Perceptions Towards COVID-19 and Adoption of Preventive Measures Among the Public in Saudi Arabia: A Cross Sectional Study

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Abstract

Background: Effective management of the spread of a novel infectious disease, such as the COVID-19 virus can be achieved through influencing people's behavior to adopt preventive measures. The public's perceptions and attitudes towards the virus, governmental guidance and preventive measures were unknown in Saudi Arabia.

Objectives:

Identify the anxiety level, risk perception, information sources, adoption of preventive measures, and ability and willingness to self-isolate during and post-lockdown periods of the COVID-19 pandemic.

Investigate socio-demographic factors associated with adoption of preventive measures against COVID-19 and self-isolation.

Method: Between April 22nd and June 21st 2020, Saudi adults aged ≥18 years completed an open web-based survey including questions on anxiety level, COVID-19 risk perceptions and adoption of preventive measures. Weighted percentages, Pearson's chi-square tests, and multiple logistic regression were applied to evaluate associations between these factors and socio-demographic variables.

Results: A total of 2,393 respondents filled-out the survey with around (27.2%) aged 35-44 years old. Around 11% of the respondents reported high anxiety level, 74% were worried about the COVID-19 outbreak, and of those, 27% reported that it is likely that they will be infected with COVID-19 with 16% believing it will be life-threatening or severe. Adoption of hygiene practices and social distancing were lower among older (65+ years) compared to younger (18-24 years) respondents (OR: 0.06; 95% CI: 0.01, 0.28, OR 0.06; 95% CI: 0.01, 0.27), respectively. Around 88% reported being able and 82% willing to self-isolate. Those with the lowest gross household income and those with at least one flu symptom were less able and willing to self-isolate. A significant increase was reported in levels of anxiety, perceived effectiveness of social distancing and hygiene practices in the post-lockdown period compared to the lockdown.

Conclusions: The study reported high levels of adoption of preventive measures and willingness and perceived ability to self-isolate during the early phase of the pandemic. Vulnerable groups such as the elderly, and those with low socio-economic status reported lower adoption of preventive measures or ability and willingness to self-isolate. Tailored public health messages and interventions are needed to achieve high adherence to these preventive measures in these groups.

Background

On December 31st ,2020, a pneumonia of unknown cause in Wuhan China was first reported to the World Health Organization (WHO) (1). On January 12th, 2020, the WHO declared the cause to be a novel coronavirus called "2019-nCoV" (1); the name was subsequently changed to "SARS-CoV-2" by the International Committee on Taxonomy of Viruses on February 11th, 2020 (2). The WHO formally named the disease caused by this novel virus "COVID-19" (1). As of September 25th ,2020, there were around 32.7 million COVID-19 globally confirmed cases, with 332 thousand in Saudi Arabia. The total number of COVID-19 related deaths around the world was around 993 thousand, with 4 thousand in Saudi Arabia (3, 4).

Saudi Arabia started a widespread awareness campaign in early February and followed with a set of gradual system-level suppressive measures (e.g. lockdown, contact tracing) once the first case was announced on March 2nd, 2020. Examples of such suppressive measures include closure of schools and worksites. Suppressive measures have shown short term success in China and South Korea (5). The key aim of suppressive measures is to reduce the average number of secondary cases each COVID-19 case generates, known as the reproduction number or R, to below one. This is intended to reduce the number of cases or eliminate human-to-human transmission (5). However, as this is a temporary measure to reduce the peak of the COVID-19 outbreak, the question remains for how long and how many times such measures will need to be enacted. Applying these suppressive measures over a long period of time is likely to have a substantial economic and social impact (6, 7).

Research into individuals' risk perception is essential to understanding their response, behavior, and adoption of individual-level preventive measures (e.g. wearing masks, washing hands) in case of an infectious disease outbreak and its aftermath. Identifying risk perception will not only help mitigate the devastating mortality and morbidity burden, but also economic loss. With no effective treatment or vaccination currently available for COVID-19 and any being developed, unlikely to be in population wide circulation till 2021, understanding and addressing behavior to reduce transmission and spread of infection is imperative (8, 9). Such insight will enable the design of policies and interventions tailored to populations with relatively low risk perceptions or low adoption of preventive measures. It will allow governments to strengthen key public health messages and design health awareness campaigns tailored to the different stages of an outbreak (5, 10–13). Furthermore, gaining insights into risk perception and behaviors can help build community resilience and influence behavior to increase uptake of future vaccination and/or treatment (5, 9–13).

In Saudi Arabia, there is limited research on how people behave or perceive the risk of previous infectious disease outbreaks (14). Our study addresses this important question in relation to the current COVID-19 pandemic. By understanding the Saudi community's perceived vulnerability and fear of COVID-19 as well as their behavior, it will be possible to develop tailored interventions to encourage adoption of preventive measures and manage anxiety and fear. Hence, this study aimed to identify the anxiety level, risk perception, information sources, adoption of preventive measures, and self-isolation practices during and post lockdown in a sample of Saudi adults. Additionally, this study aimed to explore factors associated with adoption of preventive measures against COVID-19 and self-isolation practices.

Methods

Study design:

Between April 22nd and June 21st 2020, adults aged 18 years and older from the general public were invited to complete an open web-based survey during the COVID-19 pandemic in Saudi Arabia. The survey was hosted on SURVS with full General Data Protection Regulation (GDPR) coverage (15). Multiple entries from the same individual were prevented through authentication cookies. Response bias was prevented by making the survey anonymous and participation voluntary. Each section was displayed separately, and respondents had to respond to each item before moving on to the next section. Respondents could go back to edit previous answers, but once they submitted the survey they were not allowed to change any response. On average, respondents spent 15 minutes on the survey.

The final version of the survey was distributed through social media (WhatsApp) and emails to representatives in education, health, business, and social sectors across all Saudi Arabian regions. A web-based survey was used as it was likely to capture a greater number of harder-to-reach individuals than a paper survey (16, 17). In addition, according to the Saudi Communication and Information Technology Commission, WhatsApp was the most widely used social media application (18). A 2017 report by Statista showed that Saudi Arabia's WhatsApp penetration rate was around 73%, which is one of the highest worldwide (19).

Sample size calculation and weighting:

For a representative sample of the Saudi Arabian adult population, the proportions of gender and age groups in the population (obtained from the General Authority for Statistics (20)) were considered for the sample size estimate. As a result, a sample size of 2,180 was sufficient to cover all gender and age ranges of the adult population. Age and gender were also considered for post-stratification weights to compensate for the fact that people with certain characteristics were not as likely to respond to the survey (21). Non-response weights were used to compensate for bias in the final sample. The weighted final sample size was 2393 corresponding to individuals who completed the survey .

Instrument description:

The survey was originally designed for the COVID-19 outbreak in Hong Kong (HK) by public health experts from the Chinese University of HK (12) and translated into English and used by experts at Imperial College London, London, United kingdom (UK) (22, 23). The survey was translated and adapted to the Saudi Arabian context using the WHO instrument translation process (24) and was validated by a panel of researchers and academics. Agreement scores on the translation were obtained by three bilingual researchers (GA, FA and SA) with experience in survey development and methodology. All the researchers used a Likert scale of 5 points with the values 4 and 5 corresponding to substantial or strong agreement, respectively. The Kappa value, which was significantly different from zero indicated agreement ($p = 0.004$) and the agreement scores presented a mean = 89.6%, median = 91.7%, min = 75% and max = 100% implying an almost perfect agreement. Next, pretesting and cognitive interviews were conducted on a subgroup of 23 respondents (not included in final analysis) following the WHO steps for translating instruments and to ensure all questions and responses adapted to the Saudi Arabian context were clear (24).

