs. of 1-5,

β=-1.737, p<0.001) were associated with significantly poorer knowledge scores (Table 4). Careers in health care (vs. Unemployed, β=3.592, p-value=<0.001), and the 31-45 age group (vs. 16-30, β=1.511, p-value=0.005) were associated with significantly higher knowledge scores.

Discussion:

We found an overall mean knowledge score of 75.6%, indicating that most participants were relatively knowledgeable about COVID-19, though less so compared to their counterparts in China (90%).[14] This level of knowledge was unexpected given that only 10 cases of COVID-19 had been confirmed in Syria at the time of the survey.[26]

Poor knowledge was associated with males, non-post-secondary education, non-healthcare occupations, unemployment, poor and moderate economic status, and households with more than 5 members. Similar trends were observed in China.[14] Correlating socio-demographic variables with awareness is critical to public health efforts to mitigate the spread of COVID-19. The data obtained from this study can be leveraged by the Syrian Ministry of Health to tailor prevention and educational campaigns to populations with the widest knowledge gaps.

Our study showed a relatively high level of awareness 2535(70.7%) among the population. In the general knowledge section (mean knowledge score 67%), the majority of the participants 3383(94.3%) knew that COVID-19 is caused by a virus. This was similar to a Pakistani study (93.3%).[19] Low awareness of the 2-to-14 day incubation period was found[27] among dentists (36.1%) and HCW (36.4%) in similar studies.[15 21] Syria has a relatively young population. Statistical data from 2018 showed that only an estimated 4.5% of the population

was over the age of 65.[28] 3489(97.3%) knew that COVID-19 infection can be severe and potentially fatal in elderly, chronically ill, and immunodeficient patients. This is higher than in studies conducted in China (73.2%) and India (88.37%).[14 29] 40.6% of Syrians are hypertensive, yet a staggering 79.8% of them are unaware of their condition. Diabetes is also prevalent, affecting 11.9% of the population.[30 31] Such a rampant lack of awareness about chronic diseases associated with high mortality in COVID-19 patients underscores the need for targeted awareness campaigns.

At the time of the survey, no standardized evidence-based protocols had yet been developed to treat COVID-19 infections; only 2597(72.4%) participants knew that there was no available treatment at that time. This is higher than a Kenyan study (40%) but significantly lower than a Chinese study (94%).[14 17] A minority 103(2.9%) of participants thought there was a vaccine available against COVID-19, even though vaccines have only become commercially available in the past few months. By contrast, Coimbatore District and Pakistan were less informed, with (18.6%) and (11.6%) respectively believing that such a vaccine was available at the time. In the absence of a vaccine or effective treatment protocol for COVID-19 at the time of the survey, controlling the spread of the disease was the best line of defence, and remains so given the dire shortage of medication, ventilators, ICU capacity, and the continued lack of a vaccine available to the Syrian people. We observed a considerable knowledge gap in 1268(35.3%) with regards to ibuprofen as a treatment option. There is no available evidence to suggest that ibuprofen is effective against COVID-19.[32]

Participants showed a fair level of awareness regarding transmission pathways (70.7%), very similar to a Pakistani study (70.8%).[19] The majority 3521(98.2%) of participants were aware that respiratory droplets are common transmission vectors; this is similar to a Chinese study (97.8%), but much higher than an Indian study (29.5%).[14 18] 3330(92.9%) participants

identified handshaking as a transmission pathway, higher than a study among Jordanian dentists (85.6%).[15]

The majority of survey participants were sufficiently aware of the clinical features of COVID-19 (76.0%), similar to a Pakistani study (77.7%).[19] A very high level of awareness of the most common symptoms was found: fever 3563(99.4%), dry cough 3466(96.7%), fatigue 3405(95.0%), and myalgia 3019(84.2%), similar to findings from Chinese (96.4%) and Indian (95.4%) studies.[14 29] When asked about sore throat, a high level of awareness 3037(84.7%) was found compared to studies from India (15.2%) and among dentists in Jordan (28.5%).[15 18] Knowledge about diarrhea as a symptom was lacking: only 1972(55.0%); a study among dentists also showed low awareness (39.9%). [15 18] While infected individuals are frequently asymptomatic, or present with mild symptoms, around 1 in every 5 infections can be serious enough to require hospitalisation.[33 34] Only 2221(61.9%) participants were aware that infected individuals can be asymptomatic, while a study among dentists (34.5%) reported much lower awareness. Increasing public awareness about the variability of symptoms is particularly important since those with mild or unreported symptoms may significantly contribute to the transmission of COVID-19. The lack of health insurance, paid sick leave, telecommuting, or other social and professional safety nets increase the likelihood that these "silent spreaders" will underreport symptoms for fear of being forced to miss work.

