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Adherence to COVID-19 prevention control and healthy eating habits among infected and uninfected residents of Saudi Arabia

Suzan A. Abushal

¹Department of Food Science and Nutrition, College Turabah University, Taif University, Ministry of Education, Kingdom of Saudi Arabia.



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ABSTRACT

COVID-19 became a major global threat that turned pandemic. The aim of this work was to assess the health nutrition awareness represented in prevention control and healthy eating habits among infected and uninfected residents of Saudi Arabia. We conducted an electronic questionnaire on social media between July and September 2020, was completed by a total of 976 Saudi Arabian residents from 8 provinces, and after validation, only 446 respondents have been included in the study (aged between 20 and 68 years, 59.64% female, 79% university-educated. The highest infection rate showed in Mecca (81.82%) due to its religious importance. The majority of infected respondents stated that they received healthcare at home (82.92%). Chronic diseases; asthma, cardiovascular, diabetes and Inflammatory bowel disease (IBD) showed to be high-risk groups for COVID-19 infection that represented (20.15, 15.67, 22.39 and 13.43%, respectively) of infected populations. Most of the infected participants poorly adhered with recommended safety measures; hand wash, sanitizers, face mask and physical distancing (79%, 77%, 62% and 61%). Good intake of antioxidants from food (39.77 and 53.19% respectively). Nutrition awareness showed to be related to education level, as 75% of PhD holders adhered to healthy eating behaviour and used immune boost foods (myrrh, pumpkin and turmeric). Obtained results could represent good guidance to governmental plans for pandemic management based on predicted population behaviour for a brighter future of health and wellbeing.

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Introduction

Coronaviruses (CoVs) are single-stranded RNA viruses that can infect both animals and humans. COVID-19 disease has been characterized by lower and upper respiratory tract infection and further critical complications which lead to premature mortality (Saied et al., 2021). Early in April 2020, WHO was reporting a continued steep rise in the number of cases and deaths worldwide, with the pandemic spreading to at least 240 countries and territories, according to the organization's COVID-19 report released on July 28, 2020, the latest number of total confirmed cases

and death worldwide are 268,327,816 and 5,298,992 respectively (World Health Organization, 2021).

Health nutrition awareness plays a crucial role in reducing infection and related problems by promoting good health, increasing care outcomes, and avoiding future health issues (WHO-EMRO, 2021). Additionally, higher nutritional awareness is related to healthier eating habits and stronger nutritional status. Additionally, people should be informed about disease symptoms, actions to take to protect themselves and those around them. In order to reduce the risk and consequences of infections, the intakes

*Corresponding author E-mail address: suzan.a.abushal@gmail.com (Suzan A. Abushal)

for some micronutrients may exceed the recommended dietary allowances since infections can reduce micronutrient status (Medeiros de Morais, 2021). Dietary habits had changed significantly during the COVID-19 pandemic among Riyadh residents; the quality and the quantity of the food was compromised (Alhusseini and Alqahtani, 2020).

Saudi Arabia has implemented a series of ongoing precautionary measures to control the spread of COVID-19 infection and to provide early detection strategies for the disease (Khan et al., 2021). Subsequently, a general curfew was placed on the residents and citizens of Saudi Arabia in an attempt to curtail the spread of the virus (Saudi Ministry of Health, 2021).

Nutritional therapy, as well, is an essential component for the successful treatment and recovery of COVID-19 patients.

Thus, this survey aimed to assess the health nutrition awareness represented in adherence to COVID-19 prevention control and healthy eating habits among infected and uninfected residents of Saudi Arabia to introduce good guidance for designed governmental strategies for pandemic management based on predicted population behaviour for brighter future of health and wellbeing.

Materials and Methods

Study design and participants

A sample of 446 adults from different provinces of Saudi Arabia was enrolled. The inclusion criteria were citizens and residents of Saudi Arabia age ≥ 20 years old, either male or female. The survey was conducted from 11th July to 14th of September 2020. Participants were asked to fill out an anonymous electronic questionnaire (as an appendix) that was specifically built using Google Form and distributed on various platforms, such as WhatsApp, Twitter, and email in order to reach out to all society members; the questionnaire link was sent to the authors' relatives, friends, and neighbors to participate in the study and to share the link with their contacts. Three researchers reviewed the questionnaire tool to evaluate the appropriateness, relevancy, clarity, and adequacy of the questions.