An Arabic and English version were distributed. The survey consisted of four main sections and 46 items (See Additional File 1 for survey).

The survey included:

1. Socio-demographic characteristics: age group (18–24, 25–34,35–44,45–54,55–64,65–74,75 years old and above), gender (male, female), pregnancy, marital status (married, separated/divorced, widowed, single), region of residence in Saudi Arabia in the last 7 days (13 region of Saudi Arabia), educational or work-related qualification (read and write, primary, intermediate, secondary/equivalent, pre-univ.diploma, university, high diploma, master, PhD, prefer not to say), nationality (Saudi, non-Saudi, prefer not to say), employment(working fulltime (≥ 30 hours/week), working part time (8–29 hours a week), working part time (< 8 hours a week), fulltime student, retired, unemployed, not working and other), health worker, gross household income (under SR 5,000 per month, SR 5,000 to SR 9,999 per month, SR 10,000 to SR 14,999 per month, SR 15,000 to SR 19,999 per month, SR 20,000 to SR 24,999 per month, SR 25,000 and over per month, don't know, prefer not to say), care giving responsibilities (child(ren) aged under 5, child(ren) aged 5 to 16, elderly relative/ dependent, disabled dependent, not applicable, prefer not to say, other), perceived current state of health (very good, fairly good, neither good or poor, fairly poor, very poor, prefer not to say), chronic health conditions in the last 6 months (i.e. since October 2019), chronic condition in members of the household or those under your care, and Respiratory/ Cold/ Flu-like Symptoms in the Last 14 Days (persistent fever, shivering, headache, muscle pain, cough, difficulty in breathing or shortness of breath, dizziness, runny nose, sore throat, not applicable, prefer not to say).
2. Anxiety levels assessed using the validated Arabic version of the Hospital Anxiety and Depression Scale (HADS) (25, 26).
3. Perceptions of different sources of Information regarding COVID-19 and where respondents accessed information related to COVID-19.
4. Perceptions, behaviors, and attitude in relation to COVID-19 and its prevention measures.

This was assessed by asking respondents about the following:

- worry about Covid-19 and history of testing for infection.
- perceived susceptibility to and severity of being infected with COVID-19 under Saudi Arabia's current measures (risk perceptions).
- adoption of preventive measures which included:

  adoption of different preventive measures to protect self-and/or others. These preventive measures were categorized into three groups following the surveys used in the UK and HK (12, 22, 23): hygiene practices, social distancing, and travel avoidance. And were analyzed through three variables which represent at least one adopted measure taken for each of these categories. These measures include wearing face masks, washing hands with soap and water regularly, using hand sanitizer more regularly and covering one's nose and mouth when sneezing or coughing for hygiene practices; avoiding contact with people who have a fever or respiratory symptoms or who have been in affected areas in the last 14 days, avoiding going out in general, crowded areas, going into public markets that sell fresh fish, meat, and poultry products, going to hospitals or other healthcare settings, using public

transport, going into shops and supermarkets, going to work and social events while social distancing; and avoiding travel to affected countries and areas inside and outside Saudi Arabia, regardless of whether they were affected for travel avoidance.
reasons for adoption of preventive measures.
perceived effectiveness of preventive measures.

- willingness and/or ability to self-isolate, which was defined in that period as not leaving home (even to buy food or essentials) or having any visitors for 14 days if the person returned from traveling abroad from affected countries or came in contact with an infected person.

The day before the survey dissemination (i.e. 21st April 2020), the government announced that restrictions during Ramadan-the Islamic holy month- would be slightly relaxed, after a complete nationwide lockdown for around 20 days (27). On April 26th, 2020, movement within cities were allowed, except for Makkah, between 9 am till 5 pm with certain conditions (e.g. no social gatherings of more than 5 people etc.). Breaking of curfew would result in a substantial fine and repeated offenders would be given prison sentences. Permits were given to those who needed it and essential workers during curfew hours. People were allowed a walking hour /day during curfew, conditional to the same residential neighborhood. On May 31st, 2020, lockdown was eased (free movement between 6 am-8 pm within and between regions). People were allowed to go back to work, mosques were opened, and domestic traveling was resumed. On June 21st, 2020, lockdown was completely lifted. Starting from 6 am, life went back to normal with certain guidelines, penalties and precautions (27).

Data analysis:

Descriptive analysis was used: number (n), percentage (%) and the weighted percentage (%w). Pearson's chi-square test was applied for the associations between responses and time period. A multiple logistic regression model was used to identify the associations between anxiety and risk perception, adoption of preventive measures and their perceived effectiveness, and ability and willingness to self-isolate. Odds ratios for simple (OR[1]) and multiple (OR) logistic models and OR 95% confidence intervals (95% C.I. OR) were estimated. For the time trend analysis, descriptive weighted relative frequencies of the responses in each time period (during lockdown and post lockdown) were used. Adjusted residuals (AR) were estimated to identify significant differences. All the analyses considered the weighted sample and significance level of the tests $\alpha = 5\%$. In some cases, a *p*-value greater than 5% but less than 10% was considered for a better regression model fit to indicate slight significance. Data were analyzed using the SPSS software version 22.0 (SPSS Science, Chicago, IL, USA).

Results

Sample description:

Of the 2393 respondents (59% completion rate), 19% were 18–24 years old and around 5% were 65 years old and above (Table 1). Most respondents (60%) were male, 45% university graduates, 52% worked full time, and 71% were in Riyadh (Saudi Arabia's capital) in the last 7 days before responding to the survey. Around 83% of the respondents had some kind of care giving responsibility towards children or dependent elderly, and 79% reported that their health was very good. Around 11% and 14% of the population reported high anxiety and depression, respectively in the last 14 days before filling up the survey (See Additional File 2).

Table 1
Descriptive Statistics Socio-Demographic Characteristics (Section I in the survey): absolute (n), relative (%) and weighted relative (%w) frequencies.

	n	*%*	*%w*
Age group			
18–24	920	38.4	19.4
25–34	636	26.6	25.7
35–44	469	19.6	27.2
45–54	227	9.5	15.9
55–64	120	5.0	7.5
65–74	19	0.8	2.8
75 years old and above	2	0.1	1.5
Gender			
Male	927	38.7	59.9
Female	1466	61.3	40.1
Marital Status			
Married	1033	43.2	60.3
Separated/ Divorced	86	3.6	4.0
Widowed	18	0.8	0.7
Single	1256	52.5	35.0
Region of Residence in Saudi Arabia in the last 7 days			
Makkah	349	14.6	13.0
Riyadh	1654	69.1	70.8
Asir	23	1.0	0.8
Jawf	2	0.1	0.0
Northern Borders	3	0.1	0.2
Bahah	9	0.4	0.2
Madinah	20	0.8	0.8
Ha'il	9	0.4	0.5
Najran	1	0.0	0.1
Qasim	17	0.7	0.8
Tabuk	20	0.8	1.1
Jizan	37	1.5	2.0
Eastern Province	237	9.9	8.5
Outside Saudi Arabia	8	0.3	0.4
Other	4	0.2	0.8
Educational or Work- related Qualification			
Read and Write	1	0.0	0.0
Primary	1	0.0	0.1
Intermediate	4	0.2	0.2
Secondary/Equivalent	258	10.8	7.1
Pre-Univ.Diploma	90	3.8	5.6
University	1272	53.2	45.1
High Diploma	27	1.1	1.7
Master	447	18.7	20.7

