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Knowledge and Practice of People toward Enhancing the Immune System before and during the COVID-19 Pandemic

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Abstract: In this study, we aimed to evaluate the knowledge and practices of the individuals in the UAE, to enhance the immune system during the COVID-19 comparing with before the pandemic period. We use a cross-sectional online questionnaire was administered to (n=1530) UAE participants. The questionnaire included four aspects: demographic characteristics, Knowledge questions, practice questions before the COVID-19, practice questions during the COVID-19. The findings revealed that the total score of the correct answers of the knowledge was (78%), while the total score of practices was moderate and increased from (1.90 ±0.776) to (2.15±0.80) before and during the pandemic, respectively. There was a statistically significant between knowledge and practices with gender, employment status, age group, education, marital status, and participants with positive COVID-19 test, while there was no significance with marital status and practices. females, employed people, individuals aged ≤50, high educational degree, other marital status, and negative COVID-19 test, had a higher level of knowledge than others, while females, employed people, individuals aged 40-49, college educational degree, other marital status, and positive COVID-19 test, had a higher level of practices than others. The Conclusions of this study showed that United Arab Emirates (UAE) residents showed high levels of knowledge and positive change in the practices to enhance the immune system during the COVID-19 pandemic. Continuing the health education programs by the UAE health authorities toward COVID 19 while focusing more on how to strengthen the body's immunity is recommended.

Keywords: COVID-19; Knowledge; Practice; United Arab Emirates (UAE).

1 Introduction

A novel strain of respiratory tract infection associated with the COVID-19 emerged in Wuhan in December 2019, China, this virus has global spread rapidly [1]. On 12 January 2020, this pathogenic virus was isolated by WHO and named the 2019 novel coronavirus (2019-nCoV) [2]. COVID-19 potential harm many human organs like heart, lung, liver, and kidney. The disease poses many threats and risks to the patient by the high prevalence of pneumonia [3]. Patients with a chronic disease like (diabetes, hypertension, cardiovascular disease, and respiratory issues) and elderly >=60 years old are under a higher risk for getting COVID-19 complications [4], as the general immunity reduces as you get older for shifts in leukocytes subpopulations and a weakening in many immune cell functions, which cause characterized by increased susceptibility to infections [5]. Even though the pathogenesis of COVID-19 is not yet fully known, one of the most important measures to avoid the virus is a strong and healthy immune system [6]. Word Health Organization (WHO) and the Ministry of Health-UAE (MOH) indicated that the treatment of COVID-19 symptoms depends on enhancing the level of immunity in patients, and reducing complications [7,8]. In the young people with no underlying illnesses, COVID- 19 can lead a minor infection, provided they have strong immunity and do not have activities like smoking or vaping and Consuming alcohol, which comprises the immune system and increases the risk of infection [9].

The important ways for enhancing the functioning of the immune system are eating several vitamins, elements, and supplements, which are essential to increase the effectiveness of the immune system [10]. Vitamin D has an essential role in the innate immune responses to viral respiratory tract infections, like influenza A and B, and Respiratory syncytial virus (RSV) [11]. Vitamin C has a major role as antioxidant and enzymatic co-factor for a lot of physiological response in the body, like immune potentiation, hormone production, and collagen synthesis

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[12]. Taking some elements maybe lessen the respiratory tract infection such as zinc, it's one of the micronutrients that could be consumed to decrease the intensity of COVID-19 infection and it's essential for respiratory tract infection for its antiviral properties [13].

Lifestyle factors, such as physical activity and diet behaviors significantly affect the process of immune senescence and inflammations [5]. During physical activity, many positive changes happen in the immune system [14]. Daily patterns and adopt unhealthy nutritional habits, like fast food and foods with high fat and lead to a weakened immune system [15], so, eating a healthy and balanced diet that provides all the nutrients needed to strengthen the immune system is recommended [16]. There is a relationship between sleep and the innate immune, insufficient sleep impairs immune system function, lead to contributes to inflammatory disease risk [17]. Stress and psychological problems have an impact on the immune system [18].

Due to the COVID-19 spread rapidly among people around the world, there is an urgent need to evaluate the knowledge and practices of people on enhancing their immunity against COVID-19 infection.

The aim of this study was to evaluate the knowledge and practices of the individuals in the UAE, to enhance their immune system during the COVID-19 comparing with before the pandemic period. This study considers the first study to identify the knowledge, practices, and change in practices of the public in the UAE of enhancing the immune system. Continuing the health education programs by the UAE health authorities toward COVID 19 while focusing more on programs on how to strengthen the body's immunity of healthy individuals, patients with chronic diseases, and patients with COVID-19 infection are recommended.

2 Methods

2.1 Research design

The current analysis was carried using a descriptive method approach, which is a type of research that describes the population, condition, or phenomena under-examined through gathering quantifiable data that can be used for statistical analysis. An online cross-sectional study was conducted between 16th to 29th June-2020. A google form questionnaire platform was used to administer the questionnaire among the people who live in UAE, to determine their knowledge and practice about enhancing their immunity before and during the COVID-19 pandemic. An invitation message with a questionnaire link to participate in this study was sent to more than 4000 individuals who live in UAE via, E-mail, WhatsApp, and Facebook Messenger. The purpose of this study was explained to participants and no identification was requested from the participants. The current population of the United Arab Emirates is 9,903,711 people [19]. The number of those who correctly got the invitation was 1553. Thus, a questionnaire instrument will be utilized to gather data from a sample of the population represented to the participants. The design of the study is illustrates as shown in Figure 1.