We found a high level of awareness in the preventive methods section (88.8%), similar to a Pakistani study (85%).[19] Hand hygiene has been known to be an important element of infection control since the 14th century.[35] Implementing hand-washing techniques can break the transmission cycle and reduce the risk of infection by 6%-44%.[36] Almost all 3574(99.7%) participants were aware that washing hands with soap and water is an important preventive measure against COVID-19. This finding is in accordance with studies from Joran (97.0%), and India (96.2%, and 87%).[15 18 21]

This year the WHO recommended that the following mitigation measures be implemented during the holy month of Ramadan: cancelling social and religious gatherings, holding events outdoors for adequate ventilation, physical distancing of at least 1 meter between people, and the use of technology to broadcast ceremonies on television.[37 38] The majority 3574(99.7%) identified avoiding mass gatherings as a preventive measure; studies in China (98.6%) and Coimbatore District (97.7%) reported similar awareness.[14 29] Cheap and efficient interventions such as N95 (filtration capacity=95%) have a 91% effectiveness of blocking pathogen transmission.[39] 3204(89.3%) participants considered wearing a face mask when leaving home as an effective prevention method, compared with a Coimbatore District study (93.02%).[29]

Since Syrian society is particularly vulnerable to COVID-19, this knowledge gap is potentially dangerous and should be addressed to mitigate disease spread. Only 2482(69.2%) knew that the flu vaccine offers no protection against COVID-19; this is similar to a Coimbatore District study (67.4%), but lower than a study amongst HCWs (90.7%).[21 29] 3305(92.2%) were aware that individuals showing symptoms should quarantine themselves, lower than in China (98.2%) and India (95.8%).[14 18]

North-East Syria (NES) has a population of over 4 million people, 600,000 of whom are internally displaced refugees, 100,000 of whom live in overcrowded camps: only 2 of NES's 11 hospitals are currently functioning. NES consists of 3 governorates: Ar-Raqqah, Deir-ez-Zor, and Al-Hasakah. With only 22 ICU beds, (18 in Al-Hasakah, 4 in Ar-Raqqah, and none in Deir-ez-Zor), the maximum capacity threshold is only 80 COVID-19 cases. Ar-Raqqa and Deir-ez-Zor, the most vulnerable governorates, also showed the lowest awareness in the study (71.7%), and (71.8%). This is a potentially catastrophic situation, and a concern to the international community, as an unmonitored, uncontrolled outbreak in NES can prolong the global pandemic.

Limitations:

Our findings may not be generalized to the wider Syrian population. The authors used a convenience sampling strategy involving various social media platforms. Credible published national data regarding the socio-demographic characteristics of Syrians are not available to evaluate the representativeness of our sample. Syrians vulnerable to COVID-19, such as the elderly and rural residents, are more likely to exhibit poor knowledge and awareness due to limited internet access. As such, reaching out to these populations must be prioritized. Even though all Syrian governorates were represented in this study, most participants lived in Damascus and Rural Damascus. Furthermore, an assessment of the Syrian population's practices relating to COVID-19 and the attitudes driving them is necessary to complete the picture.

Conclusion:

COVID-19 has been a dire warning to humanity about the fragility of its social, economic, and healthcare institutions. Our study revealed good public awareness of clinical features and preventive measures. However general knowledge and knowledge about transmission pathways was suboptimal. Syrians of good socio-economic status, in particular young well-educated women, have shown good knowledge. Our national response must adapt to the growing threat of COVID-19 by adopting public awareness strategies and behaviours to contain the disease both within and beyond our borders.

Abbreviations: COVID-19: Coronavirus Disease 2019; MERS: Middle East Respiratory Syndrome; SARS: Severe Acute Respiratory Syndrome; WHO: World Health Organization; PHEIC: Public Health Emergency of International Concern; ICU: Intensive care unit; IRB: Institutional Review Board; SPSS: Statistical Package for Social Sciences; SD: Standard Deviation; HCW: Health Care Worker.

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Availability of data and materials:

All data related to this paper's conclusion are available and stored by the authors. All data are available from the corresponding author on a reasonable request.

