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Household Food Insecurity Scores Are Higher among Adults Infected with COVID-19: A Cross-Sectional Online Study among an Iranian Population

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ABSTRACT

Introduction: Food insecurity has negative impacts on health, including the function of the immune system. The association between food insecurity and COVID-19 infection rates has not been fully understood. This study aimed to examine whether food-insecure households are more vulnerable to COVID-19 infection.

Materials and Methods: This online cross-sectional study was conducted on 2,871 Iranian adults (31 provinces), from August to September 2020. Demographic and socio-economic information was collected using a questionnaire. The Household Food Insecurity Access Scale (HFIAS) was used for assessing household food insecurity. The data analysis was performed by SPSS.22, using Chi-square test, ANOVA test, and Multinomial Logistic Regression Model.

Results: The findings indicated that healthcare personnel were at higher risk of COVID-19 (CI = 1.90, 7.05; OR = 3.66; P < 0.001). It was also shown that HFIAS scores were significantly higher among infected people compared to non-infected (CI = 1.00, 1.05; OR = 1.03; P < 0.05). Women were at lower risk of infection compared to men (CI = 0.41, 0.87; OR = 0.60; P < 0.05).

Conclusions: Based on the results, in addition to long-term policies to improve food security, policymakers are recommended to implement short-term policies to reduce the vulnerability of the community to COVID-19 virus.

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Introduction

The novel COVID-19 virus has had consequences on people's lives all over the world [1].These effects include not only physical and mental health [2], but also other risk factors [3] and economic status [4]. Many people, especially those who were self-employed, lost their jobs or suffered a decline in income [5]. The pandemic has also disrupted food supply chains, including production, processing, distribution, and demand [4]. This has led to reduced access to healthy foods, [6] and/or increased food prices [7]. Unfortunately, these conditions were accompanied with increased food insecurity around the world [7, 8].

Food insecurity is a condition in which people do not have physical, social and/or economic

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access to sufficient, safe and nutritious food [9]. Based on various international studies, a rise in food insecurity has been reported, specifically among socio-economically vulnerable populations. In a cohort study among low-income African-Americans, an 80% increase in food insecurity was seen in the first weeks of the outbreak, and government food aid had little effect on reducing it [10]. Another study in an Italian population found that food insecurity doubled during the COVID-19 outbreak [11]. Similar studies have been conducted in other countries, such as Mexico [12], Brazil [13], and Iran[14].

Food insecurity has negative impacts on health [15], including the function of the immune system [16,17]. The consumption of a healthy and nutritious diet, which is essential for better immune function [18], is less common in food-insecure households [19]. In a study conducted by Larson among adults in Minnesota, reduced food security was associated with lower consumption of healthy foods, such as fruit and vegetables, and higher consumption of calorie-rich fast foods and snacks [20]. In another study among Brazilian favelas, a 46% decrease was also seen in the consumption of healthy and nutritious food [13]. Psychologically, higher levels of mental illness, including perceived stress, are experienced in food-insecure households [21], which may also be associated with impaired immune response [22].

There are various studies among Iranian populations which have tried to assess food insecurity status during the COVID-19 pandemic. For instance, one study was conducted among rural households in Dashtestan county, Bushehr province, by Yazdanpanah et al. [23]; another among households from community health centers in Kerman province by Tezerji et al. [24]; and among a population in Tehran by Pakravan-Charvadeh [14]. These studies only reported food insecurity prevalence and determinants, but not its associations with COVID-19 infection rates. However, there are limited studies which have assessed this relationship [25,26]. Given the novelty of COVID-19, the aim of the current study was to examine whether food-insecure households are more vulnerable to COVID-19 infection. The results of this study will help policymakers and decision-makers to adopt evidence-based policies to fight such pandemics, by outlining the dimensions of vulnerability to infection.

Materials and Methods

Study design, population, and data collection

An online cross-sectional study was performed among Iranian adults (the age of over 18 years) across the whole country (31 provinces).

The inclusion criteria were the age of over 18 years; living in Iran; and interest in participating. The exclusion criteria included incomplete data of participants.

The minimum sample size in this study was calculated using OpenEpi software version3 (http://www.openepi.com/SampleSize/SSPropor.htm), based on the prevalence of food insecurity reported in a systematic review (49 %), [27] with a 95% confidence interval (N = 384). In order to reduce the online sampling error, the minimum sample size was considered for each region (in total, five regions) of the country. According to a national division by the Ministry of Interior, the provinces were divided into five districts, based on criteria, such as proximity, geographical location, and commonalities. The regions were as follows: 1. Tehran (7 provinces), 2. Isfahan (6 provinces), 3. Tabriz (6 provinces), 4. Kermanshah (6 provinces), and 5. Mashhad (6 provinces).