Study questionnaire and instruments

The questionnaire had five sections. The first section included socio-demographic characteristics such as age; gender, nationality, place of residence, education, marital status, monthly income in Saudi Riyal (SR) and anthropometric measurements, including self-reported weight in kilograms and height in centimeters which were used to calculate the body mass index (BMI) (WHO, 2006,

2014); the second section covered healthy lifestyle habits such as disease history, smoking, taste and smell sense; the third section contained questions about respondents' adherence to the Ministry of Health (MOH) instructions on COVID-19 pandemic preventive measures (specifically hand washing wearing of face masks and social distancing) ; the fourth section included food hygiene pattern such as intake vitamins and antioxidants supplements; appetite and different foods and cooking methods that enhance the immune system; while the fifth section included nutritional awareness, participants were asked about their preferred consumption some food such as fruits, vegetables, salt, sugar, honey, ginger, garlic, onion; consumption breakfast, dinner, snacks and cooking methods.

Statistical analyses

Categorical variables are presented as counts and percentages. The chi-square test was used to determine the association between categorical variables. The correlation between variables and nutrition awareness score was calculated with component loadings. In this analysis, values >0.3 were considered as having an effect on the component construction. Each participant was given a score based on the sum of the component loadings of each food group. Results were significant for p-value < 0.05 . Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM, Chicago, IL, USA) (Ismail et al., 2020).

Results and discussion

Socio-demographic and anthropometric characteristics

Participants On the 14th of Sept 2020, at the end of the web-survey, was concluded, and the collected data were analyzed. Table (1) reported the Socio-demographic and anthropometric characteristics of participants. A total of 976 participants completed the questionnaire, and after validation of the data, only 446 respondents have been included in the study, aged between 20 and 68 years. The female respondents represented 59.64% of the participants and showed to be more exposed to infection than males (58.52% of infected). According to age distribution, the sample reflected that 58.3% of internet users are older than 30 years, however, most of the respondents (41.70%) aged between 20-30 years who happened to be more exposed to COVID-19 infection (44.32%). Most of the respondents were Saudi (89.24%), university graduates with a bachelor's degree (70.85%), whereas 13.90% of participants possess educational qualifications of secondary school. The respondents income fluctuated between 3000- 6000, 6001- 10000 or < 10000 (31.84, 26.01, 26.46%) respectively. Body Mass Index (BMI) of

most respondents was overweight (38.57%) followed by normal then obesity I (28.25, 20.18%), respectively.

The questionnaire spread to cover 8 Saudi provinces; 3 Western Provinces; Mecca (84.75%), El Madinah (4.93%), Al Bahah (1.79%), one Eastern Province; Dammam (4.04%), two in the center; Riyadh (2.24%), Al Qassim (0.45%), One Northern Province; Tabuk (1.35%) and one Southern Province, Jizan (0.45%). The highest infection rate showed in Mecca (81.82%) then with great significance El Madinah and Dammam (6.25, 5.11%) (Fig.1). Due to lock down, where people worked from home and E-learning in schools and universities (Al-

Musharaf, 2020), only religious sites (Mecca and El Madinah) showed higher infection.

Healthcare and symptoms during COVID-19 infection

The majority of infected respondents stated that they received healthcare at homes (82.92%) (Fig. 2A), 13.64% at hospitals and only 3.41% were isolated in a hotel. Adherence to self-isolation depends on knowledge, motivation, and opportunity (Smith et al., 2021). The activity that was most likely previously reported during self-isolation was going out for medical reasons other than getting or returning a COVID-19 (Brown, 2021).