Declarations:

Ethics approval and consent to participate:

This study was approved by the Institutional Review Board (IRB) at the Syrian Private University (SPU). The IRB at SPU did not provide us with a number/ID. All Participants confirmed their written consent by answering a yes-no question. Participants under the age of 18 required verbal informed parental consent, as well as submission of parent/guardian contact information. The researchers were responsible for contacting the parents/guardians to obtain verbal consent before the child was given access to the survey. The verbal and written form of consent was approved by the IRB at SPU. Participation in the study was voluntary and participants were assured that anyone who was not inclined to participate or decided to withdraw after giving consent would not be victimized. All information collected from this study was kept strictly confidential.

Consent for Publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

Authors' contributions:

FM conceptualized the study, participated in the design, wrote the study protocol, performed the statistical analysis, did a literature search, and drafted the manuscript. BB participated in study design, did a literature search, and drafted the manuscript. HA, and NA did a literature search and revision of the draft. All authors read and approved the final draft.

Tables and Figures:

Table 1.

Table 1. Socio-demographic characteristics: (n=3586)

Gender (%)	**Male**	**1142(31.8)**	**Education (%)**	**Primary School**	**25(0.7)**
	Female	**2444(68.2)**		**Intermediate School**	**166(4.6)**
Age (%)	**<20**	**1204(33.6)**		**Secondary school**	**375(10.4)**
	20-24	**1104(30.8)**		**College/University**	**2839(79.2)**
	25-29	**446(12.4)**		**Master's degree**	**157(4.4)**
	30-34	**266(7.4)**		**PhD**	**24(0.7)**
	35-39	**186(5.2)**	**Occupation (%)**	**Health care worker**	**634(17.7)**
	>39	**380(10.6)**		**Government institution**	**283(7.9)**
Social Status (%)	**Single**	**2279(63.5)**		**Private institution**	**182(5.1)**
	In a relationship	**286(8.0)**		**Business**	**198(5.5)**
	Married	**943(26.3)**		**Military**	**32(0.9)**

	Divorced	**46(1.3)**		**Unemployed**	**1822(50.8)**
	Widowed	**32(0.9)**		**Other**	**435(12.1)**
Economic Status (%)	**[1]Poor**	**247(6.9)**	**Household members (%)**	**0**	**46(1.3)**
	[2]Moderate	**1247(34.8)**		**1-5**	**2751(76.7)**
	[3]Good	**1761(49.1)**		**>5**	**789(22)**
	[4]Excellent	**331(9.2)**			

[1]Poor: income does not provide essential needs for the family. [2]Moderate: income provides essential needs for the family but no more. [3]Good: income provides essential needs and some luxury requirements. [4]Excellent: income provides luxury requirements.

Table 2.

Table 2. General Knowledge, Transmission, Signs and Symptoms, and Prevention of COVID-19: (n=3586)

General Knowledge					
Causative Agent N(%)	Virus	3383(94.3)	**Incubation period N(%)**	1 Minute to 1 Hour	18(0.5)
	Bacteria	39(1.1)		1 Hour to	58(1.6)

				2 Days	
	Parasite	8(0.2)		2 Days to 2 Weeks	2535(70.7)
	Immune deficiency	46(1.3)			
	Fungus	0(0.0)		2 Weeks to 1 Month	958(26.7)
	Inherited	2(0.1)			
	Do Not Know	108(3.0)		>1 Month	17(0.5)

	YES(%)	**NO(%)**	**DO NOT KNOW(%)**
Can infection with COVID-19 confer permanent immunity?	815(22.7)	1500(41.8)	1271(35.5)
Can COVID-19 cause severe illness and lead to death in elderly, chronically ill, and immunodeficient patients?	3489(97.3)	28(0.8)	69(1.9)
Can COVID-19 cause infertility?	461(12.9)	1222(34.1)	1903(53.0)
Is COVID-19 teratogenic (i.e. cause malformations/ abnormalities to an embryo/fetus)?	157(4.4)	1433(40.0)	1996(55.6)
Is there no available treatment against COVID-19?	2597(72.4)	515(14.4)	474(13.2)