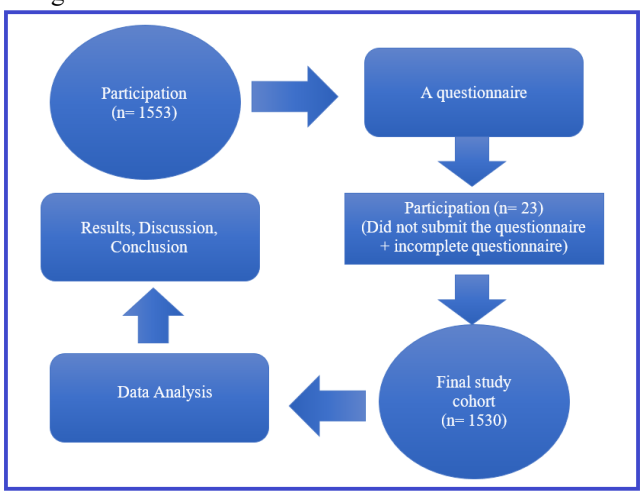

Fig. 1. Study flow diagram.

2.2 Participation

An online cross-sectional study was conducted between 16th to 29th June-2020. A google form survey platform was used to administer the questionnaire among the people who live in UAE, to determine their knowledge and practice about enhancing their immunity before and during COVID-19 pandemic. An invitation message with survey link to participate in this study was sent to more than 4000 individuals who live in UAE via, E-mail, WhatsApp, and Facebook Messenger. The purpose of this study was explained to participants and no identification was requested from the participants. The current population of the United Arab Emirates is 9,903,711 people [19]. Figure 2.

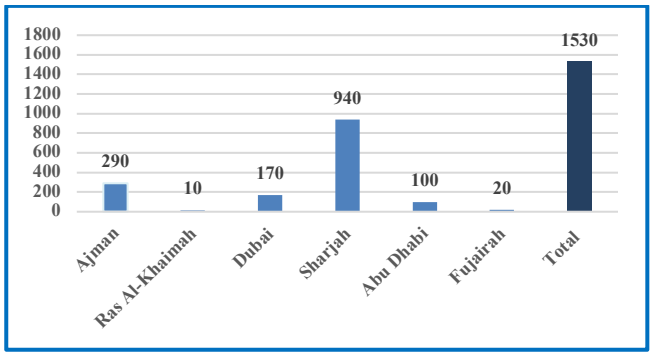

Fig. 2. Participation in study.

2.3 Study Instrument

The questionnaire of a five-dimensional Likert scale was used to gather data from the participants, and it was introduced to them during the second semester of the

academic year 2019/2020 during the duration of the COVID-19 pandemic. Out of 1553, A total of 1530 individuals participated in this study from six emirates: Abu Dhabi, Ajman, Dubai, Sharjah, Fujairah, and Ras Al-Khaimah, in the United Arab Emirates. The questionnaire was created depending on the different literature review available, WHO, and CDC reports regarding the development of a healthy and strong immune system to avoid COVID-19 infection [10, 16, 20, 21]. The questionnaire, designed in both Arabic and English languages, was pilot tested by 18 individuals and expert faculty members by telephone interviews to clarify and correct any question or statement, resulting in few modifications.

The questionnaire consisted of two sections, the first section concerned general demographic characteristics of each participant, such as gender, age, marital status, place of residence, education level, employment status, nationality, chronic diseases, and Coronavirus test positive or negative. The second part of the questionnaire represented consisted of three main domains: The first domain: Knowledge to enhancing the immune system, which included 10 questions, the second domain: Practices to enhancing immune system before COVID-19 pandemic, which included 15 questions, while the third domain: Practices on enhancing the immune system during COVID-19 pandemic, which included 15 questions.

2.4 The validity and Reliability of the Instrument

A group of arbitrators (10 faculty members of UAE Universities) who have extensive experience in the field of Measurement, Evaluation, Psychology, and Health Sciences were requested to express their views on the items of the questions in terms of the relevance of items for achieving research aims and the number and comprehensiveness of the questionnaire items. The necessary adjustments were made so that the questionnaire was ready according to the research objective. To verify the internal consistency coefficient of the study tool, Cronbach's α was used. It was applied to a pilot study involving (60) students from outside the study sample and then calculated the Cronbach alpha coefficient (0.822).

2.5 Statistical Analysis of the Data

Data analysis conducted using SPSS software package version 26. for conducting the descriptive analyses (frequencies, percentages, mean, and standard deviation). Furthermore, participants' knowledge and practice scores were compared with demographics factories using independent samples t-test, one-way ANOVA, and the Scheffe test. A P-value of less than ($p < 0.05$) was considered statistically significant. To measure the level of knowledge (K1 to K10) and practice (P1 to P15) participants were given "3 items (true /not sure/false) and (always, some time, never), respectively. Correct answer of true / always to an item was marked 2 score, not sure / sometime not response was marked 1 score, and incorrect answer false/ never was marked 0. The total scores were categorized into three levels including low (1.00–1.66), moderate (1.67–2.33), and high (2.34–3.00).