Table 1 Socio-demographic and anthropometric characteristics of participants

Variable		Infected		Uninfected		Total		p-value
		n= 352	%	n= 94	%	n= 446	%	
Gender	Male	146	41.48	34	36.17	180	40.36	0.351
	Female	206	58.52	60	63.83	266	59.64	
Age group (Years)	20-30	156	44.32	30	31.91	186	41.70	0.007
	31-40	70	19.89	12	12.77	82	18.39	
	41-50	80	22.73	38	40.43	118	26.46	
	51-60	30	8.52	10	10.64	40	8.97	
	>60	16	4.55	4	4.26	20	4.48	
Marital status	Married	100	28.41	22	23.40	122	27.35	0.064
	Single	232	65.91	72	76.60	304	68.16	
	Divorced	12	3.41	0	0.00	12	2.69	
	Widowed	8	2.27	0	0.00	8	1.79	
Nationality	Saudi	312	88.64	86	91.49	398	89.24	0.428
	Other	40	11.36	8	8.51	48	10.76	
Education	Ph.D.	8	2.27	0	0.00	8	1.79	0.378
	M.Sc.	22	6.25	6	6.38	28	6.28	
	B.Sc.	248	70.45	68	72.34	316	70.85	
	Secondary	48	13.64	14	14.89	62	13.90	
	Preparatory	14	3.98	6	6.38	20	4.48	
	Primary	8	2.27	0	0.00	8	1.79	
	Illiterate	4	1.14	0	0.00	4	0.90	
Monthly Income (S.R)	< 3000	50	14.20	20	21.28	70	15.70	0.180
	3000 – 6000	112	31.82	30	31.91	142	31.84	
	6001 – 10000	90	25.57	26	27.66	116	26.01	
	>10000	100	28.41	18	19.15	118	26.46	
BMI	Underweight	14	3.98	0	0.00	14	3.14	0.011
	Normal	104	29.55	22	23.40	126	28.25	
	Overweight	134	38.07	38	40.43	172	38.57	
	Obesity I	65	18.47	25	26.60	90	20.18	
	Obesity II	19	5.40	5	5.32	24	5.38	
	Obesity III	16	4.55	4	4.26	20	4.48	

- BMI, Body Mass Index (Kg/m²), Normal, 18.5-24.9; Overweight, 25-29.9; Obesity I, 30-34.9; Obesity II, 35-39.9; Obesity III, 40 or more (WHO, 2006, 2014)

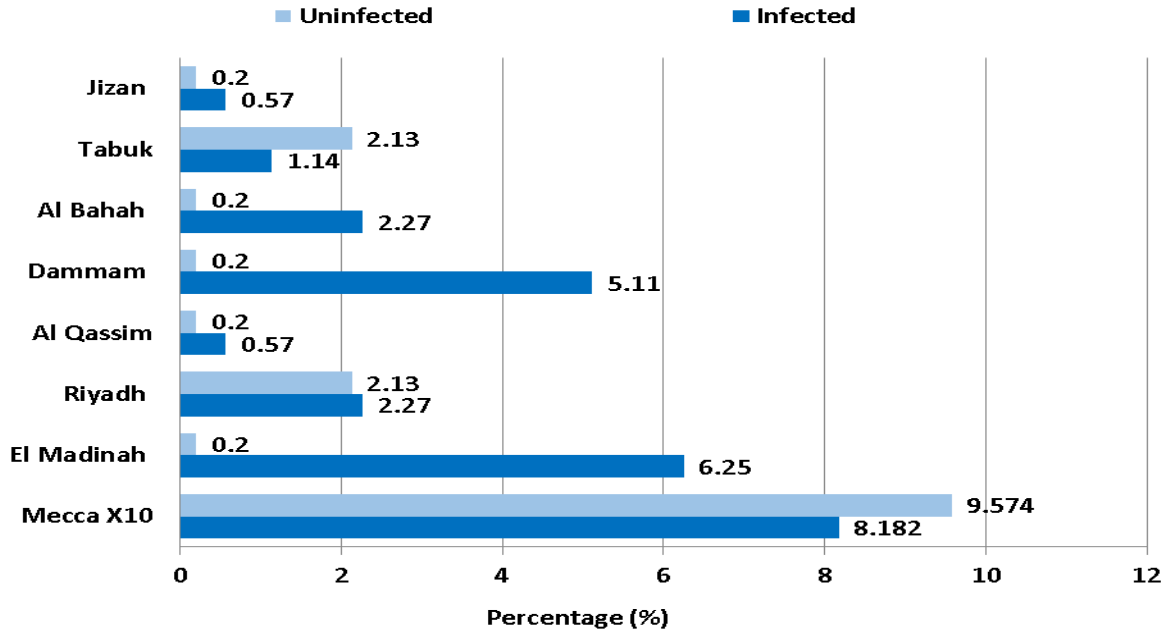


Fig 1. Location distribution of COVID-19 infected and uninfected participants.