	n	%	*%w*
PhD	286	12.0	19.2
Prefer not to say	7	0.3	0.3
Nationality			
Saudi	2160	90.3	85.8
Non-Saudi	211	8.8	12.6
Prefer not to say	22	0.9	1.6
Employment			
Working fulltime (≥ 30 hours/week)	919	38.4	52.1
Working part time (8–29 hours a week)	100	4.2	5.4
Working part time (< 8 hours a week)	64	2.7	2.9
Fulltime student	819	34.2	21.1
Retired	82	3.4	6.1
Unemployed	65	2.7	2.0
Not working	259	10.8	6.8
Other	85	3.6	3.6
Gross Household Income			
under SR 5,000 per month	149	6.2	4.9
SR 5,000 to SR 9,999 per month	254	10.6	10.4
SR 10,000 to SR 14,999 per month	363	15.2	17.1
SR 15,000 to SR 19,999 per month	281	11.7	12.9
SR 20,000 to SR 24,999 per month	200	8.4	8.9
SR 25,000 and over per month	549	22.9	25.5
Don't know	342	14.3	8.5
Prefer not to say	255	10.7	11.8
Care Giving Responsibilities			
Child(ren) aged under 5	532	22.2	27.6
Child(ren) aged 5 to 16	756	31.6	38.8
Elderly relative/ dependent	358	15.0	16.4
Disabled dependent	52	2.2	2.3
Not applicable	1015	42.4	32.7
Prefer not to say	123	5.1	5.0
Other	106	4.4	6.7
Perceived Current State of Health			
Very good	1832	76.6	78.6
Fairly good	404	16.9	15.4
Neither good or poor	83	3.5	2.7
Fairly poor	42	1.8	1.3
Very poor	10	0.4	0.4
Prefer not to say	22	0.9	1.6
Chronic Health Conditions in the Last 6 Months (i.e. Since October 2019)			
Eye conditions	41	1.7	1.5
Ear, nose and/ or throat condition	222	9.3	8.6

	n	*%*	*%w*
Cancer	7	0.3	0.4
Epilepsy/ seizure	8	0.3	0.3
Stroke	1	0.0	0.0
Hypertension	120	5.0	7.2
Heart disease	13	0.5	0.7
Asthma	131	5.5	4.6
Emphysema, bronchitis, bronchiectasis	10	0.4	0.4
Tuberculosis	2	0.1	0.0
Thyroid glands disease	107	4.5	4.5
Diabetes mellitus	100	4.2	7.6
Hyperlipidaemia	41	1.7	2.1
Kidney condition	17	0.7	0.7
Liver condition	6	0.3	0.3
Bowel condition	59	2.5	2.7
Anaemia	227	9.5	5.8
Genetic blood disorders	9	0.4	0.2
Skeletomuscular disorders	55	2.3	2.5
Autoimmune disorder	19	0.8	0.8
Skin condition	111	4.6	3.9
Depression	193	8.1	6.5
Anxiety	297	12.4	9.6
Schizophrenia	7	0.3	0.9
Not applicable	1291	53.9	53.6
Prefer not to say	51	2.1	2.4
Other	34	1.4	1.4
Chronic Condition in Members of the Household or Those Under Your Care			
Yes, they do	1109	46.3	39.8
No, they don't	1146	47.9	54.8
Don’t know	112	4.7	3.7
Prefer not to say	26	1.1	1.7
Respiratory/ Cold/ Flu-like Symptoms in the Last 14 Days			
Persistent fever	23	1.0	0.8
Shivering	15	0.6	0.4
Headache	370	15.5	11.5
Muscle pain	115	4.8	4.3
Cough	94	3.9	3.3
Difficulty in breathing or shortness of breath	78	3.3	2.3
Dizziness	107	4.5	2.7
Runny nose	156	6.5	5.3
Sore throat	135	5.6	6.0
Not applicable	1770	74.0	77.7
Prefer not to say	28	1.2	1.1

	n	*%*	*%w*
Total	2393	100.0	100.0

Most respondents (94%) were not tested for COVID-19 (See Additional File 2). Information about COVID-19 was mostly obtained through official websites (72%) such as local governmental agencies and the WHO, and their social media outlets with 70% of respondents perceiving that information source as very reliable while 48% viewed unofficial websites as very unreliable. The second source of information was social media platform (48%). Around 57% of respondents would like to receive the latest research explaining what is known about coronavirus from a trusted source. At least 78% believe that coronavirus is most likely transmitted through physical contact with someone who has the virus with or without symptoms. And 31% believe that it is very unlikely that transmission could happen through consumption of meat made of wild animals.

Risk Perception and Anxiety:

In general, most of the respondents were worried about the COVID-19 outbreak in Saudi Arabia (75%) (Table 3**). Of those, 27% reported that it is likely that they will be infected with COVID-19 with 16% believing it will be life-threatening or severe and 38% expecting it to be moderate.** Older respondents (aged 35 years and older) were less likely to worry about COVID-19 and their perceived susceptibility and severity were lower compared to the younger respondents (aged between 18–24 years) (Table 2). The worry about COVID-19 was less in those with the highest gross household income of 25,000SR and over (OR: 0.58; 95%CI: 0.33,0.99) compared to those in the lowest gross household income of under 5,000SR. The perceived susceptibility and severity was higher in those with the highest gross household income compared to those with the lowest (OR: 1.68,95%CI:1.09–2.58, OR: 1.83; 95%CI: 1.20,2.80). Respondents aged between 45 and 64 years old and those with gross household income of 15,000SR per month and over were less anxious (45–54 and 55–64 years old groups, OR: 0.48; 95%CI: 0.30,0.75 and OR: 0.22; 95%CI: 0.10,0.48, respectively, and 15,000–19,999 SR, 20,000–24,999 SR,25,000SR and over, OR: 0.43; 95%CI: 0.25,0.74, OR: 0.48; 95%CI: 0.27,0.85 and OR: 0.545; 95%CI: 0.33,0.88, respectively) compared to younger respondents and those in the lowest gross household income groups, respectively (Table 3).

Table 2

Risk perception odds ratio estimates (OR[1] and OR) and OR 95% confidence interval (95% C.I. OR) of the multiple logistic regression model.