3 Results

3.1 Respondents' Demographic Characteristics

Demographic characteristics are shown in **Table 1.** a total of 1553 surveys were collected, 1530 participants were included in the current study, an incomplete questionnaire of respondents was excluded from the study (completion rate of 98.5%). The majority of respondents 1068 (69.8%) were females and 426 (30.2%) were males. Most ages of the respondents, 35.3% were between 40-49 years. About 77.1% of the respondents were married, 20.9, and 2.0% were single and others, respectively. Around 61.5% were from Sharjah, while 6.5, 19.0, 11.1, 1.3, and 0.7% were from Abu Dhabi, Ajman, Dubai, Fujairah, and Ras Al-Khaimah, respectively. Almost 46.4% of the respondents were employed and 53.6% were unemployed. Regarding the education level, most of the respondents 47.7% had a college-level degree, while 28.1, 22.9, 1.3% had a postgraduate, high school or diploma, and illiterate /primary degrees, respectively. 11.1% of respondents were Emirati and 88.9% were Non-Emirati. Nearly 12.5% of the respondents have been tested for COVID-19 and 87.5% did not get tested. 2.0% of respondents had a positive COVID-19 test, 98.0% had negative COVID-19 test.

Table 1. Demographic characteristics of participants, UAE (n= 1530)

Demographic factors		Frequency (n)	Percent (%)
Gender	Male	426	30.2
	Female	1068	69.8
Age	18-29	300	19.6
	30-39	340	22.2
	40-49	540	35.3
	≥50	350	22.9
Marital status	Single	320	20.9
	Married	1180	77.1
	Other*	30	2
Place of residence	Abu Dhabi	100	6.5
	Ajman	290	19
	Dubai	170	11.1
	Sharjah	940	61.4
	Fujairah	20	1.3
	Ras Al-Khaimah	10	0.7
Education level	Illiterate\primary	20	1.3
	High school\diploma	350	22.9
	College level	730	47.7
	Postgraduate	430	28.1
Employment status	Employed	710	46.4
	Unemployed	1360	53.6
Nationality	Emirati	170	11.1
	Non- Emirati	1360	88.9
COVID-19 test	Yes	190	12.4
	No	1340	87.5
COVID-19 test result	Positive	30	2.1
	Negative	1500	97.9
*Other included divorced, and widows			

3.2 Prevalence of Chronic Diseases Reported by Individuals in the UAE

A total of 1530 participants, 81.4% were healthy people, while 28.6% have chronic diseases, the most common chronic disease reported by the respondents were given in Figure. 3. The most prevalent diseases were, heart conditions 4%, diabetes 3.3%, asthma 2.6%, thalassemia 2.6%, sickle cell anemia 1.4%, chronic lung diseases 0.7%, and chronic liver disease was 0.7%.

3.3 Respondents' knowledge about Enhancing the Immune System to Avoid COVID 19

As presented in Table 2, the responses of participants to the questions of knowledge to enhance the immune system. The total mean score of 10 knowledge questions was high 77.84% (2.52 ± 0.688). When we asked if exercising regularly reduces the risk of developing a COVID-19 infection, about 78.5% of the participants answered correctly. Almost 89%, answered that the smoking and

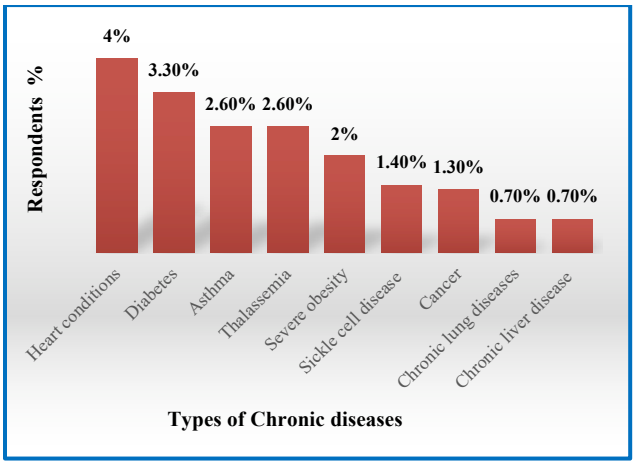

Fig..3. Prevalence of chronic diseases reported by individuals in the UAE, (n = 1530).

vaping increase the risk of serious lung disease caused by COVID-19, while around 80.5% knew that drinking alcohol reduces the body's immunity and makes a man susceptible to COVID-19. The majority of participants 90.8% agreed that stress and anxiety can cause a weakened immune system and make the person more susceptible to COVID-19. More than half of respondents 64.1, 55, and 89.5% of participants knew that taking vitamin D, zinc nutrient, and vitamin C, respectively are necessary for good immune system response and reduces the risk of COVID-19 infection. Around 86.3% of the respondents had knowledge regarding if the ample sleep supports the immune system and reduces the risk of COVID-19 infection. When we asked about whether eating a healthy balanced diet reduces the risk of contracting COVID-19, A high number of participants 88.9% answered correctly, while 56.2% had believed that obesity can increase the risk of severe illness from COVID-19.