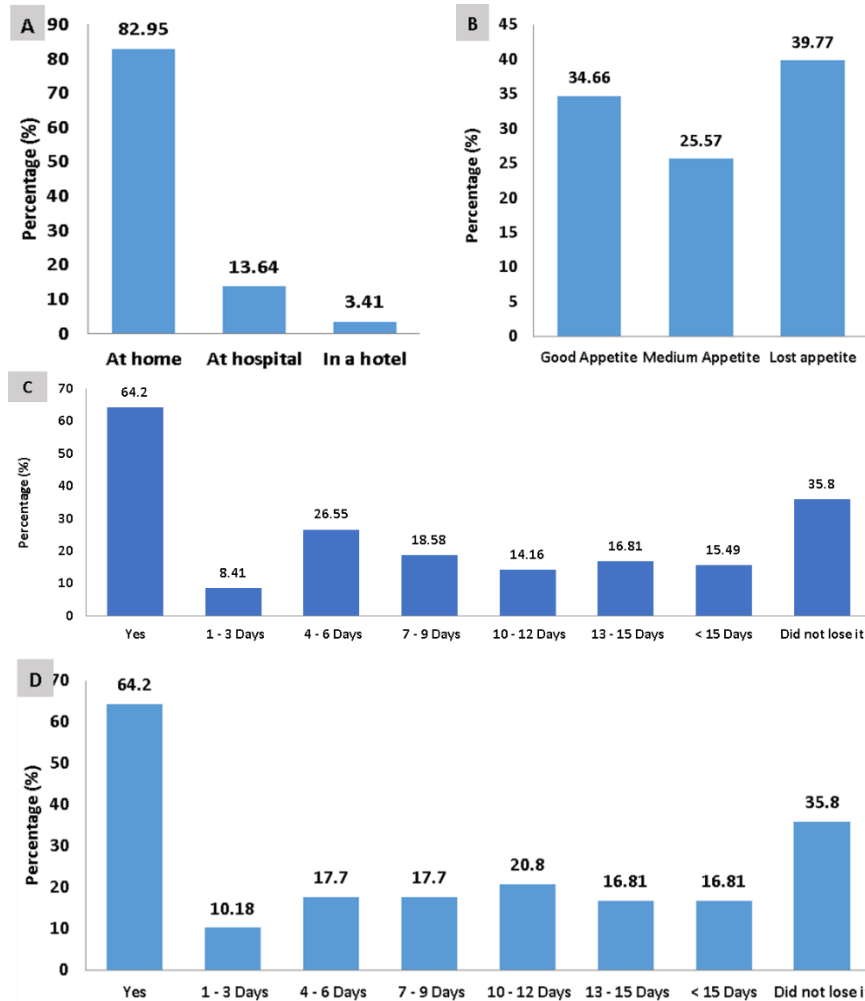


Fig 2. Healthcare and symptoms during COVID-19 infection where study sample (n = 446). A, Healthcare place; B, Appetite during COVID-19 infection; C, Losing taste sense; D, Losing smell sense.

Associations between health status and COVID-19 infection

Health status of the COVID-19 infected and uninfected participants with regards to chronic disease are exhibited in Tables 2 & 3. The only health status that showed an association with COVID-19 infection are chronic diseases (Table 2), especially asthma, cardiovascular, diabetes and Inflammatory bowel disease (IBD) (Table 3). The infected participants with these chronic diseases compromised (20.15, 15.67, 22.39 and 13.43%) compared with (5.88, 5.88, 17.65 and 11.76%) of uninfected participants, respectively. On the other hand, high pressure and chronic thyroiditis disease did not show to be related with COVID-19 infection, as they revealed more uninfected participants (41.18 and 17.65%) comparing to (14.93 and 12.69%) infected participants respectively. Smoking did not show to be threatening with infection as 15.34% of infected participants were smokers versus 23.40% of uninfected smokers. Pre-infection with Middle East Corona, seasonal flu or pre-infected family members did not show significant effects on COVID-19 infections compared to uninfected participants. The association between some prevalent chronic diseases and increased risk of COVID-19 was previously reported. It brings a greater understanding of the community's risk perceptions

of serious COVID-19 disease (Laires et al., 2021). Hence, these data may aid health authorities to better adapt measures to the real needs of the population and to identify vulnerable individuals requiring education, awareness and vaccination for preventive measures.

Adherence to safety measures to avoid COVID-19 infection

Variables of adherence to safety measures to avoid COVID-19 infection represented in; hand wash, hand sterilization, wearing face mask and keeping physical distancing are illustrated in Table (4). Poor adherence with recommended safety measures of COVID-19 was observed among the infected participants as 79% adhered to frequent hand wash, 77% used sanitizers, 62% adhered to wearing face mask and 61% kept physical distancing more than one meter. On the other hand, uninfected participants adhered to the same safety measures with higher percentages of 87%, 85%, 68% and 68%, respectively. This was available evidence implies with that wearing face masks protect people (both healthcare workers and the general public), sanitized hands, and physical distancing could play a crucial role in avoiding infection by coronaviruses. These results came in agreement with Yehualashet et al., (2021).