		Risk Perception											
		Worried about COVID19				Perceived suspebitblity (likely to be infected)				Perceived severity (expect at least a moderate infection)			
Socio-demographic factors		OR[1]	OR	95% C.I.OR	p-value	OR[1]	OR	95% C.I.OR	p-value	OR[1]	OR	95% C.I.OR	p-value
Age Group	18–24												
	25–34	1.04	0.878	(0.628–1.226)	0.445	1.32**	0.866	(0.641–1.168)	0.345	0.90	0.796	(0.603–1.049)	0.105
	35–44	0.84*	**0.621**	**(0.415–0.929)**	**0.020**	1.24*	**0.638**	**(0.447–0.912)**	**0.014**	0.7**	**0.600**	**(0.45–0.8)**	**< 0.001**
	45–54	0.47**	**0.366**	**(0.234–0.571)**	**< 0.001**	1.17	**0.623**	**(0.417–0.931)**	**0.021**	0.69**	**0.659**	**(0.473–0.92)**	**0.014**
	55–64	0.58**	**0.436**	**(0.258–0.737)**	**0.002**	0.87	**0.438**	**(0.271–0.707)**	**0.001**	0.61**	**0.537**	**(0.351–0.822)**	**0.004**
	65 years old and above	0.34**	**0.313**	**(0.17–0.574)**	**< 0.001**	0.65*	**0.410**	**(0.224–0.75)**	**0.004**	0.82	1.275	(0.733–2.215)	0.390
Gender	**Female**	1.54**	**1.704**	**(1.375–2.111)**	**< 0.001**	0.97				0.96			
Marital status	**Single**												
	Married	0.92	**1.586**	**(1.155–2.179)**	**0.004**	1.18*	**1.522**	**(1.157-2)**	**0.003**	0.87*			
	Separated/ Divorced	0.67*	0.938	(0.551-1.6)	0.816	1.5*	**1.988**	**(1.22–3.24)**	**0.006**	0.76*			
	Widowed	0.70	0.846	(0.273–2.619)	0.771	1.06	1.706	(0.577–5.044)	0.334	0.65			
Educational or Work-related Qualification	**PhD**												
	Until Secondary/Equivalent	1.99**				0.57**	**0.524**	**(0.349–0.788)**	**0.002**	1.28*	1.217	(0.811–1.825)	0.342
	Pre-Univ.Diploma	1.56**				0.36**	**0.340**	**(0.218–0.531)**	**< 0.001**	1.22	1.413	(0.932–2.141)	0.104
	University	1.68**				0.68**	**0.600**	**(0.458–0.785)**	**< 0.001**	1.49**	**1.503**	**(1.154–1.957)**	**0.003**
	High Diploma	1.74*				0.89	0.807	(0.41–1.587)	0.534	0.62*	0.686	(0.338–1.392)	0.296
	Master	1.7**				1.01	0.852	(0.638–1.137)	0.276	1.68**	**1.765**	**(1.326–2.35)**	**< 0.001**
Nationality	**Saudi**	1.77**	**1.433**	**(1.076–1.909)**	**0.014**	1.01				1.22*			
Employment	**Unemployed/Not working/Other**												
	Working/Student full time	1.25*	**1.512**	**(1.11–2.059)**	**0.009**	1.74**	**1.348**	**(1.029–1.767)**	**0.030**	1.67**	**1.756**	**(1.348–2.287)**	**< 0.001**
	Working part time	1.36*	**1.630**	**(1.037–2.561)**	**0.034**	1.13	0.981	(0.66–1.458)	0.926	1.01	1.077	(0.73–1.591)	0.708
	Retired	0.97	**1.772**	**(1.055–2.976)**	**0.031**	0.97	1.039	(0.643–1.679)	0.876	1.06	0.985	(0.616–1.577)	0.951
Healthcare worker		1.2*				1.73**	**1.659**	**(1.304–2.111)**	**< 0.001**	1.11			
Gross Household Income	**under 5,000 SR per month**												

**p-value < 0.20; ** p-value < 0.05. The first categories are the references*

		Risk Perception											
	SR 5,000 SR to 9,999 per month	0.82	0.836	(0.468–1.496)	0.547	1.21	1.231	(0.772–1.96)	0.382	1.09	1.160	(0.732–1.837)	0.527
	SR 10,000 to SR 14,999 per month	0.84	0.885	(0.507–1.544)	0.666	1.43*	1.485	(0.956–2.307)	0.078	1.07	1.167	(0.757–1.799)	0.483
	SR 15,000 to SR 19,999 per month	0.68*	0.721	(0.408–1.275)	0.261	1.6**	1.440	(0.912–2.272)	0.117	0.90	1.061	(0.677–1.663)	0.795
	SR 20,000 to SR 24,999 per month	0.46**	**0.462**	**(0.257–0.831)**	**0.010**	2.05**	**1.926**	**(1.19–3.116)**	**0.008**	1.01	1.159	(0.72–1.865)	0.543
	SR 25,000 and over per month	0.55**	**0.582**	**(0.339–0.999)**	**0.050**	1.84**	**1.681**	**(1.094–2.582)**	**0.018**	1.53**	**1.838**	**(1.203–2.808)**	**0.005**
	Don't know/ Prefer not to say	0.58**	0.639	(0.373–1.095)	0.103	1.16	1.190	(0.774–1.83)	0.429	0.81	0.833	(0.546–1.272)	0.398
Perceived Current State of Health	**Fairly or Very poor/ Prefer not to say**												
	Very good	2.29**	1.639	(0.961–2.796)	0.070	1.29				1.53*	**1.674**	**(1.015–2.761)**	**0.044**
	Fairly good	1.94**	1.321	(0.748–2.334)	0.338	1.53*				2.42**	**2.407**	**(1.416–4.092)**	**0.001**
	Neither good or poor	6.5**	**4.098**	**(1.566–10.723)**	**0.004**	1.88*				2.76**	**2.803**	**(1.371–5.732)**	**0.005**
At Least One Chronic Health Conditions Currently		1.05				1.11*				1.45**	**1.445**	**(1.207–1.729)**	**< 0.001**
Chronic Condition in Members of the Household or Those Under Your Care		1.29**				1.25**	**1.268**	**(1.06–1.517)**	**0.010**	1.25**			
At Least One Respiratory/ Cold/ Flu-like Symptom		1.18*	1.247	(0.973–1.597)	0.081	1.38**	**1.439**	**(1.171–1.769)**	**0.001**	1.36**	**1.213**	**(0.984–1.496)**	**0.070**

**p-value < 0.20; ** p-value < 0.05. The first categories are the references*

Table 3

Anxiety and Depression odds ratio estimates (OR[1] and OR) and OR 95% confidence interval (95% C.I. OR) of the multiple logistic regression model.

		Anxiety				Depression			
Socio-demographic factors		OR[1]	OR	95% C.I.OR	p-value	OR[1]	OR	95% C.I.OR	p-value
Age Group	18–24								
	25–34	0.97	1.146	(0.828–1.587)	0.411	1.25*	1.357	(1.005–1.833)	0.047
	35–44	0.65**	0.792	(0.559–1.122)	0.190	1.00	1.060	(0.776–1.449)	0.714
	45–54	0.32**	0.483	(0.308–0.757)	0.002	0.88	0.952	(0.661–1.37)	0.790
	55–64	0.14**	0.229	(0.108–0.484)	< 0.001	0.44**	0.445	(0.272–0.727)	0.001
	65 years old and above	0.57**	0.751	(0.365–1.546)	0.437	0.48**	0.213	(0.106–0.426)	< 0.001
Gender	Female	1.49**	1.426	(1.137–1.787)	0.002	1.00			
Marital status	Single								
	Married	0.51**				0.71**			
	Separated/ Divorced	0.65*				0.64*			
	Widowed	1.11				0.97			
Educational or Work-related Qualification	PhD								
	Until Secondary/Equivalent	4.05**	3.311	(1.944–5.64)	< 0.001	1.37*	1.232	(0.776–1.956)	0.376
	Pre-Univ.Diploma	4.56**	5.290	(3.086–9.066)	< 0.001	1.94**	2.556	(1.609–4.058)	< 0.001
	University	2.5**	2.057	(1.378–3.069)	< 0.001	1.39**	1.311	(0.963–1.786)	0.086
	High Diploma	1.71*	2.119	(0.798–5.626)	0.132	0.72	0.667	(0.283–1.574)	0.356
	Master	2.67**	2.413	(1.585–3.674)	< 0.001	1.51**	1.386	(1.004–1.914)	0.047
Nationality	Saudi	1.27*				0.69**	0.594	(0.441–0.799)	0.001
Employment	Unemployed/Not working/Other								
	Working/student full time	1.23*	1.850	(1.301–2.632)	0.001	0.94			
	Working part time	0.97	1.422	(0.85–2.377)	0.180	0.69*			
	Retired	0.19**	0.598	(0.247–1.447)	0.254	0.35**			
Healthcare worker		1.74**	1.725	(1.302–2.285)	< 0.001	1.35**	1.268	(0.99–1.624)	0.060
Gross Household Income	under 5,000 SR per month								
	SR 5,000 to SR 9,999 per month	0.57**	0.622	(0.368–1.05)	0.075	1.08	1.328	(0.804–2.194)	0.268
	SR 10,000 to SR 14,999 per month	0.53**	0.626	(0.383–1.025)	0.063	1.15	1.733	(1.072–2.802)	0.025
	SR 15,000 to SR 19,999 per month	0.32**	0.437	(0.256–0.748)	0.003	0.81	1.314	(0.794–2.177)	0.288
	SR 20,000 to SR 24,999 per month	0.37**	0.485	(0.275–0.858)	0.013	0.96	1.663	(0.974–2.84)	0.063