Table 2. Descriptive statistics of general knowledge with correct knowledge score about strengthening the immune system to avoid COVID 19 of participants in UAE (n= 1530)

	Knowledge questions		TRUE	FALSE	Not sure
K1	Doing an exercise regularly reduces the risk of developing a COVID-19 infection	N	1200	150	180
		%	78.4	9.8	11.8
K2	Smoking increase the risk of serious lung disease caused by COVID-19	N	1360	40	130
		%	88.9	2.6	8.5
K3	Drinking alcohol reduces the immunity and can make a person more vulnerable to COVID-19	N	1230	30	270
		%	80.4	2	17.6
K4	Stress and anxiety can cause weaken immune system make the persona more susceptible to COVID-19	N	1390	60	80
		%	90.8	3.9	5.2
K5	Taking vitamin D is essential for the proper functioning of the immune system and decreases the risk of COVID-19 infection	N	980	130	420
		%	64.1	8.5	27.5
K6	Taking zinc reduce the risk of COVID-19 infection	N	840	60	630
		%	54.9	3.9	41.2
K7	Taking vitamin C is necessary for the proper functioning of the immune system and decreases the risk of COVID-19 infection	N	1370	10	150
		%	89.5	0.7	9.8
K8	Ample sleep supports the immune system, which reduces the risk of COVID-19 infection	N	1320	10	200
		%	86.3	0.7	13.1
K9	Eating a healthy balanced diet reduces the risk of contracting COVID-19	N	1360	40	130
		%	88.9	2.6	8.5
K10	Obesity can increase the risk of severe illness from COVID-19	N	860	160	510
		%	56.2	10.5	33.3
	Total	**%**	**77.84**		

* The correct responses for each item are bolded

3.4 Correlation between demographic Characteristics with knowledge (K) score of Participants to Enhance the Immune System, UAE.

As presented in Table 3, a significant positive correlation was found between the knowledge and demographic characteristics of respondents (P <0.05). However, the

females reported significantly (P <0.0001) higher levels of knowledge (2.63±0.356) than males. Respondents with older ages ≥50 years had more level of knowledge (2.64±0.366) significantly (P <0.015) than other ages. We observed that divorced, and widow participants had significantly (P <0.004) higher level of knowledge (2.73±0.38) than married and single participants. Respondents with higher education levels showed significantly (P <0.0001) high level of knowledge (2.71±0.301) than lower education levels. A significantly (P <0.0001) higher mean score (2.66±0.430) was found among employed than unemployed participants. The respondents who had negative COVID-19 significantly (P <0.0001) had a higher-level score of knowledge (2.613±0.389) than people with negative COVID-19 test.

Table 3. Enhancing immune system knowledge by demographic factors, UAE (n= 1530)

Demographic factors		N	Mean	SD	Df	p-value
Gender	Female	1068	2.632	0.35647	1	0.000*
	Male	462	2.5325	0.49403		
Age	18-29	300	2.6067	0.32911	3	0.015*
	30-39	340	2.5471	0.42227		
	40-49	540	2.6056	0.45151		
	≥50	350	2.6457	0.36646		
Marital Status	Single	320	2.6562	0.31666	2	0.004*
	Married	1180	2.5839	0.42524		
	Others*	30	2.7333	0.38357		
Education	Illiterate\ primary	20	2.2	0	3	0.000*
	Secondary\diploma	350	2.4629	0.50504		
	College level	730	2.6123	0.38417		
	Postgraduate	430	2.7163	0.30146		
Employment	Employed	710	2.6606	0.43066	1	0.000*
	Unemployed	820	2.5512	0.37513		
COVID-19 test result	Positive	30	2.0333	0.69646	1	0.000*
	Negative	1500	2.6133	0.38943		

*Other included divorced, and widows
*Significant at p<0.05

3.5 Respondents' Practices to Enhancing the Immune System before and during Covid-19 Pandemic

As presented in Table 4, the response of participants to the questions of practices to enhance the immune system, the table showed that the total score of practices increased significantly across the categories from (1.9±0.776) to be (2.15±0.806). The results show that the mean score of participants who were sleeping 6-8 hours before the pandemic, increased from (1.42±0.747) to be (2.60±0.765) during the pandemic. The mean score of smokers increased from (1.89±0.465) to (1.93±.0.414) during the COVID-19 pandemic, while the score for individuals who consume alcohol has not changed (2.01±0.081). We found that the mean score of participants that exercise changed to be (2.16±0.846) in comparison with before pandemic (2.08±0.832). Participants that manage their stress efficiently during the pandemic had a score of (2.10±0.918), more than before COVID-19 pandemic (2.05±0.892). When we asked if the participants eat food rich in vitamin D, the practice score risen from low (1.56±.0.870) to moderate (1.76±0. 873), while the score level of participants that were taking vitamin D supplements before pandemic (1.90±0.839) increased to be (2.38±0.851) during the pandemic. Our findings showed that the score (1.80±.952) of participants were eating citrus fruits before pandemic increased to be (2.44±0.873), while the score of participants that took vitamin C supplements before pandemic (2.07±0.810) changed to (2.29±0.844) during the pandemic. The mean score of participants that were eating foods with high zinc was risen to the (2.03±0.926), while taking zinc supplements practice score changed to (2.39 ±0.651). Almost the score of participants that avoid food with high fat and high sugar before pandemic (1.98±0.867) increased during pandemic to be (2.12± 0.920), and (2.04 ±0.933), respectively. The number of people who were drinking 8–10 cups of water every day increased during pandemic to (2.01± 0 .956), regarding the managing of weight, the practices will increase from (1.75. ±0.890) to be (2.01±0.956).