The participants consisted of 2,871 Iranian adults who were invited to participate via popular social networks, such as Telegram Messenger, WhatsApp Messenger, and Instagram (between August and September 2020). Due to the vastly increased use of the internet during recent years in Iranian populations (1), high levels of access to social networks can be assumed.

The data were collected by electronic questionnaire and availability sampling methods. Research information (including research subject, inclusion criteria, and ethical and privacy considerations) were mentioned in the invitation text. The participants were connected to the questionnaire by clicking on the link provided in

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the invitation text. The questionnaire was hosted on a private website (https://porsall.com/). The informed consent for participation in the study was provided on the first page of the questionnaire, and the participants began to answer the questions if they agreed. The participants were also told that they could drop out at any time. Sampling was carried out until the minimum sample size was collected from each region. When data collection was completed, an Excel output was downloaded from the user page in the website.

Measurements

General information

This questionnaire contained demographic (age, sex, and family size), socio-economic (educational level, job, and family monthly income), and COVID-19-related health status (infection status and perceived COVID-19 prevention score).

The participants were asked to choose their infection status to COVID-19, including 1. I have been infected (Diagnosis by a physician using PCR test or CT scan tests of the lungs); 2. I have had a suspected infection (Definite infection of someone in close contact; or signs of disease without a diagnostic test in participants); and 3. None of these conditions (considered as non-infected). They were also asked to score their preventive behaviors (frequent hand washing, wearing a mask, keeping social distance, not attending closed public places, not leaving home except when necessary, etc.) against COVID-19. The range of this score was between 1 (lowest) and 10 (highest), and was termed "perceived COVID-19 prevention score" in this study. The questionnaire was designed based on the study goals, and assessed by four experts (in the fields of community and clinical nutrition; and demographics) to ensure content validity.

Household food security assessment

Household Food Insecurity Access Scale (HFIAS) is a 9-item questionnaire used in examining household food security status. There are four options for each item, which assess the frequency of incidence and are rated on a Likert scale (most of the time = 3, sometimes = 2; rarely = 1; and no = 0). The higher total scores of the questionnaire, the greater the food insecurity level. Two examples of questions are as follows: "Did you or any household member eat just a few different kinds of food daily due to the lack of resources?" or "Did you or any household member go a whole day without eating because there was not enough food?. Mohammadi et al. developed a standard Persian questionnaire, with acceptable validity and reliability (Cronbach's alpha = 0.85) [28]. This validated questionnaire was used in the current study.

Statistical analysis

The analysis of data was done by IBM SPSS software, Version 22.0, using Chi-square test, ANOVA test, and Multinomial Logistic Regression model. P-values of less than 0.05 were considered significant. The assessment of data normality was also checked by Kolmogorov–Smirnov test.

Ethical Issue

This research was approved by the Ethics Committee of the National Nutrition and Food Technology Research Institute, Shahid Beheshti University of Medical Sciences (Ethics code: IR.SBMU.nnftri.Rec.1399. 028).

Results

The general information of participants is provided in Table 1. The prevalence of women (82.8%) was much higher than men (17.2%), so before the data were analyzed, sex weighting was carried out based on the census data of the Statistics Center of Iran (103 men for every 100 women).

Table 1: General information of the participants

Quantitative variables	**(Mean ± SD [a])**
Age	32.99 ± 8.31
Family size	3.49 ± 1.29
Perceived prevention score	7.73 ± 1.98
HFIAS[b] score	3.60 ± 5.36
Qualitative variables	**N (%)**
Educational level	
Diploma and lower	621(21.6)
Associate degree and bachelor	1352(47.1)
Masters' degree and higher	897(31.3)
Occupation	
University student	377(13.1)
Housewife	511(17.8)
Employee	709(24.7)
Healthcare personnel	223(7.8)
Manual worker	210(7.3)
Self-employed	539(18.8)
Other	302 (10.5)
Monthly household income	
Under 1800000 Rials	494(17.2)
18000000-36000000 Rials	621(21.6)
36000000-54000000 Rials	670(23.3)
54000000-72000000 Rials	408(14.2)
More than 72000000 Rials	679(23.6)
COVID-19 infection status	
Infected	187(6.5)
Suspected	512(17.8)
Not Infected	2172(75.7)
Living regions	
Tehran region [c]	1088(37.9)
Isfahan region [d]	509 (17.7)
Tabriz region [e]	466 (16.2)
Kermanshah region [f]	419 (14.6)
Mashhad region [g]	388 (13.5)