Can COVID-19 be treated with antibiotics?	1228(34.3)	1790(49.9)	568(15.8)
Can COVID-19 be treated with Ibuprofen?	1268(35.3)	1921(53.6)	397(11.1)
Are there available COVID-19 vaccines?	103(2.9)	2986(83.3)	497(13.8)
Transmission Pathways			
Respiratory droplets (from coughing or sneezing)	3521(98.2)	21(0.6)	44(1.2)
Handshaking	3330(92.9)	189(5.3)	67(1.8)
Touching an infected person's personal belongings	3387(94.4)	131(3.7)	68(1.9)
Animals-to-human	910(25.4)	1973(55.0)	703(19.6)
Undercooked food	1301(36.3)	1734(48.3)	551(15.4)
Sexual contact	1210(33.7)	1477(41.2)	899(25.1)
Horizontal transmission	1130(31.5)	1160(32.4)	1296(36.1)
Signs and Symptoms			
Fever	3563(99.4)	9(0.2)	14(0.4)
Sneezing	2353(65.6)	1000(27.9)	233(6.5)
Sore throat	3037(84.7)	358(10.0)	191(5.3)

Headache	3186(88.8)	190(5.3)	210(5.9)
Chest pain	3050(85.0)	254(7.1)	282(7.9)
Body aches (generalized pain)	3019(84.2)	260(7.2)	307(8.6)
Fatigue	3405(95.0)	72(2.0)	109(3.0)
Diarrhea	1972(55.0)	971(27.1)	643(17.9)
Dry cough	3466(96.7)	44(1.2)	76(2.1)
Productive cough	458(12.8)	2586(72.1)	542(15.1)
Bleeding	130(3.6)	2613(72.9)	843(23.5)
Asymptomatic	2221(61.9)	375(10.5)	990(27.6)
Prevention Methods			
Does wearing a face mask outside the home offer protection from COVID-19?	3204(89.3)	314(8.8)	68(1.9)
Does washing hands with soap and water offer protection from COVID-19?	3574(99.7)	5(0.1)	7(0.2)
Does avoiding crowded places offer protection from COVID-19?	3574(99.7)	4(0.1)	8(0.2)
Does the flu vaccine offer protection from COVID-19?	331(9.2)	2482(69.2)	773(21.6)

Does staying at home offer protection from COVID-19?	3554(99.1)	15(0.4)	17(0.5)
Does using hand sanitizer offer protection from COVID-19?	3430(95.6)	104(2.9)	52(1.5)
Does cleaning household surfaces with bleach offer protection from COVID-19?	3408(95.0)	110(3.1)	68(1.9)
Does cleaning fruits and vegetables with soap and water offer protection from COVID-19?	3262(90.9)	221(6.2)	103(2.9)
Does cleaning surfaces with a mixture of Flash and bleach offer a safe protection from COVID-19?	158(4.4)	3301(92.1)	127(3.5)
Does the quarantine of symptomatic individuals protect others from COVID-19?	3305(92.2)	241(6.7)	40(1.1)
Do cumin, anise, and mint offer protection from COVID-19?	1041(29.0)	1934(53.9)	611(17.1)

Table 3.

Table 3. Mean knowledge score of participants by demographic variables, and source of information (one way ANOVA), (n= 3586)

Characteristics		Number of participants (%)	Mean Knowledge Score (±SD%)	F-test/ T-test	P-value
Gender	Male	1142(31.8)	75.0(±10.1)	-2.625	0.009*
	Female	2444(68.2)	75.9(±9)		
Age-group (years)	**<20**	1204(33.6)	75.0(±9.9)	2.990	0.011*
	20-24	1104(30.8)	76.4(±9.3)		
	25-29	446(12.4)	76.0(±9.4)		
	30-34	266(7.4)	75.4(±9.4)		
	35-39	186(5.2)	76.1(±7.6)		
	>39	380(10.6)	75.1(±8.6)		
Social	Single	2279(63.5)	75.8(±9.3)	2.485	0.042*

status	In a relationship	286(8.0)	76.6(±8.6)		
	Married	943(26.3)	75.1(±9.4)		
	Divorced	46(1.3)	73.9(±8.8)		
	Widowed	32(0.9)	73.4(±15.9)		
Residence	Urban	2426(67.7)	75.8(±9.3)	1.652	0.099
	Rural	1160(32.3)	75.3(±9.6)		
Education	Primary school	25(0.7)	66.5(±12.4)	26.176	<0.001*
	Intermediate school	166(4.6)	73.2(±9.3)		
	Secondary school	375(10.4)	70.0(±13)		
	College/University	2839(79.2)	76.3(±8.9)		

	Master's degree	157(4.4)	77.2(±9.7)		
	PhD	24(0.7)	76.6(±8.5)		
Occupation	Health care worker	634(17.7)	78.6(±8.6)	16.379	<0.001*
	Government institution	283(7.9)	75.7(±7.9)		
	Private institution	182(5.1)	75.5(±9)		
	Business	198(5.5)	73.4(±10.2)		
	Military	32(0.9)	71.2(±15.6)		
	Unemployed	1822(50.8)	75.3(±9.2)		