Table 4. Enhancing immune system practice before and during Covid-19 pandemic, UAE (n= 1530)

No.	Practices questions	Before COVID-19		During COVID-19		df	p-value
		Mean	SD	Mean	SD		
P1	I sleep 6-8 hours a day	1.42	0.747	2.6	0.765	1	0.000*
P2	I am smoker	1.89	0.465	1.93	0.414	1	0.000*
P3	I consume alcohol	2.01	0.081	2.01	0.081	1	0.000*
P4	I exercise regularly	2.08	0.832	2.16	0.846	1	0.001*
P5	I am managing my stress efficiently and relax regularly	2.05	0.892	2.1	0.918	1	0.05*
P6	I eat foods fortified rich with vitamin D every day	1.56	0.87	1.76	0.873	1	0.000*
P7	I take vitamin D supplements	1.9	0.839	2.38	0.851	1	0.000*
P8	I eat citrus fruits	1.8	0.952	2.44	0.873	1	0.000*
P9	I take vitamin C supplements	2.07	0.81	2.29	0.844	1	0.000*
P10	I eat the foods with high zinc	1.99	0.908	2.03	0.926	1	0.041*
P11	I take zinc Supplements	2.15	0.665	2.39	0.651	1	0.000*
P12	I avoid food with high fat	1.98	0.867	2.12	0.92	1	0.000*
P13	I avoid food with high sugar	1.93	0.88	2.04	0.933	1	0.000*
P14	I drink 8–10 cups of water every	1.99	0.937	2.02	1.242	1	0.333*

	day						
P15	I manage my weight well	1.75	0.89	2.01	0.956	1	0.000*
Total		**1.9**	**0.776**	**2.15**	**0.806**		
*Significant at p<0.05							

3.6 Correlation between Demographic Characteristics with Practice (P) Score of Participants to Enhance the Immune System during COVID-19 Pandemic, UAE

As presented in **Table 5**, the total score of the participants (out of 3) toward COVID-19 was highly significant (P <0.000) across gender, age groups, employment status, and education level, while COVID-19 result was (p=0.0335). We found no significant correlation between marital status and practices of participants (p=0.726). The results indicate that the female gender had a better practice score (2.17±0.27) than males. Respondents aged 40-49 years had a higher-level score of practice (2.1920 ± 0.26706) compared with other lower age groups. Regarding marital status, divorced, and widows' participants shared a higher level of practice (2.1933±0.25392) than other marital status participants. The results indicated that participants with college degrees showed higher practices score (2.2013 ±0.30742) than those with a lower level of degree. The practices of employed participants (2.209 ±0.29178) were higher than those who identified themselves as unemployed, while, the participant's people who had tested COVID-19 positively showed elevated practice score (2.2022± 0.2911) than that with negative the result of the test.

4 Discussion

This study is expected to be the first to evaluate the level of knowledge and practices to strengthening the immune system follow COVID-19 pandemic among the general public in UAE and focus, compared with the practices before the pandemic. Enhancing the immune system during the periods for COVID-19 can be achieved through focusing on sleeping well, eating healthy food, avoiding food with high sugar and fat, stop smoking and drinking alcohol, taking vitamin D and C, and high zinc nutrients. In this study, most of our participants were females, under 40-49 years old, married, non-Emirati, from Sharjah, college to higher education levels, this is consistent with the UAE population and similar demographics of respondents of recent research studies in the UAE [19, 22, 23].

We noticed in this study that the most prevalent diseases between our participants were heart conditions 4%, and diabetes 3.3 that increase a person's risk of severe COVID-19 illness, our results are consistent with the Dubai Statistical Center study that shows UAE nationals have a higher prevalence rate of diabetes and heart conditions illness. Another study for chronic disease patients in the UAE reported that 74.1% were Diabetics [21, 24]. The current study revealed that the UAE population had a high level of knowledge and a moderate level in practice. Moreover, it reported that the participant's practices have changed positively during the COVID-19 pandemic, to raise the level of the body's immunity. This might be due to the preventive measures implemented by the UAE authorities to control the spread of the disease such as health awareness, education, daily Informational briefing on COVID, website updates of UAE. Overall, the highest score level of knowledge reported on stress, smoking, and eating a healthy diet. Almost 91% of participants answered that stress and anxiety may hinder the immune system. Many studies focused that stress and anxiety have an impact on the immune system, short-term stress enhances the activity of humoral and cellular immunity. prolonged stress can weaken immunity and thus increase the risk of illness[18].

Our study indicated that a few participants started to manage their stress and anxiety during the COVID-19 pandemic, similar studies for a population sample in Spain reported higher levels of anxiety symptoms during the lockdown period [25]. Also, higher than our findings 34.3% recorded among students and administration staff in Vita-Salute San Raffaele University, Milan, during the COVID-19 pandemic [26]. The difference in findings may be due to the difference in timings of data collection, the studies also did not address the changes in stress and anxiety. Exposure to tobacco smoke leads to an inflammatory process in the lungs [27]. Our study found that the knowledge and practice on smoking were equivocal. Our study found that a high number 90% of respondents had knowledge regarding the relationship between smoking and risk of COVID-19, but at the same time, the COVID-19 pandemic had a negative impact on practice, the number of smokers increased during COVID-19. This is may be because some of the respondents preferred to reduce their stress with smoking. Similar to our results, a large number of the Indian population believed that smoking and vaping increases the risk of contracting COVID-19 [28]. less than our result about knowledge of the bad effect of smoking showed between never smoking and ex-smokers in UAE 47.9%, 70.0%, respectively [29], Health education programs pursued by the UAE authorities increase the level of health knowledge and practice of the population, similar to our results of our study, the e-cig consumption has marginally increased during the lockdown of COVID-19 pandemic among people across five countries: Italy, India, South Africa, the United Kingdom, and the United States [28]. While no foods or dietary supplements can prevent COVID-19 infection, many studies reported that eating a healthy diet is essential during the COVID-19 pandemic; it affects our body's ability to prevent, fight, and recover from infections, and supports the immune system. Foods rich with sugars and fats lead to a weakened immune system [15]. Our results on eating healthy food showed a higher level of knowledge 90% than that indicated for