Table 2 Health status of the infected and uninfected participants

Variable		Infected		Uninfected		Total		P-
		n= 352	%	n= 94	%	n= 446	%	
Chronic Diseases	Yes	134	38.07	34	36.17	168	37.67	0.736
	No	218	61.93	60	63.83	278	62.33	
Smoking	Yes	54	15.34	22	23.40	76	17.04	0.065
	No	298	84.66	72	76.60	370	82.96	
Middle East Corona	Yes	80	22.73	24	25.53	104	23.32	0.568
	No	272	77.27	70	74.47	342	76.68	
Seasonal Flu	Yes	134	38.07	42	44.68	176	39.46	0.244
	No	218	61.93	52	55.32	270	60.54	
Pre-Corona Family	Yes	124	35.23	32	34.04	156	34.98	0.092
	No	228	64.77	62	65.96	290	65.02	

Table 3 Chronic diseases cases among participants

Variable	Infected		Uninfected		Total	
	n=134	%	n=34	%	n=168	%
Asthma	27	20.15	2	5.88	29	17.26
Cardio vascular disease (CVD)	21	15.67	2	5.88	23	13.69
High pressure	20	14.93	14	41.18	34	20.24
Diabetes	30	22.39	6	17.65	36	21.43
<i>Chronic thyroiditis disease</i>	17	12.69	6	17.65	23	13.69
Inflammatory bowel disease (IBD)	18	13.43	4	11.76	22	13.10
Chronic liver disease (CLD)	1	0.75	0	0.00	1	0.60

Table 4 Adherence to safety measures to avoid COVID-19 infection

Variable		Infected		Uninfected		Total		<i>p</i> -value
		n =352	%	n = 94	%	n = 446	%	
Hand wash	Yes	280	80.68	82	87.23	362	81.17	0.000
	Sometimes	64	14.20	10	10.64	74	16.59	
	No	8	5.12	2	2.13	10	2.24	
Use hand sanitizer	Yes	284	77.84	70	74.47	354	79.37	0.328
	Sometimes	50	14.20	16	17.02	66	13.45	
	No	18	7.95	8	8.51	26	7.17	
Wearing face mask	Yes	218	61.93	64	68.09	282	63.22	0.000
	Sometimes	20	5.68	12	12.77	32	7.17	
	No	114	32.39	18	19.15	132	29.59	
Keeping physical distance	Yes	216	61.36	64	68.09	280	72.54	0.000
	Sometimes	118	33.52	8	8.51	126	17.10	
	No	18	5.11	22	23.40	40	10.36	

Healthy eating behaviour among participants

Participants were asked about their perception of overall healthy eating behaviour and healthy lifestyle either infected or uninfected with COVID-19. Most of the infected population (53.41%) declared higher vitamins intake versus (38%) of the uninfected (Table 5). This may rely to COVID-19 followed protocol in Saudi Arabia that depends on vitamins intake (Saudi Ministry of Health, 2021). On the contrary, uninfected participants gave priority to foods that boost immunity with a percentage of (97.87%) that exceeded the infected participants (87.5%). On the other hand, both infected and uninfected populations were keen to attain a good intake of antioxidants from food (39.77 and 53.19%, respectively). Considering cooking methods that boost immunity; grilling (23.30%) and braising (15.91%) (Table 6), were the most applied cooking methods for infected participants, which reflected poor behaviour that 61.93 % them indicated their ignorance to follow healthy cooking methods (Table 5). Similar attitude was recorded for the uninfected population

as baking and grilling (25.53 and 19.15% respectively) (Table 6), were their main cooking methods, and 55.32% indicated not to follow cooking methods that boost immunity (Table 5). Enhanced dietary intake, positive cooking behaviours, changes in cooking and food practices are shown to be important variables related diet quality (Murphy et al., 2021).

Fig. 3 could reflect adherence to healthy eating habits by COVID-19 infected and uninfected participants. Uninfected participants showed more adherence to healthy eating habits by eating more fruits and vegetables, giving importance to take breakfast, light snack meals and less tea, coffee, salt and sugar intake with percentages of 72.34, 60.64, 55.32, 34.04, 10.64, 14.89% respectively, versus 52.84, 51.14, 36.93, 38.07, 18.18, 19.89% in infected participants.