[a] Standard Deviation
[b] Household Food Insecurity Access Scale
[c] Includes provinces: Tehran, Alborz, Golestan, Mazandaran, Qazvin, Qom, Semnan
[d] Includes provinces: Bushehr, Chaharmahal and Bakhtiari, Fars, Hormozgan, Isfahan, kohgiluyeh and BoyerAhmad
[e] Includes provinces: Ardabil, East Azerbaijan, Gilan, Kordestan, West Azerbaijan, Zanjan
[f] Includes provinces: Kermanshah, Hamedan, Ilam, Khuzestan, Lorestan, Markazi
[g] Includes provinces: Kerman, North Khorasan, Razavi Khorasan, South Khorasan, Sistan and Baluchestan, yazd

ANOVA test

Table 2 indicates the results of the one-way ANOVA test. Mean age and family size were significantly different between the three groups ($P < 0.05$) (Table 2). The mean perceived prevention score was statistically higher among the non-infected group ($P < 0.001$). The mean score of HFIAS was also higher among the infected group, compared to the suspected and non-infected groups ($P < 0.05$).

Table 2: Comparison of quantitative and qualitative variables in three groups of COVID-19 infection status

Quantitative variables	COVID-19 infection status Infected Mean ± SD[a] (n = 187)	Suspected Mean ± SD (n = 512)	Non-infected Mean ± SD (n = 2172)	P-value[b]
Age	32.7 ± 6.6	32.1 ± 7.6	33.1 ± 8.5	0.045
Family size	3.4 ± 1.3	3.6 ± 1.41	3.4 ± 1.2	0.047
Perceived prevention score	7.4 ± 2.1	7.3 ± 2.0	7.8 ± 1.9	<0.001
Household food insecurity score	4.5 ± 6.4	3.6 ± 5.1	3.5 ± 5.3	0.034
Qualitative variables	**Infected** N(%)	**Suspected** N(%)	**Non-infected** N(%)	**P-value[c]**
Gender				
Women	68(4.8)	248(17.6)	1090(77.5)	0.001
Educational level				
Diploma and lower	44(7.1)	110(17.7)	467(75.2)	
Associate degree and Bachelor	91(6.7)	241(17.8)	1021(75.5)	0.883
Masters' degree and higher	51(5.7)	162(18)	685(76.3)	
Occupation				
Student	11(2.9)	84(22.3)	281(74.7)	
Housewife/househusband	24(4.7)	100(19.6)	387(75.7)	
Employee	58(8.2)	116(16.3)	536(75.5)	
Healthcare personnel	31(13.9)	39(17.5)	153(68.6)	
manual worker	24(11.4)	37(17.5)	150(71.1)	<0.001
Self-employed	23(4.3)	89(16.5)	427(79.2)	
other	17(5.6)	47(15.6)	238(78.8)	
Family income (per month)				
Under 1800000 Rials	37(7.5)	83(16.8)	374(75.7)	
18000000-36000000 Rials	43(6.9)	102(16.4)	476(76.7)	
36000000-54000000 Rials	36(5.4)	121(18.1)	513(76.6)	
54000000-72000000 Rials	28(6.9)	79(19.4)	300(73.7)	0.808
More than 72000000 Rials	43(6.3)	126(18.6)	509(75.1)	

[a]Standard Deviation [b]ANOVA [c] Chi-square test

Chi-square test

Chi-square test did not show any significant association between educational levels and COVID-19 infection status (P > 0.05) (Table 2). The prevalence of infected, suspected, and non-infected individuals by job status was also examined by Chi-square test. The prevalence of infected individuals was statistically higher among healthcare personnel and employees (P < 0.001) (Table 2). There was also a significant difference between groups by gender: the infection status was found to be lower among women (P < 0.05) (Table 2). Finally, there was no difference observed between groups in terms of monthly family income (P > 0.05) (Table 2).

Multinomial logistic regression models

Based on the results (ANOVA test and Chi-square test), significant predictors were included in multinomial logistic regression models. As shown in Table 3, the first category of coefficients compared infected versus non-infected groups; the next category compared suspected versus infected groups. The first column shows the effect of the variables individually (unadjusted model). The second column predicts COVID-19 infection status based on the household food insecurity score, by controlling confounding factors (adjusted model).

The results indicated that food insecurity score, job status, and gender were all significantly different between infected and non-infected people (P < 0.05). The comparison between suspected and non-infected individuals only indicated differences in perceived COVID-19 prevention scores (P < 0.05).