	Other	435(12.1)	74.0(±10.2)		
Economic status	Excellent	331(9.2)	76.6(±11.1)	7.108	<0.001*
	Good	1761(49.1)	76.2(±9.4)		
	Moderate	1247(34.8)	74.9(±9)		
	Poor	247(6.9)	74.3(±9.3)		
Household members	0	46(1.3)	74.4(±10.6)	15.451	<0.001*
	1-5	2751(76.7)	76.1(±9)		
	>5	789(22.0)	74.0(±10.2)		
Source of information	Health websites	2823(78.7%)	76.4(±8.7)	24.523	<0.001*
	Social media	1998(55.7%)	74.6(±9.6)		

	Television/ radio	1572(43.8%)	75.5(±9)		
	Family members/ friends	528(14.7%)	74.0(±10.3)		
	Lectures	517(14.4%)	78.2(±7.5)		
	Magazines/ books	266(7.4%)	77.6(±8.8)		

Table 4.

Table 4. Multiple linear regression on variables associated with poor COVID-19 knowledge

Variable	Coefficient	Standard error	t	P
Male gender (reference: female)	-0.933	0.334	-2.794	0.005*
education of secondary school or lower (reference: college/university and above)	-3.782	0.466	-8.125	<0.001*

careers in government, private, business, military, and "other" sectors, as well as unemployment (reference: health care workers)	-3.592	0.474	-7.579	<0.001*
poor and moderate economic status (reference: good and excellent)	-0.669	0.325	-2.057	0.040*
>5 household members (reference: of 1-5)	-1.737	0.374	-4.648	<0.001*

Figures and tables legends:

Table 1. Sociodemographic characteristics

Table 2. General Knowledge, Transmission, Signs and Symptoms, and Prevention around COVID-19

Table 3. Mean knowledge score of participants by demographic variables

Table 4. Multiple linear regression on variables associated with poor COVID-19 knowledge

Figure 1. Distribution of participants according to governorates and education level

References:

1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet* 2020;395(10223):497-506. doi: 10.1016/s0140-6736(20)30183-5
2. Viner RM, Ward JL, Hudson LD, et al. Systematic review of reviews of symptoms and signs of COVID-19 in children and adolescents. 2020
3. Rahman HS, Aziz MS, Hussein RH, et al. The transmission modes and sources of COVID-19: A systematic review. 2020

4. Affairs UOftCoH, Organization WH. Syrian Arab Republic: COVID-19 Humanitarian Update No. 23 As of 1 February 2021. *World Health Organization* 2021
5. Al-awsat A. Syria Grapples with Third COVID-19 Wave. *Alsharq Al-awsat* 2021
6. McKernan B. Syria confirms first Covid-19 case amid fears of catastrophic spread. *The Guardian* 2020
7. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 106. 2020
8. Gharibah M, Mehchy Z. COVID-19 pandemic: Syria's response and healthcare capacity. 2020
9. Ajilore K, Atakiti I, Onyenankeya K. College students' knowledge, attitudes and adherence to public service announcements on Ebola in Nigeria: Suggestions for improving future Ebola prevention education programmes. *Health Education Journal* 2017;76(6):648-60.
10. Tachfouti N, Slama K, Berraho M, et al. The impact of knowledge and attitudes on adherence to tuberculosis treatment: a case-control study in a Moroccan region. *Pan African Medical Journal* 2012;12(1)
11. McNatt Z, Boothby NG, Al-Shannaq H, et al. Impact of Separation on Refugee Families: Syrian Refugees in Jordan. 2018
12. Syria anniversary press release. *United Nations Office for the Coordination of Humanitarian Affairs (OCHA)* 2020
13. UNICEF Syria Crisis Situation Report 2019
14. Zhong B-L, Luo W, Li H-M, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *International Journal of Biological Sciences* 2020;16(10):1745.
15. Khader Y, Al Nsour M, Al-Batayneh OB, et al. Dentists' Awareness, Perception, and Attitude Regarding COVID-19 and Infection Control: Cross-Sectional Study Among Jordanian Dentists. *JMIR Public Health and Surveillance* 2020;6(2):e18798.
16. Qarawi A, Ng SJ, Gad A, et al. Awareness and Preparedness of Hospital Staff against Novel Coronavirus (COVID-2019): A Global Survey - Study Protocol. *SSRN Electronic Journal* 2020 doi: 10.2139/ssrn.3550294
17. Austrian K, Pinchoff J, Tidwell JB, et al. COVID-19 related knowledge, attitudes, practices and needs of households in informal settlements in Nairobi, Kenya. 2020
18. Roy D, Tripathy S, Kar SK, et al. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian Journal of Psychiatry* 2020:102083.
19. Hussain T, Khan S, Gilani U, et al. Evaluation of General Awareness Among Professionals Regarding COVID-19: A Survey Based Study from Pakistan. 2020
20. Zhou M, Tang F, Wang Y, et al. Knowledge, attitude and practice regarding COVID-19 among health care workers in Henan, China. *Journal of Hospital Infection* 2020
21. Bhagavathula AS, Aldhaleei WA, Rahmani J, et al. Novel Coronavirus (COVID-19) Knowledge and Perceptions: A Survey on Healthcare workers. *medRxiv* 2020
22. Organization WH. Introduction to COVID-19: methods for detection, prevention, response and control. 2020
23. Organization WH. Q&As on COVID-19 and related health topics.
24. Organization WH. Water, sanitation, hygiene and waste management for COVID-19: technical brief, 03 March 2020: World Health Organization, 2020.
25. Organization WH. Key planning recommendations for mass gatherings in the context of COVID-19: interim guidance, 19 March 2020: World Health Organization, 2020.
26. Organization WH. Coronavirus disease 2019 (COVID-19): situation report, 71. 2020
27. Backer J, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. *Eurosurveillance* 2020;25 doi: 10.2807/1560-7917.ES.2020.25.5.2000062
28. Plecher H. Age structure in Syria 2018. *Statista* 2020