These results were compatible with variations in food preference shown in Fig. 4, where uninfected showed higher interest in fruits, vegetables, legumes, spices, milk and dairy products, meat and nuts. Therefore, nutrition

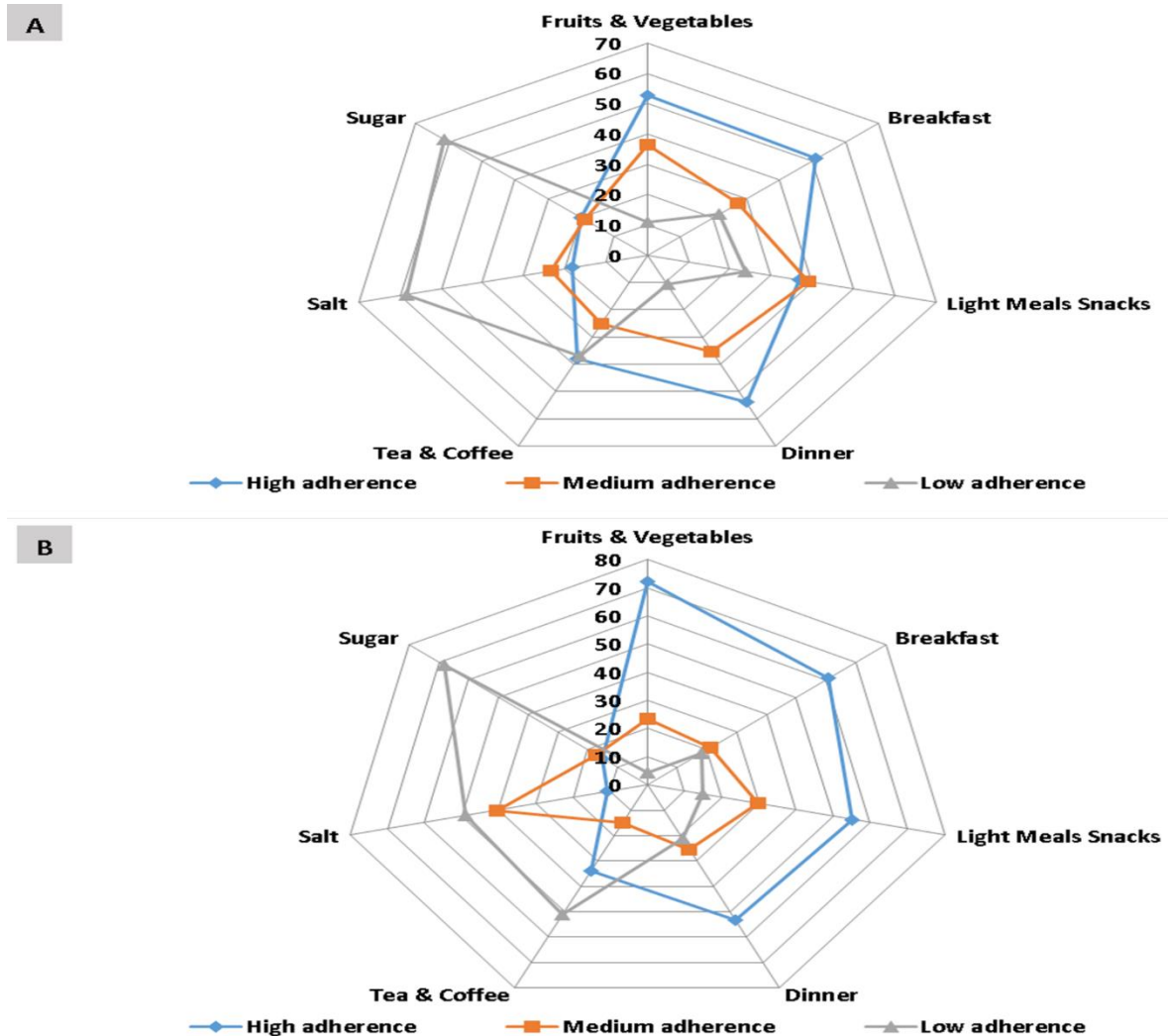


Fig 3. Adherence to healthy eating habits by COVID-19 infected and uninfected participants. A, Adherence to healthy eating habits in COVID-19 infected participants; B, Adherence to healthy eating habits in COVID-19 uninfected participants. Data represented in percentage (%).