**p-value < 0.20; ** p-value < 0.05. The first categories are the references*

		Anxiety				Depression			
	SR 25,000 and over per month	0.34**	**0.545**	**(0.335–0.885)**	**0.014**	0.64**	1.128	(0.696–1.83)	0.624
	Don't know/ Prefer not to say	0.5**	**0.524**	**(0.324–0.845)**	**0.008**	0.85	1.074	(0.67–1.721)	0.767
Perceived Current State of Health	**Fairly or Very poor/ Prefer not to say**								
	Very good	0.22**	0.259	(0.151–0.443)	**< 0.001**	0.1**	**0.090**	**(0.049–0.166)**	**< 0.001**
	Fairly good	0.65*	0.664	(0.377–1.17)	0.157	0.24**	**0.186**	**(0.099–0.35)**	**< 0.001**
	Neither good or poor	1.07	1.015	(0.481–2.141)	0.968	0.54*	**0.445**	**(0.199–0.994)**	**0.048**
At Least One Respiratory/ Cold/ Flu-like Symptom		3.1**	2.338	(1.845–2.962)	**< 0.001**	2.35**	**1.923**	**(1.547–2.391)**	**< 0.001**

**p-value < 0.20; ** p-value < 0.05. The first categories are the references*

Other socio-demographic factors were associated with higher risk perception and anxiety; being female increased the odds of worry about COVID-19 spread and anxiety by 70% and 43% compared to male, respectively and being married increased the odds of worry by 59% and the perceived susceptibility by 52%.

Adoption of preventive measures:

All the COVID-19 preventive measures listed in the survey (See Additional File 1) were adopted by more than 67% of the respondents to protect themselves). Around 98% adopted hygiene practices, 98% practiced social distancing, and 89% adopted measures related to travel avoidance. The most applied measures were washing hands more frequently with soap and water (96%), avoiding crowded areas (92%), and avoiding social events (90%) (See Additional File 2). Protecting others mostly involved covering one's nose and mouth while sneezing or coughing (66%), wearig a face mask (56%), avoiding social events (52%), and washing hands more frequently with soap and water (51%).

Hygiene Practices

Being 65 years or older decreased the odds of adopting hygiene practices compared to being 18–24 years old (OR:0.06; 95% CI:0.01,0.27) (Table 4). Being married compared to single (OR:13.21; 95% CI:3.86,45.21), being Saudi compared to being of other nationality (OR: 3.15; 95% CI: 1.26,7.89), working or studying full time in relation to not working/others (OR:3.18; 95% CI:1.24,8.17), and reporting good current states of health (very good OR: 9.64; 95% CI:3.12,29.74 and fairly good OR:4.66; 95% CI:1.29,16.77) increased the odds of hygiene practices.

Table 4

Adoption of preventive measures odds ratio estimates (OR[1] and OR) and OR 95% confidence interval (95% C.I. OR) for the multiple logistic regression mod

		Adoption of Preventive Behaviour										
		Hygiene Practices				Social Distancing				Travel Avoidance		
Socio-demographic factors		OR[1]	OR	95% C.I.OR	p-value	OR[1]	OR	95% C.I.OR	p-value	OR[1]	OR	95% C.I.OR
Age Group	18–24											
	25–34	5**	2.670	(0.684–10.427)	0.158	1.84*	0.977	(0.351–2.72)	0.964	1.21		
	35–44	2.3*	0.489	(0.144–1.66)	0.251	2.22*	**0.324**	**(0.097–1.085)**	**0.068**	1.34*		
	45–54	2.17*	0.314	(0.07–1.404)	0.130	1.51	**0.155**	**(0.036–0.672)**	**0.013**	1.33*		
	55–64	2.62	0.298	(0.038–2.31)	0.247	1.32	**0.151**	**(0.025–0.894)**	**0.037**	1.83**		
	65 years old and above	0.1**	**0.063**	**(0.014–0.277)**	**< 0.001**	0.09**	**0.061**	**(0.014–0.271)**	**< 0.001**	0.46**		
Gender	**Female**	0.34**				0.61*	**2.433**	**(1.095–5.407)**	**0.029**	0.87		
Marital status	**Single**											
	Married	7.51**	**13.216**	**(3.863–45.212)**	**< 0.001**	6.2**	**23.410**	**(7.182–76.306)**	**< 0.001**	1.86**	**1.658**	**(1.241–2.215)**
	Separated/ Divorced	1.10	1.972	(0.435–8.944)	0.379	1.68	3.307	(0.675–16.196)	0.140	0.96	0.872	(0.479–1.588)
	Widowed	0.37*	0.592	(0.08–4.37)	0.607	0.42	0.966	(0.135–6.932)	0.972	1.08	1.043	(0.243–4.466)
Educational or Work-related Qualification	**PhD**											
	Until Secondary/Equivalent	2.56*				2.26*				0.72*		
	Pre-Univ.Diploma	-				3*				1.62*		
	University	3.45**				3.77**				1.44**		
	High Diploma	-				-				2.89*		
	Master	16.13**				6.35**				1.14		
Nationality	**Saudi**	7.16**	**3.156**	**(1.261–7.899)**	**0.014**	5.67**	**2.882**	**(1.201–6.915)**	**0.018**	1.83**	**1.802**	**(1.273–2.553)**
Employment	**Unemployed/Not working/Other**											
	Working/Student full time	10.96**	**3.188**	**(1.243–8.177)**	**0.016**	7.19**	**2.597**	**(1.026–6.576)**	**0.044**	1.83**		
	Working part time	2.42**	0.372	(0.108–1.287)	0.118	3.31**	0.750	(0.186–3.017)	0.686	1.55*		
	Retired	12.56**	4.494	(0.426–47.424)	0.211	3.47**	0.692	(0.136–3.531)	0.658	1.26		
Healthcare worker		1.72				0.96	0.443	(0.181–1.083)	0.074	0.92		
Gross Household Income	**under 5,000 SR per month**											
	SR 5,000 SR to 9,999 per month	2.77*				1.86				0.95		