participants at the University Community in Sharjah, UAE, 47% [30, 31]. Similarly, this study found revealed that the practices of some participants on avoiding food with high fat and sugar positively changed during the COVID 19 pandemic higher than our finding found for Polish adults in Poland, 8.4 and 36.6% reduced high sugar-sweetened beverages and unhealthy food Intake, respectively during the COVID-19 pandemic [32]. Lack of sleep results in an increase of chronic diseases, obesity, and premature death. Sufficient sleep with a good night's sleep activates the immune system to prevent the penetration of viruses and bacteria and builds up good humoral and cellular immunity. Many recent studies notify changes in sleeping habits during COVID 19 pandemic, 30.0% of Polish adults in Poland, and 4.9% of the Italian population in Italy increased their sleeping hours during COVID-19 pandemic to be 6-8 hours and 7-9 hours, respectively (32, 33].

Our study presented that 78.5% had high knowledge about doing an exercise regularly reduces the risk of developing the COVID-19 infection. During physical activity, many positive processes occur in the immune system, low levels of physical activity may increase the risk of COVID-19 infection [14]. The knowledge of respondents in our results was higher than that of 47.3% for Medical students in UAE [34]. In the current study, a slight increase in physical activity has been reported during the COVID-19 pandemic, higher than our findings were presented 38.3,19.1% among Italian people in Italy [33]. As well as, a higher level of physical activity observed during lockdown than before COVID-19 pandemic among individuals in Australia, UK, and USA [35]. Studies indicated that alcohol damages the body's immune system and increases the risk of negative health consequences (Ding et al., 2020), The percentage we found was higher than that for UAE residents in UAE, 70.5% [22]. The total score practices of alcohol consumption did not change before and during the COVID-19 outbreak, that may be due to the low percentage of participants in our study that consumed alcohol. Similar to our finding, 16% of polish people in Poland changed their drinking habits and started drinking less during lockdown pandemic [36], while another study in Poland saw an increase in alcohol consumption in 14.6% of polish people during the lockdown period [37].

Through our study, we found that 64% of participants had knowledge about vitamin D, our finding was similar to that of 72.0 % among the UAE population and higher than that of 39 % among the adult population in Sharjah, UAE [38,39]. Interestingly, a high number of the participants in the current study positively changed their habits on consuming foods fortified with vitamin D, and took vitamin D supplements, which confirms that people took an approach to boost immunity. Although the participant's knowledge about Zinc may reduce the risk of COVID-19 infection, was low, 55%, the results revealed that 89.5% of the respondents were aware of vitamin C. In addition, some of the respondents changed their practices during a pandemic and declared an increase in eating the food fruitful with zinc, vitamin C, and supplements to decrease the intensity of COVID-19 infection. Lower than the current results, 46.1% of individuals in Al-tif city were aware of vitamin C. [40].

In our study, a few numbers of participants started to drink 8–10 cups of water every day during the COVID-19 pandemic, A similar study 24% of Polish adults in Poland show an increase in water intake during COVID-19 pandemic [32]. The knowledge level reported in the current study on obesity can increase the risk of severe COVID-19 illness, was 56.2%, this percentage was similar to that reported for female students in UAE, 50% [24].

In this study, some of the participants started to manage their weight during the COVID-19 pandemic, contrary to a similar study, 48.6% of Italian people in Italy gained weight [33]. The changes in results may be due to the difference in timings of data collection, in addition to the high health awareness adopted by the UAE government during the COVID-19 pandemic lead to an increase in knowledge and practice. Finally, this current study has shown that there was a better knowledge and practice associated with gender (Females), old people (≤ 40), education (higher education), and employment status (employed). Our results are consistent with other studies that reported similar significance in terms of better knowledge among the females, educated, old people, and employed people [22- 23].

Table 5. Enhancing immune system practice during Covid-19 pandemic by demographic factors

Demographic factors		N	Mean	Std. Deviation	Df	p-value
Gender	Female	1068	2.1762	0.27516	1	0.000*
	Male	462	2.0934	0.32197		
Age	18-29	300	2.1867	0.35633	3	0.000*
	30-39	340	2.1506	0.2797		
	40-49	540	2.192	0.26706		
	≥50	350	2.0585	0.25994		
Marital Status	Single	320	2.1492	0.3565	2	0.726
	Married	1180	2.1507	0.27371		
	Others	30	2.1933	0.25392		
Education	Illiterate\primary	20	2.04	0.14574	3	0.000*
	Secondary School /diploma	350	2.1623	0.24439		
	College level	730	2.2013	0.30742		
	Postgraduate	430	2.0623	0.28616		
Employment	Employed	710	2.2093	0.29178	1	0.000*
	Unemployed	820	2.0841	0.27879		

COVID-19 test result	Positive	30	2.2022	0.29111	1	0.335*
	Negative	1500	2.1502	0.29251		
*Other included divorced, and widows *Significant at p<0.05						

5 Conclusions

Overall, UAE residents showed high levels of knowledge and positive change in the practices to enhance the immune system during the COVID-19 pandemic. Strategies to keep continuing the daily COVID-19 media briefing program of the UAE government and health education programs by the Ministry of Health and Prevention in the UAE is essential in maintaining the high level of awareness of individuals health toward COVID 19. This should be with focusing more on programs on how to strengthen the body's immunity of healthy individuals, patients with chronic diseases, and patients with COVID-19 infection.