29. Vadivu TS, Annamuthu P. An Awareness and Perception of COVID-19 among General Public–A Cross Sectional Analysis. 2014
30. Organization WH. Web World Health Organization–Diabetes country profiles: Diakses, 2016.
31. Tailakh A, Evangelista LS, Mentes JC, et al. Hypertension prevalence, awareness, and control in A rab countries: A systematic review. *Nursing & health sciences* 2014;16(1):126-30.
32. The use of non-steroidal anti-inflammatory drugs (NSAIDs) in patients with COVID-19. *World Health Organization* 2020
33. Surveillances V. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)—China, 2020. *China CDC Weekly* 2020;2(8):113-22.
34. Organization WH. Getting your workplace ready for COVID-19: How COVID-19 spreads, 19 March 2020: World Health Organization, 2020.
35. Best M, Neuhauser D. Ignaz Semmelweis and the birth of infection control. *Quality & safety in health care* 2004;13:233-4. doi: 10.1136/qhc.13.3.233
36. Rabie T, Curtis V. Handwashing and Risk of Respiratory Infections: A Quantitative Systematic Review. *Tropical medicine & international health : TM & IH* 2006;11:258-67. doi: 10.1111/j.1365-3156.2006.01568.x
37. Practical considerations and recommendations for religious leaders and faith-based communities in the context of COVID-19. *World Health Organization* 2020
38. Safe Ramadan practices in the context of the COVID-19 *World Health Organization* 2020
39. Jefferson T, Foxlee R, Del Mar C, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses: systematic review. *Bmj* 2008;336(7635):77-80.