professionals in Saudi Arabia should pay further attention to increase awareness regarding the importance of adopting healthier diets that have a higher intake of fruits, vegetables (the Mediterranean diet), which has been recommended to be followed during COVID-19 owing to its role in strengthening the immunity (Angelidi et al., 2021; Bakhsh et al., 2020). Uninfected participants were noticed to use Myrrh, pumpkin and turmeric with a great difference compared to the infected population. In Saudi Arabia, people perceive that Myrrh is more effective than modern medicine, such as chlorhexidine (Alyafei, 2020). Pumpkin and pumpkin seeds are included within the daily diet identified guidelines for adequate intake of micronutrients important for optimizing the immune system, placing special emphasis on zinc and vitamins C, A, and D (De Faria Coelho-Ravagnani et al., 2021). Turmeric (*Curcuma*

longa) is a plant of the ginger family Zingiberaceae. Turmeric's medicinal properties are attributed to three main curcuminoids-curcumin, demethoxy-curcumin, and bisdemethoxycurcumin. Curcumin (diferuloylmethane) is the most abundant bioactive curcuminoid in turmeric. It elicits diverse pharmacological activities, including immunomodulatory, anti-bacterial and antiviral activity against many enveloped viruses, including respiratory viruses such as influenza and SARS-CoV (Kumar et al., 2021; Thimmulappa et al., 2021). On the other hand, the infected population showed higher consumption of Indian costus, *Nigella sativa*, lemon, which could be advised through their COVID-19 infection (De Faria Coelho-Ravagnani et al., 2021).

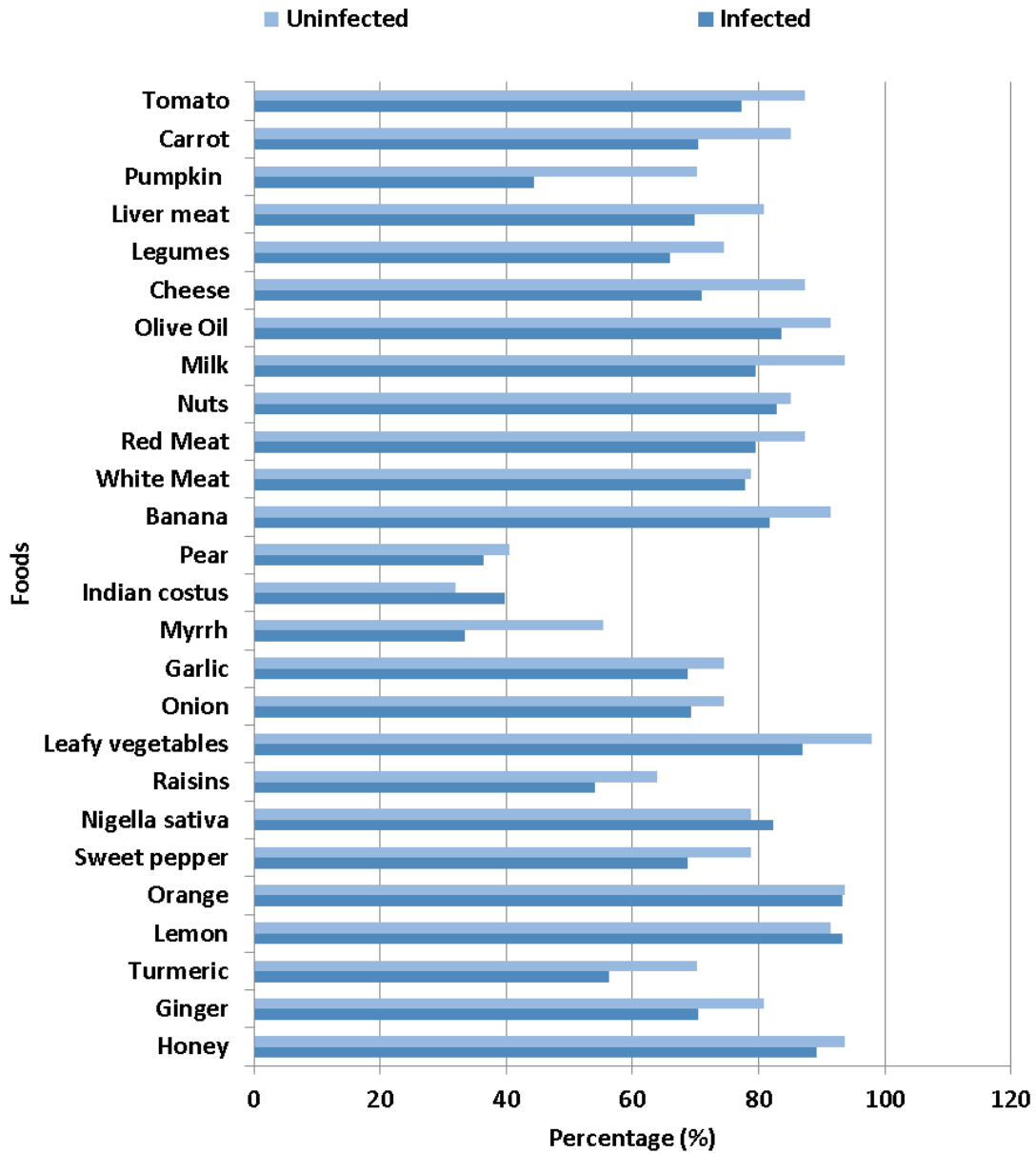


Fig. 4. Variations in food preference for COVID-19 infected and uninfected participants.