**p-value < 0.20; ** p-value < 0.05. The first categories are the references*

		Adoption of Preventive Behaviour										
	SR 10,000 to SR 14,999 per month	4.95**				3.12*				1.17		
	SR 15,000 to SR 19,999 per month	2.26*				1.06				1.00		
	SR 20,000 to SR 24,999 per month	10**				2.45				1.50		
	SR 25,000 and over per month	10.9**				2.69*				0.78		
	Don't know/ Prefer not to say	0.67				0.52				0.68		
Perceived Current State of Health	**Fairly or Very poor/ Prefer not to say**											
	Very good	36.8**	**9.643**	**(3.127–29.744)**	**< 0.001**	33.49**	**10.647**	**(4.014–28.241)**	**< 0.001**	5.13**	**3.130**	**(1.816–5.394)**
	Fairly good	18.83**	**4.661**	**(1.295–16.776)**	**0.018**	24.96**	**11.931**	**(3.59-39.652)**	**< 0.001**	4.83**	**3.238**	**(1.744–6.012)**
	Neither good or poor	29.1**	6.444	(0.513–80.908)	0.149	10.76**	3.896	(0.777–19.52)	0.098	5.44**	**4.013**	**(1.494–10.777)**
At least one chronic health conditions currently		0.39**				0.26**	**0.436**	**(0.203–0.938)**	**0.034**	0.93		
Chronic Condition in Members of the Household or Those Under Your Care		1.7*				1.53*				0.72**	**0.731**	**(0.553–0.966)**
At Least One Respiratory/ Cold/ Flu-like Symptom		0.2**				0.25**				0.66**		

**p-value < 0.20; ** p-value < 0.05. The first categories are the references*

Social Distancing and Travel Avoidance

The odds of social distancing increased when the respondent was female (OR:2.43; 95% CI:1.09,5.40), married (OR:23.41; 95% CI:7.18,76.30), Saudi (OR:2.88; 95% CI:1.20,6.91), working or studying full time (OR:2.59; 95% CI:1.02,6.57) and had a better current state of health (very good OR: 10.64; 95% CI:4.01,28.24 and fairly good OR:11.93; 95% CI:3.59,39.65), and decreased for older age (45–54 years old OR 0.15; 95% CI:0.03,0.67, 55–64 years old OR 0.15; 95% CI:0.02,0.89 and 65 + years old group OR 0.06; 95% CI:0.01,0.27)(Table 4). Being married (OR:1.65; 95% CI:1.24,2.21) or Saudi (OR:1.80; 95% CI:1.27,2.55) increased the odds of travel avoidance. A fair or very poor current state of health or chronic health conditions in the household or responsibilities for care of others decreased the odds of travel avoidance.

Reasons for adoption of preventive measures:
Preventive measures were applied by 93% of respondents in response to Saudi Arabia's government guidelines, followed by 52% in response to news coverage of the outbreak, and 46% in response to the growing number of COVID-19 cases in the country (See Additional File 2).

Perceived effectiveness of adoption of preventive measures:
The perceived effectiveness of adoption of hygiene practices, social distancing, and travel avoidance were 99%, 99%, and 97%, respectively. At least, 80% of respondents thought that washing hands frequently with soap and water, covering their noses and mouths while sneezing or coughing, avoiding contact with people who have a fever or respiratory symptoms, or have been to affected areas within the last 14 days, refraining from crowded areas, social events, and travel to affected and other areas in the world were very effective measures in preventing the spread of COVID-19.

Being female or single increased the odds of perceiving all three categories of preventive measures: hygiene practices, social distancing and travel avoidance as effective (Table 5). Having at least one respiratory/cold, flu-like symptom increased the odds of travel avoidance perceived effectiveness (OR: 2.79;95% 1.12,6.97) but decreased the odds for hygiene practice (OR: 0.35;95%0.16,0.77).

Table 5

Perceived Effectiveness of Preventive Measures odds ratio estimates (OR^1 and OR) and OR 95% confidence interval (95% C.I.OR) for the multiple logistic regre model.

		Perceived Effectiveness of such Behaviours											
		Hygiene Practices				Social Distancing				Travel Avoidance			
Socio-demographic factors		OR^1	OR	95% C.I.OR	p-value	OR^1	OR	95% C.I.OR	p-value	OR^1	OR	95% C.I.OR	p-va
Age Group	18–24												
	25–34	2.32*				1.63				1.27			
	35–44	1.39				0.46*				0.56*			
	45–54	0.39**				0.34*				0.5*			
	55–64	-				-				0.80			
	65 years old and above	0.54				-				-			
Gender	Female	2.7**	4.113	(1.535–11.02)	0.005	2.55**	2.669	(1.036–6.874)	0.042	3.93**	4.417	(1.997–9.774)	< 0
Marital status	Single												
	Married	0.70	0.769	(0.169–3.503)	0.734	0.38**	0.321	(0.108–0.953)	0.041	0.5**	0.828	(0.39–1.76)	0
	Separated/ Divorced	0.19**	0.109	(0.02–0.597)	0.011	0.29*	0.166	(0.028–0.976)	0.047	0.33**	0.252	(0.073–0.865)	0
	Widowed	0.19*	0.160	(0.009–2.951)	0.218	0.06**	0.035	(0.004–0.307)	0.003	0.15**	0.098	(0.014–0.687)	0
Educational or Work-related Qualification	PhD												
	Until Secondary/Equivalent	1.14				0.76	0.367	(0.071–1.885)	0.230	0.70	0.357	(0.111–1.155)	0
	Pre-Univ.Diploma	0.33**				0.22**	0.168	(0.049–0.584)	0.005	0.47*	0.446	(0.15–1.332)	0
	University	2.08*				1.05	0.599	(0.2-1.794)	0.360	1.56	0.840	(0.355–1.986)	0
	High Diploma	-				-	-			-	-		
	Master	1.28				0.85	0.560	(0.166–1.893)	0.351	0.45**	0.313	(0.146–0.669)	0
Nationality	Saudi	0.61				1.21				3.32**	3.174	(1.741–5.783)	0
Employment	Unemployed/Not working/Other												
	Working/student full time	0.40				0.63				0.59			
	Working part time	0.17**				0.26*				0.32**			
	Retired	0.29*				0.45				0.33*			
Healthcare worker		0.65				1.13				0.98			
Gross Household Income	under 5,000 SR per month												
	SR 5,000 SR to 9,999 per month	0.38				2.13				0.64			
	SR 10,000 to SR 14,999 per month	3.53				11.04**				0.81			

**p-value < 0.20; ** p-value < 0.05. The first categories are the references.*

		Perceived Effectiveness of such Behaviours											
	SR 15,000 to SR 19,999 per month	0.32				1.42				0.68			
	SR 20,000 to SR 24,999 per month	0.40				1.72				0.80			
	SR 25,000 and over per month	0.50				2.44*				0.79			
	Don't know/ Prefer not to say	0.33				1.53				0.48			
Perceived Current State of Health	**Fairly or Very poor/ Prefer not to say**												
	Very good	1.38				7.64**	**12.394**	**(4.737–32.428)**	**< 0.001**	2.22*	**3.661**	**(1.254–10.692)**	**0**
	Fairly good	2.08				55.65**	**75.234**	**(5.757-983.184)**	**0.001**	5.42**	**9.020**	**(2.169–37.517)**	**0**
	Neither good or poor	1.08				16.96*	17.434	(0.61-498.564)	0.095	1.40	1.658	(0.329–8.349)	0
At Least One Chronic Health Conditions Currently		0.5**				0.88				1.7**			
Chronic Condition in Members of the Household or Those Under Your Care		1.97*				1.76*				0.89			
At Least One Respiratory/ Cold/ Flu-like Symptom		0.5*	**0.352**	**(0.161–0.772)**	**0.009**	1.49				3.22**	**2.795**	**(1.121–6.97)**	**0**
**p-value < 0.20; ** p-value < 0.05. The first categories are the references.*													

Self-isolation:

Most respondents believe they were able (88%) and willing to self-isolate (82%), but over 40% would need to stock up on food supplies and toiletries in preparation (See Additional File 2). In three out of five age groups, the odds of being able to self-isolate decreased compared to the 18–24 year old group; being 25–34 year old decreased the odds by 47%, 35–44 years old decreased the odds by 53% and 65 + year old decreased the odds by 68%. Being married or retired increased the odds of being able to self-isolate compared to being single and unemployed/not working/other (OR:1.50;95% 1.02,2.23;and 11.60;95%2.19,61.46), respectively. Four out of the five gross household income compared to the lowest had higher odds of being able and willing to self-isolate; the 5,000 to 9,999 SR per month group increased the odds by 88% and 63%, the odds of the 10,000 to 14,999 SR per month group were 2.7 and 2.8 times larger, the odds of the 20,000 to 24,999 SR per month group were 2.2 and 3.5 times larger and the odds of the 25,000 SR per month and over were 2.1 and 1.8 time larger. At least one respiratory/ cold/ flu-like symptom decreased the odds of self-isolation by 45% and 41% to being able and willing to self-isolate, respectively (Table 6). The main worry about self-isolation was its effect on their mental health (39%) and how difficult it would be to separate themselves from those in their household (30%) (See Additional File 2). Although most respondents would report or seek help if they experience symptoms of COVID-19, 6% would not do so if they experienced severe or moderate symptoms and 11% if they experienced mild symptoms.

Table 6

Self-Isolation odds ratio estimates (OR[1] and OR) and OR 95% confidence interval (95% C.I.OR) for the multiple logistic regression model.

		Self-Isolation							
		Able				Willing			
Socio-demographic factors		OR[1]	OR	95% C.I.OR	p-value	OR[1]	OR	95% C.I.OR	p-value
Age Group	18–24								
	25–34	0.74*	0.532	(0.353–0.801)	0.002	0.96	0.841	(0.613–1.154)	0.284
	35–44	0.67**	0.467	(0.286–0.762)	0.002	1.00	0.990	(0.7-1.398)	0.953
	45–54	1.59*	0.967	(0.519–1.805)	0.917	1.83**	1.816	(1.175–2.807)	0.007
	55–64	1.73*	0.802	(0.366–1.757)	0.581	2.87**	2.690	(1.457–4.965)	0.002
	65 years old and above	0.52**	0.324	(0.146–0.717)	0.005	0.93	0.941	(0.521-1.7)	0.841
Gender	Female	1.01	1.266	(0.96–1.671)	0.095	0.99			
Marital status	Single								
	Married	1.39**	1.509	(1.02–2.233)	0.039	1.47**			
	Separated/ Divorced	1.13	1.155	(0.573–2.33)	0.686	1.18			
	Widowed	0.64	0.514	(0.134–1.966)	0.331	0.92			
Educational or Work- related Qualification	PhD								
	Until Secondary/Equivalent	1.06				0.77*			
	Pre-Univ.Diploma	0.67*				0.99			
	University	0.83				0.88			
	High Diploma	1.60				1.32			
	Master	0.85				1.17			
Nationality	Saudi	1.83**	1.424	(0.985–2.06)	0.060	1.46**	1.388	(1.009–1.909)	0.044
Employment	Unemployed/Not working/Other								
	Working/student full time	1.53**	1.271	(0.864–1.87)	0.223	1.4**			
	Working part time	1.22	0.933	(0.542–1.608)	0.804	1.32*			
	Retired	19.95**	11.608	(2.192–61.469)	0.004	5.49**			
Healthcare worker		0.81*				1.06			
Gross Household Income	under 5,000 SR per month								
	SR 5,000 SR to 9,999 per month	2.16**	1.882	(1.035–3.42)	0.038	1.87**	1.631	(0.984–2.703)	0.058
	SR 10,000 to SR 14,999 per month	3.31**	2.662	(1.477-4.8)	0.001	3.61**	2.837	(1.708–4.713)	< 0.001
	SR 15,000 to SR 19,999 per month	1.6*	1.104	(0.627–1.944)	0.733	1.65**	1.148	(0.701–1.879)	0.584
	SR 20,000 to SR 24,999 per month	3**	2.202	(1.126–4.305)	0.021	4.57**	3.508	(1.901–6.473)	< 0.001

**p-value < 0.20; ** p-value < 0.05. The first categories are the references.*

		Self-Isolation							
	SR 25,000 and over per month	3.13**	**2.079**	**(1.184–3.648)**	**0.011**	2.71**	**1.822**	**(1.132–2.933)**	**0.013**
	Don't know/ Prefer not to say	1.62**	1.333	(0.783–2.27)	0.290	1.95**	**1.633**	**(1.026–2.599)**	**0.039**
Perceived Current State of Health	**Fairly or Very poor/ Prefer not to say**								
	Very good	4.45**	**2.361**	**(1.319–4.224)**	**0.004**	3.36**	**2.336**	**(1.399-3.9)**	**0.001**
	Fairly good	2.68**	1.447	(0.775–2.704)	0.246	2.83**	**2.045**	**(1.171–3.571)**	**0.012**
	Neither good or poor	2.45**	1.300	(0.546–3.094)	0.554	1.66*	1.233	(0.585-2.6)	0.582
At Least One Chronic Health Conditions Currently		0.72**				0.8**			
Chronic Condition in Members of the Household or Those Under Your Care		0.94				0.97			
At Least One Respiratory/ Cold/ Flu-like Symptom		0.43**	**0.545**	**(0.412–0.721)**	**< 0.001**	0.5**	**0.591**	**(0.464–0.752)**	**< 0.001**
**p-value < 0.20; ** p-value < 0.05. The first categories are the references.*									

Personal experience of problems associated with COVID-19:

More than half the respondents (54%) experienced/witnessed spreading of misinformation about COVID-19 and only 4% experienced or witnessed violence in relation to COVID-19 (See Additional File 2).

Temporal differences:

During the lockdown period (21 April-22 May), 1,767 respondents completed the survey, and in the post lockdown period (31 May-21 June) 606 completed the survey. There was a significant difference in anxiety during lockdown compared to post lockdown (10% vs 14%, $P = 0.03$). There was no significant difference in the adoption of preventive measures; however, the perceived effectiveness of social distancing was slightly higher in the post lockdown period compared to lockdown (99.8% vs. 98.4%, $P = 0.02$). As for hygiene practices' perceived effectiveness, there was a slightly significant difference between the two periods with a slight increase in the post lockdown period. There was no significant difference between the two periods in being able and/or willing to self-isolate.

Discussion

This survey provides important insights into risk perception and adoption of preventive measures in a sample population of 2,393 Saudi adults during the lockdown and post lockdown periods in the early months of the COVID-19 pandemic. Most respondents reported that they were worried about the spread of COVID-19 and believed that if they were infected it would be either a moderate infection that requires bed rest or a severe one. Around 11% reported high anxiety levels in 14 days prior to participating in the survey. The level of anxiety post-lockdown was higher than that during the lockdown period, accompanied with an increase in the perceived effectiveness of hygiene practices and social distancing to reduce the chances of COVID-19 infection. Washing hands frequently with soap and water and avoiding crowds and social events were reported as the most adopted measures to protect oneself. While protecting others involved mostly covering one's nose and mouth while sneezing or coughing rather than wearing a mask

Comparison with similar studies in existing literature:

When compared to two studies using the same survey tool, one in the United Kingdom (UK) (22, 23) with 2,108 respondents and another in Hong Kong (HK) (12) with 1,715 respondents; both studies reported high levels of worry about the pandemic. Unlike the study based in the UK, but similar to the study based in HK, the perceived effectiveness of preventive measures and their adoption was high in this study. This might reflect the experience Saudi Arabia and HK had with the previous epidemics of SARS (28)and MERS (29), respectively. The source of information most commonly used in the UK population was television (22, 23), while for HK, social media platforms and websites (both official and unofficial) were used (12); while for Saudi Arabia official websites and their social media platforms were used. Adoption of social distancing measures was higher in Saudi Arabia compared to the UK (45.2%) (22, 23) and HK (range: 39%-93%) (12). The greater use of official websites and level of adoption of social distancing measures might be explained by the differences in context, timing and duration of data collection. In Saudi Arabi, the survey was available for almost two months during lockdown and post lockdown; additionally, the government used a transparent approach by having a large media presence and awareness messages provided by Saudi Arabia's Ministry of Health on a daily basis through their scheduled media conferences (4, 30). The effect of their approach is clear in this study with official websites and their associated social media outlets being used as the main source of information and perceived as the most reliable source of information by the majority of respondents. That might reflect trust in the government, which was reported by another cross-sectional study that assessed Saudi Arabian population's trust and compliance with measures enforced by the government to prevent or reduce COVID-19 transmission during the early phase of the pandemic and found high levels of trust (31).

Despite the fact that the elderly are more vulnerable to COVID-19, in this study the adoption of hygiene practices and social distancing was lower (in both adjusted and unadjusted models) amongst those aged 65 years and older compared to the youngest age group. This finding contradicts with the findings of the study in the UK, where social distancing was adopted more amongst those aged 70 years and older (22, 23). This association between age and adoption of preventive measures has been explored in other studies and it showed inconsistencies across different countries and during different pandemics (23, 28, 32, 33) .In addition, perceived susceptibility levels were also lower among this age group, and that was similar to a survey conducted in Germany where the elderly reported lower risk perception (34). This might be related to optimism bias where people expect better results than reality(35) (i.e. in the case of Saudi Arabia, there might be a belief that the risk is low if they are practicing some degree of preventive measures). Moreover, in Saudi Arabia, religious beliefs tend to have a stronger effect on elderly health behaviors and perceptions(7). As for the differences between genders, females tend to have higher perceived susceptibility and adoption of preventive measures compared to males across different studies(12, 28, 32, 33, 36, 37). Females also had higher levels of anxiety compared to males, which was also measured in another study conducted in Saudi Arabia during the pandemic (38). The same study showed that those practicing social distancing or hygiene practices were less likely to have anxiety, but this was not seen in the present study (38). Even for certain older age groups who had lower anxiety levels compared to the younger age groups, they were not practicing preventive measures. The differences in associations between socio- demographic factors, perceived risk perceptions, anxiety levels during pandemics and adoption of preventive measures seem inconsistent across studies and warrant further investigation

Public Health recommendations:

This study has certain implications for public health and healthy policy. The most prominent one is the trust that people have in the government recommendations in Saudi Arabia, this was highlighted when the majority of the respondents reported official government social media accounts and websites as their first trustworthy source of information, and the reason for adherence or adoption of preventive measures was based on government recommendations; other cross-sectional studies showed similar favorable attitudes toward the government during the early phase of the pandemic (31, 39). The willingness of the public to report their symptoms to health authorities and the high rate of preventive measures adoption might be to some degree influenced by government efforts. As well as the high use of social media and website account of authorities, should be taken into consideration with the current non-pharmaceutical interventions applied by the government and for COVID-19 vaccinations or treatment when available (40–42).

The temporal differences in anxiety levels between lockdown and post lockdown might indicate a need for well-being intervention programs and a focus on designing health awareness messages that do not raise anxiety to the degree that could increase the burden of poor mental health associated with the pandemic worldwide (38, 43–45).

Another point to consider is how to facilitate the process of self-isolation which is currently recommended for those with mild COVID-19 symptoms or those who were in contact with a COVID-19 case in Saudi Arabia (3). There are certain factors that were associated with a decrease in willingness or/and ability to self-isolate that need to be targeted. The first one was having at least one flu symptom in the last 14 days of filling the survey, people who had symptoms were less likely to be able or willing to self-isolate; that might have reflected their own experience. The second involves those with the lowest category of income compared to others. Those two groups need to be targeted to facilitate their adoption of self-isolation as they are more likely to be vulnerable to COVID-19 (1, 3, 12, 23). While taking into consideration the most common worries with regard to self-isolation, e.g., inability to provide food and medication or inability to self-isolate from family members or those living in the same household. Interventions or programs to help deliver food and medication to those who are self-isolating, especially those with no help available from friends and families or are economically disadvantaged, need to be available. Examples of such services include but is not limited to help with grocery shopping, collecting medication from pharmacies, and befriending services for people who suffer loneliness.

The final point has to do with future research, this study showed the potential to further investigate the effect of socio-demographic characteristics on the population's adoption of preventive measures and risk perception, and the role of context across countries. For Saudi Arabia specifically, research interest during COVID 19 is oriented more toward epidemiology and understanding the disease's pathway and treatment. However, it is important to understand why older population and those with lower socio-economic status have lower risk perception and adoption of preventive measures compared to the younger population. By understanding their perceptions and barriers, interventions can be developed for these groups informed by evidence. And understanding how people in general perceive risk of the disease and react to system and individual level preventive measures for the control of future outbreaks is urgently needed and can be gained through the use of qualitative studies(14).

Strengths and limitations:

One of the key strengths of this study is the use of an online method to collect data resulting in a large sample that exceeded the required sample size. In addition, temporal changes were investigated as the pandemic progressed and the government's suppressive measures changed. The survey tool used in this study was also applied in other international research groups, which may enable cross-country comparisons. The translation process followed the WHO guidelines for translating instruments (24) and used quantitative and qualitative methods to ensure a rigorous process. As for the limitations, the study design does not allow for causal inferences. The online method might have excluded an important group of the population (the elderly, people with learning disabilities or those without access to the internet), who might have been equally or more vulnerable to COVID-19, also, self-reported data may be a possible source of error. Furthermore, the sample was obtained through convenience sampling and contained people from a higher socio-economic status, which might potentially exclude the deprived socio-economic groups.

Conclusion

During an emerging pandemic, there is a great reliance on the public to adopt and practice preventive measures in order to stop the spread of the virus, particularly when pharmaceutical interventions are not yet available on a large scale. Understanding the factors that influence public's response can assist in

developing targeted interventions to facilitate adoption of preventive measures. By targeting specific groups through either providing appropriate resources or directing tailored interventions to change people's behavior, it could help in increasing adoption of preventive measures and help in reducing COVID-19 related morbidity and mortality rate.

Abbreviations

WHO World Health Organization

UK United Kingdom

HK Hong Kong

AR Adjusted Residuals

OR Odds Ratios

COVID-19 COrona VIrus Disease-19

SR Saudi Riyal

Declarations

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

A summary of the research was included at the beginning of the web-based survey. In order to complete the survey, respondents had to provide consent into the study via a tick box. Data was not collected until respondents agreed to complete the survey. No incentives were used for completing the survey or distributing it. Approval for study procedures was obtained by King Saud University Institutional Review Board (Reference number: KSU-HE-20-143) and King Fahad Medical City Institutional Review Board (Reference number: 20-298E).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Availability of Data and Materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Contributions

All authors conceptualized the study; GA collected the data and drafted the manuscript; GA and FA interpreted data; GA,FA,SA and GJ translated the survey; GA and RDS analyzed the data and RDS performed statistical analysis; all authors critically reviewed and improved the manuscript. All authors substantially contributed to the study and approved its submission.

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