Abbreviations

- COVID-19: Coronavirus disease 2019
- UAE: United Arab Emirates
- 2019-nCoV: 2019 novel coronavirus
- WHO: Word Health Organization
- MOH: Ministry of Health
- RSV: Respiratory syncytial virus
- CDC: Centers for Disease Control and Prevention
- ANOVA: Analysis of variance
- K: knowledge
- P: Practice
- UK: United Kingdom
- USA: United States of America
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Author's contributions All authors were involved in research design, implementation of the study, data gathering, data analysis, and writing of the manuscript. All authors approve submission of the manuscript for publication consideration. All authors read and approved the final manuscript.

Availability of data and materials We would have loved to share the data however, the data is primary in nature and the authors do not wish to share the data as this may breach participant confidentiality.

Compliance with ethical standards

Ethical considerations The Research Ethics Committee (RIC) at Sharjah University, Sharjah UAE, approved the current study. With reference number: REC-20-06-02-01 on 14/06/2020.

Informed consent Informed consent was obtained from all individual participants included in the study.

Competing interests As authors, we declare that have no significant financial, professional or personal interests that may affect the performance or presentation of the work described in this manuscript. (The authors declare that they have no competing interests)

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References

[1] WHO1, World Health Organization. Coronavirus disease (COVID-19) pandemic. 2020. https://www.who.int.

[2] WHO2, World Health Organization. Novel coronavirus (2019-nCoV). 2019 https://www.who.int/emergencies/diseases/novel- Geneva

[3] Hmming I, Timens W, Bulthuis ML, Lely AT, Navis G, van Goor H. Tissue distribution of ACE2 protein, the functional receptor for SARS coronavirus: a first step in understanding SARS pathogenesis. J Pathol **203**(2), 631-637 (2020).

[4] Zhang J, Wang X, Jia X, Li J, Hu K, Chen G. Risk factors for disease severity, unimprovement, and mortality in COVID-19 patients in Wuhan, China. CMI **26**(6), 767-772 (2020)

[5] Weyh C, Krüger K, Strasser B. Physical Activity and Diet Shape the Immune System during Aging. Nutrients **12**(3), 622 (2020).

[6] Nizami N, and Mujeeb UCS. Strong Immunity- A Major Weapon to Fight against Covid-19, IOSR-JPBS **15**(3), 22-29 (2020).

[7] MOH, Ministry of Health and Prevention, UAE. 2020 https://www.mohap.gov.ae/en/AwarenessCenter/Pages/COVID-19.aspx

[8] WHO3, World Health Organization. COVID-19 Immunity & Clinical Manifestations. 2020. https://www.who.int/docs/default-source/coronaviruse/risk-comms-updates/update-24-immuniy-n-clinical-manifestations.pdf?sfvrsn=7c84a6bf_4.

[9] Bhopal RS. COVID-19 zugzwang: Potential public health moves towards population (herd) immunity. Public Health in Practice **1** (1), 100031(2020).

[10] Jayawardena R, Sooriyaarachchi P, Chourdakis M, Jeewandara C, Ranasinghe P. Enhancing immunity in viral infections, with special emphasis on COVID-19: A review. Diabetes & Metabolic Syndrome: Clinical Research & Reviews **14**(4): 367-382 (2020).

[11] Zdrenghea MT, Makrinioti H, Bagacean C, Bush A, Johnston SL, Stanciu LA. Vitamin D modulation of innate immune responses to respiratory viral infections. Rev Med Virol 2017; **27**(1), 1-12 (2017).

[12] Kim Y, Kim H, Bae S, Choi J, Lim SY, Lee N, et al. Vitamin C is an essential factor on the anti-viral immune responses through the production of interferon-α/β at the initial stage of influenza A virus (H3N2) infection. Immune network **13**(2), 70-74 (2013).

[13] Read SA, Obeid S, Ahlenstiel C, Ahlenstiel G. The Role of Zinc in Antiviral Immunity. Adv Nutr **10**(1), 696-710 (2019).

[14] Nieman DC, Henson DA, Austin MD, Brown VA. Immune response to a 30-minute walk. Medicine and Science in Sports and Exercise **37**(1), 57-62 (2005) DOI: 10.1249/01.MSS.0000149808.38194.21

[15] Schyns G, Roefs A, Jansen A.Tackling sabotaging cognitive processes to reduce overeating; expectancy violation during food cue exposure. Physiol Behav **222** (1), 112924 (2020).

[16] Yousfi N, Bragazzi NL, Briki W, Zmijewski P, Chamari K. The COVID-19 pandemic: how to maintain a healthy immune system during the lockdown – a multidisciplinary approach with special focus on athletes. Biology of Sport **37**(3), 211-216 (2020).