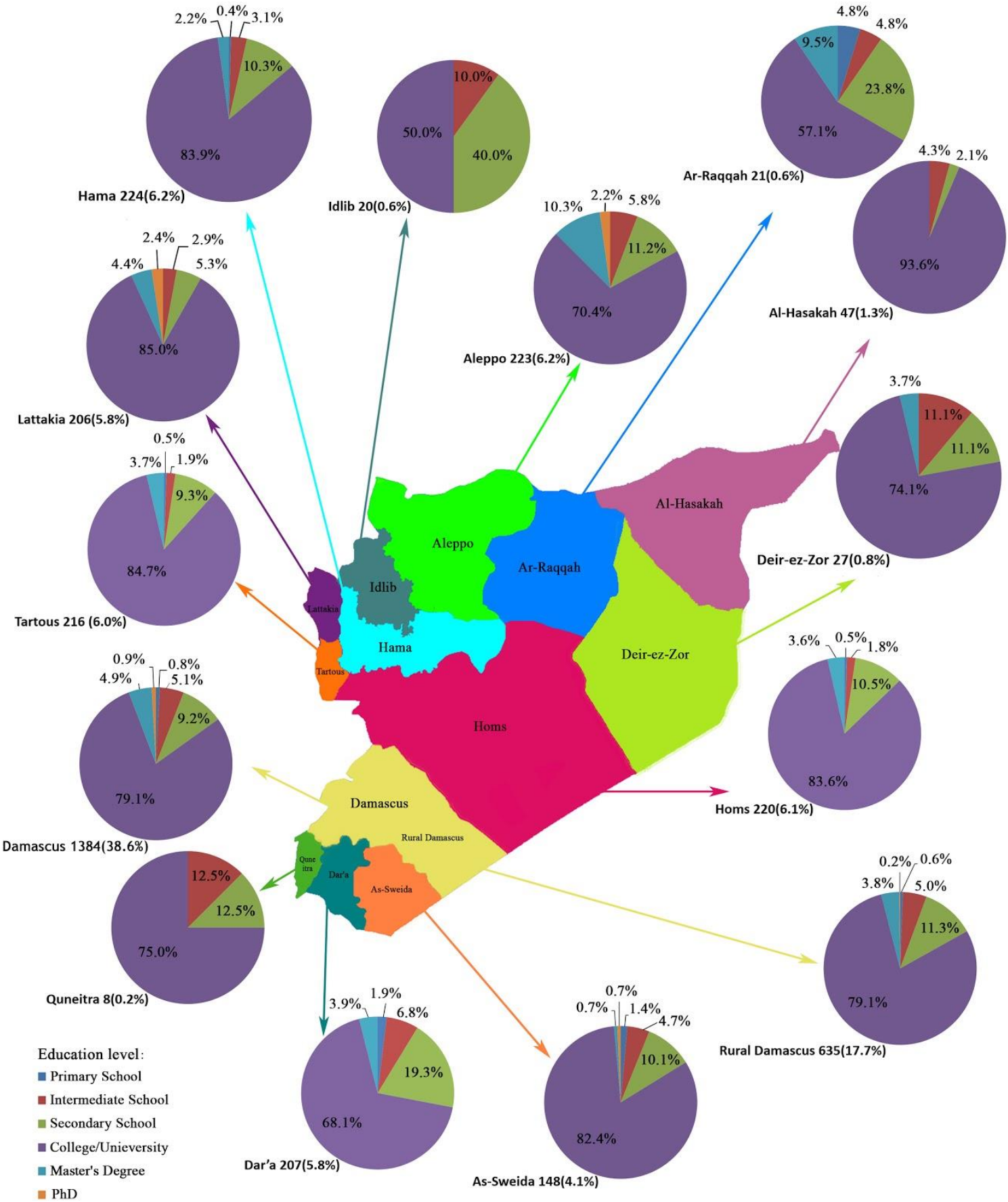

Figure 1. Distribution of participants according to governorates and education level

Attached Survey:

Appendix 1

Socio-demographic Characteristics	
Age (years): ☐ Below 15 ☐ 15-20 ☐ 20-30 ☐ 30-50 ☐ 40-50 ☐ 50-60 ☐ 60-70 ☐ Above 70	**Gender:** ☐ Male ☐ Female
Marital status: ☐ Single ☐ Relationship ☐ Married ☐ Divorced ☐ Widowed	**Educational level:** ☐ Primary school ☐ Intermediate school ☐ Secondary school ☐ University/College ☐ Master's Degree ☐ PHD Degree
Occupation: ☐ Health care worker ☐ Government institution ☐ Private institution ☐ Business ☐ Military ☐ Unemployed ☐ Other	**Residence:** ☐ Damascus/Rural Damascus ☐ Hama ☐ Aleppo ☐ Homs ☐ Tartous ☐ Lattakia ☐ Dara'a ☐ As-Sweida ☐ Al Hasakah ☐ Deir-ez-Zor ☐ Idlib ☐ Ar-Raqqah ☐ Quneitra
Area: ☐ Rural ☐ Urban	**Economic Status:** ☐ Excellent ☐ Good ☐ Moderate ☐ Poor
Do you smoke? ☐ Yes ☐ No	**Do you drink alcohol?** ☐ Yes ☐ No
How many people do you live with? ☐ Alone ☐ 1-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ Above 20	
Do you share toiletries/personal care products with others? ☐ Yes ☐ No	
Do you know anyone infected with COVID-19? ☐ Yes ☐ No	