Correlation between variables and nutrition awareness

Correlation between variables and nutrition awareness score represented in (Table 7), showed that uninfected participants tended to show high nutrition awareness (54%) versus average awareness (45%) shown by infected participants. Education level as well shown to be correlated with nutrition awareness as PhD, MSc and BSc degrees holders had high awareness (75, 57 and 44% respectively), while starting from high school students and lower education levels tended to show average awareness (approx. 50%). Obtained results reflected that border

knowledge could safeguard the health of citizens from external threats as pandemic highlighted that the health of the individuals became a direct function of their own awareness and choices. Therefore, it is crucial to spread nutrition awareness during the COVID-19 pandemic through public awareness campaigns, nutrition education, emergency news bulletins, radio and TV announcements and interviews, and the dedication of specific telephone hotlines for direct communication with government representatives (Naja and Hamadeh, 2020).

Table 5 Healthy eating behavior among participants

Variable		Infected		Uninfected		Total		<i>p</i> -value
		n = 352	%	n = 94	%	n = 446	%	
Vitamins	Yes	188	53.41	36	38.30	224	50.22	0.024
	Sometimes	60	17.05	18	19.15	78	17.49	
	No	104	29.55	40	42.55	144	32.29	
Foods boost Immunity	Yes	308	87.50	92	97.87	400	89.69	0.000
	Sometimes	0	0	0	0	0	0	
	No	44	12.50	2	2.13	46	10.31	
Cooking Methods boost Immunity	Yes	134	38.07	42	44.68	176	39.46	0.662
	Sometimes	0	0	0	0	0	0	
	No	218	61.93	52	55.32	270	60.54	
Food Contain Antioxidants	Yes	106	30.11	22	23.40	128	28.70	0.065
	Sometimes	140	39.77	50	53.19	190	42.60	
	No	106	30.11	22	23.40	128	28.70	

Table 6 Cooking methods Used by participants

Variable	Infected		Uninfected		Total	
	n=352	%	n=94	%	n=446	%
Braising	56	15.91	8	8.51	64	14.35
Grilling	82	23.30	18	19.15	100	22.42
Steaming	8	2.27	0	0.00	8	1.79
Frying	42	11.93	8	8.51	50	11.21
Boiling	32	9.09	6	6.38	38	8.52
Baking	50	14.20	24	25.53	74	16.59
Other	82	23.30	30	31.91	112	25.11

Table 7 Correlation between variables and nutrition awareness score

Variable	Low		Average		High		Total
	n	%	n	%	n	%	n
Infection status							
Infected	58	16.48	160	45.45	134	38.07	352
Uninfected	6	6.38	37	39.36	51	54.26	94
Total	64	14.35	197	44.17	185	41.48	446
Education level							
Ph.D.	0	0.00	2	25.00	6	75.00	8
M.Sc.	0	0.00	12	42.86	16	57.14	28
B.Sc.	39	12.34	136	43.04	141	44.62	316
Secondary	16	25.81	33	53.23	13	20.97	62
Preparatory	4	20.00	8	40.00	8	40.00	20
Primary	3	37.50	4	50.00	1	12.50	8
Illiterate	2	50.00	2	50.00	0	0.00	4
Total	64	14.35	197	44.17	185	41.48	446

Conclusion

The highest infection rate was in Mecca due to its religious importance. Receiving healthcare at home was the most common. Poor adherence to recommended safety measures showed to be an effective factor in infection. Nutrition awareness showed to be related to education level and very effective for adherence to healthy eating behaviour and avoiding COVID-19 infection. Obtained results could represent good guidance to governmental plans for pandemic management based on predicted population behaviour. In this perspective, a governmental framework for action and recommendations are needed for a brighter future of health and wellbeing.

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Ethics approval

The anonymous nature of the web survey does not allow tracing in any way sensitive personal data. Therefore, this web-survey study does not require approval by the Ethics Committee.

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