[17] Bryant PA, Trinder J, Curtis N. Sick and tired: does sleep have a vital role in the immune system? Nat Rev Immunol **4**(6), 457-67 (2004).

[18] Choukèr A. Stress Challenges and Immunity in Space. Springer, Cham 373-404 (2020) https://doi.org/10.1007/978-3-030-16996-1_20

[19] UAEPS, United Arab Emirates Population Statistics. 2020. https://www.globalmediainsight.com/blog/uae-population-statistics/.

[20] Calder P.C. Nutrition, immunity and COVID-19, BMJ Nutrition, Prevention & Health **3**(1), 74-92 (2020). doi:10.1136/bmjnph-2020-000085

[21] CDC.2020 https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html

[22] Ahmed SBM, Amer S, Hussein A, Kampani DD, Al Hasham N, Assker MM, Shawa N, Saleh D, Alfarouk KO. Assessing the Knowledge of Environmental Risk Factors for Cancer among the UAE Population: A Pilot Study, Int. J. Environ. Res. Public Health **17**(9), 2984 (2020).

[23] Abu-Gharbieh E., Saddik B, El-Faramawi M, Hamidi S, Basheti M. Oral Health Knowledge and Behavior among Adults in the United Arab Emirates, Hindawi BioMed Research International vol**2019**, 1-7 (20219).

[24] Osama H, Ibrahim M, Jirjees FJ, Mahdi HM. Barriers affecting compliance of patients with chronic diseases: A preliminary study in United Arab Emirates (UAE) population. AJPCR **4**(2), 1-14 (2011).

[25] Ozamiz-Etxebarria N, Dosil-Santamaria M, Maitane Picaza-Gorrochategui, Mondragon I. . Stress, anxiety, and depression levels in the initial stage of the COVID-19 outbreak in a population sample in the northern Spain. Cad. Saúde Pública **36** (4), 30 (2020).

[26] Marelli S., Castelnuovo A., Somma A., Castronovo V., Mombelli S., Bottoni D., Leitner C., Sati A.F., Ferini-Strambi L. (2020) Impact of COVID-19 lockdown on sleep quality in university students and administration staff. Journal of Neurology **268**(1), 8-15 (2021).

[27] Berlin I, Thomas D. COVID-19 and smoking. Nicotine & Tobacco Research **22**(9), 1650-1652 (2020). doi: 10.1093/ntr/ntaa059.

[28] Yach D. Tobacco Use Patterns in Five Countries During the COVID-19 Lockdown.Nicotine Tob Res **22**(9),1671-1672 (2020).

[29] Alraeesi FH, Farzin FJ, Abdouli KA, Sherif FEY, Almarzooqi KA, AlAbdool NH. Smoking behavior, knowledge, attitude, and practice among patients attending primary healthcare clinics in Dubai, United Arab Emirates. J Family Med Prim Care **9**(1), 315–320 (2020).

[30] WHO4, World Health Organization. Healthy diet. (2020). https://www.who.int/campaig ns/connecting-the-world-to-combat-coronavirus/healthyathome/healthyathome---healthy-diet_

[31] Attlee A, Abu-Qiyas S, Obaid RS. Assessment of Nutrition Knowledge of a University Community in Sharjah, United Arab Emirates. Malays. J. Nutr **20**(3), 327-337 (2014).

[32] Górnicka M, Drywie´n ME, Zielinska MA, Hamułka J. Dietary and Lifestyle Changes During COVID-19 and the Subsequent Lockdowns among Polish Adults: A Cross-Sectional Online Survey PLifeCOVID-19 Study. Nutrients 2020; 12(8): 2324; https://doi.org/10.3390/nu12082324

[33] Renzo LD, Gualtieri P, Pivari F, Soldati L, Attinà A, Cinelli G. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. J Transl Med Title **18(1),** 229 (2020).

[34] Shaikh RB, Mathew E, Sreedharan J, Muttappallymyalil J, Al Sharbatti S, Basha SH. Knowledge regarding risk factors of hypertension among entry year students of a medical university. J Family Community Med **18**(3), 124–129 (2011).

[35] Ding D, Pozo Cruz BD, Green MA, Bauman AE. Is the COVID-19 lockdown nudging people to be more active: a big data analysis. Br J Sports Med Month **54**(20),1183-1184 (2020).

[36] Chodkiewicz YJ, OrcID, Talarowska M, Miniszewska J, Nawrocka N, Bilinski P. Alcohol Consumption Reported during the COVID-19 Pandemic: The Initial Stage. Int. J. Environ. Res. Public Health **17**(13), 4677 (2020).

[37] Sidor A, Rzymski P. Dietary Choices and Habits during COVID-19 Lockdown: Experience from Poland. Nutrients **12**(6), 1657 (2020).

[38] Salmanpour VA, Ibrahim HS, Salameh AG, Yahya AM, Debal BK. Vida A. Salmanpour, Vitamin D deficiency: knowledge and practices among the adult population in Sharjah, United Arab Emirates. Arch Osteoporos **11**(1), 15 (2016).

[39] Ibrahim OM, Al-Tameemi NK, Dawoud D. Knowledge and perceptions of vitamin d deficiency among the United Arab Emirates population. AJPCR **12**(8):183-186 (2019).

[40] Al-Haddad MS, Abdallah Q, Alhamyani AH, Althomali AJ, Alshakhshir SM. General public knowledge and practices about the common cold. Journal of Taibah University Medical Sciences **11**(2), 104-109 (2016).