Table 2. General Knowledge about COVID-19

What is COVID-19? ☑ Virus ☐ Bacteria ☐ Parasite ☐ Fungus ☐ Immunodeficiency ☐ Inherited ☐ Do not know	**Do you know how long after being infected with COVID-19 can a person suffer from signs and symptoms?** ☐ 1 Minute to 1 Hour ☐ 1 Hour to 2 Days ☑ 2 Days to 2 weeks ☐ 2 Weeks to 1Month ☐ Over a 1 month
Can an infection with COVID-19 confer permanent immunity (once infected with COVID-19 you cannot contract another infection)? ☐ Yes ☑ No ☐ Do not know	
Can COVID-19 cause severe illness and lead to death in elderly, chronically ill (hypertension, diabetes, asthma . . .), and those who have compromised immune systems? ☑ Yes ☐ No ☐ Do not know	
Can COVID-19 cause infertility? ☐ Yes ☐ No ☑ Do not know	
Is COVID-19 teratogenic (i.e. cause malformations/abnormalities to an embryo/fetus)? ☐ Yes ☑ No ☐ Do not know	

Treatment for COVID-19

	Yes	No	Do Not Know
No treatment available	✓		
Antibiotics		✓	
Ibuprofen		✓	

Is there an available vaccine for COVID-19?
☐ Yes ☑ No ☐ Do not know

Table 3. Transmission Pathways

	Yes	No	Do Not Know
Can COVID-19 be transmitted via respiratory droplets (coughing or sneezing) of infected individuals?	✓		
Can COVID-19 be transmitted after shaking-hands with an infected individual?	✓		

Can COVID-19 be transmitted after touching an infected individual's personal belongings?	✓		
Can COVID-19 be transmitted from animals to humans?			✓
Can COVID-19 be transmitted via undercooked food?			✓
Can COVID-19 be transmitted via sexual contact?			✓
Can COVID-19 be transmitted via vertical transmission (mother to fetus)?	✓		

Table 4. Signs and Symptoms of COVID-19

	True	False	Do Not Know
Is fever/temperature among the signs and symptoms of COVID-19?	✓		
Is sneezing among the signs and symptoms of COVID-19?	✓		
Is sore throat among the signs and symptoms of COVID-19?	✓		
Is headache among the signs and symptoms of COVID-19?	✓		
Is Chest pain among the signs and symptoms of COVID-19?	✓		
Is body aches (generalized pain) among the signs and symptoms of COVID-19?	✓		
Is fatigue among the signs and symptoms of COVID-19?	✓		
Is diarrhea among the signs and symptoms of COVID-19?	✓		
Is a runny nose among the signs and symptoms of COVID-19?	✓		
Is dry cough among the signs and symptoms of COVID-19?	✓		
Is productive cough among the signs and symptoms of COVID-19?	✓		
Is bleeding among the signs and symptoms of COVID-19?		✓	
Can a person be infected with COVID-19 and have no signs and symptoms?	✓		

Table 5. Prevention Methods			
	True	**False**	**Do Not Know**
Does wearing a face mask outside the home offer protection from COVID -19?	✓		
Does washing hands with soap and water offer protection from COVID-19?	✓		
Does avoiding crowded places offer protection from COVID -19?	✓		
Does the flu vaccine offer protection from COVID -19?		✓	
Does staying at home offer protection from COVID -19?	✓		
Does using hand sanitizer offer protection from COVID -19?	✓		
Does using bleach to clean household surfaces prevent COVID-19 infection?	✓		
Does cleaning fruits and vegetables with soap and water offer protection from COVID-19?	✓		
Does cleaning surfaces with a mixture of Flash and bleach offer protection from COVID -19?		✓	
Does the quarantine of symptomatic individuals protect others from COVID -19?	✓		
Do cumin, anise, and mint offer protection from COVID -19?		✓	

What is your main source of information about COVID-19? (You may choose more than one option)

☐ Internet (social media platforms)
☐ Internet (Official websites like world health organization)
☐ TV/Radio
☐ Friends/Member of family
☐ Magazines/Books
☐ Lectures

If you had new information about COVID-19 would you share it with friends and family to raise awareness?

☐ Yes ☐ No

12

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2,3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6,7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6,7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Not applicable
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	Not applicable (no missing data)
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up	8

	was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
€	Describe any sensitivity analyses	-

Continued on next page

Results			**Page No.**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	Not applicable
		© *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	-
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	-
		Cross-sectional study—Report numbers of outcome events or summary measures	29-35
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	34,35
		(*b*) Report category boundaries when continuous variables were categorized	29-33
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.