Table 3: Unadjusted and adjusted multinomial logistic regression models to predict the COVID-19 infection determinants among the studied population

COVID-19 infection status		Unadjusted Exp (B)	Unadjusted 95% CI* lower ,upper	Adjusted Exp (B)	Adjusted 95% CI lower ,upper
Infected	Age	0.99	0.97, 1.01	0.98	0.96, 1.00
	Perceived COVID-19 prevention score	0.91	0.84, 0.97**	0.96	0.89, 1.03
	Household food insecurity score	1.03	1.00, 1.05**	1.03	1.00, 1.05**
	Gender(Ref: male)				
	female	0.57	0.41, 0.77***	0.60	0.41, 0.87**
	Occupation (Ref: other)				
	Student	0.57	0.264, 1.248	0.59	0.26, 1.34
	Housewife/househusband	0.87	0.45, 1.67	1.35	0.66, 2.72
	Employee	1.55	0.88, 2.74	1.78	0.99, 3.20
	Healthcare personnel	2.89	1.54, 5.43**	3.66	1.90, 7.05***
	Manual worker	2.27	1.17, 4.39**	1.84	0.93, 3.61
	Self-employed	0.75	0.39, 1.45	0.75	0.38, 1.47
Suspected	Age	0.98	0.97, 0.99**	0.99	0.97, 1.00
	Perceived COVID-19 prevention score	0.88	0.84, 0.93***	0.88	0.84, 0.93***
	Household food insecurity score	1.00	0.98, 1.02	0.99	0.97, 1.01
	Gender(Ref: male)				
	female	0.93	0.76, 1.13	0.89	0.70, 1.13
	Occupation (Ref: other)				
	Student	1.50	1.01, 2.23**	1.38	0.91, 2.10
	Housewife	1.29	0.88, 1.90	1.43	0.95, 2.15
	Employee	1.08	0.74, 1.57	1.07	0.73, 1.57
	Healthcare personnel	1.28	0.80, 2.05	1.29	0.79, 2.08
	Manual worker	1.23	0.76, 1.98	1.02	0.62, 1.66
	Self-employed	1.04	0.71, 1.53	0.97	0.65, 1.44

Note 1: The reference is COVID-19 non-infected status
Note 2: Model control variables (in adjusted model) included: age, perceived COVID-19 prevention score, gender, employment status
*Confidence Interval ** P-value < 0.05 ***P-value < 0.001

Discussion

The current study was conducted among an Iranian adult population in order to assess the associations between COVID-19 infection status and household food insecurity scores. The results indicated that men and healthcare personnel were at higher risk of contracting COVID-19. It was also shown that the household food insecurity score was significantly higher among infected people, compared to non-infected people. This finding is consistent with the study by Escobar et al. conducted on the Californians [26]. The higher infection rates of people with food insecurity can be explained via different dimensions. Firstly, it has been shown that food insecurity can be associated with a weaker immune system response [16]. Food insecurity is also associated with greater inflammation in the body [29]. In a study conducted by Kelly et al., Ebola deaths was much higher among food-insecure individuals [17]. HIV-infected people who suffered from food insecurity and malnutrition were also found to be more vulnerable to disease progression [30,31]. There was a similar study on the vulnerability of food-insecure children to frequent colds [32]. Leddy et al. also showed that antiretroviral drug function was significantly affected by food security status [33].

The food quality and dietary diversity of food-insecure households are lower than food-secure ones [19,34]. A healthy diet that provides the micronutrients needed by the body contributes to the better functioning of the immune system [35]. Low-quality diets cause a lack of vital micronutrients for proper bodily function [36]. Selenium deficiency, for instance, has been shown to be associated with severe status of COVID-19 infections [37], due to its important role in immune system function [38]. Vitamin D deficiency has also been related to higher mortality and morbidity from COVID-19 infection [39–41]; this deficiency has been correlated with food insecurity [42] and low family income [43].

Another reason for the higher food insecurity scores among infected individuals may be due to their increased exposure to the virus, because of non-compliance with quarantine. It has been shown that people with lower economic status were less likely to stay at home during the pandemic [44]. One explanation for this finding might be the need to provide food and basic needs for their families. As seen in the United States, racial and socio-economic inequalities were evident in terms of COVID-19 infection rates [45]. People with lower socio-economic status have encountered more concerns about employment, income, access to health care, and sufficient food during the pandemic [46]. Therefore, economically vulnerable people may need immediate financial [4] or food assistance in critical situations, including in a pandemic outbreak [3]. However, in the present study, no significant relationship was found between job status and COVID-19 infection (except for health personnel), but further studies are recommended in this area.

The online nature of the study has some inevitable limitations, including participation bias. In this study, the participation of young people was higher. The involvement of individuals with very low socio-economic status might be lower, due to less access to, or use of, a smartphone or the internet. Therefore, food insecurity may be under-reported, which should be considered when interpreting the results. The self-reporting method of data collection may also have biases. Some people with severe COVID-19 status may not have been able to participate in the study, or may not have reported their infection; thus, there may be underreporting in the number of infected people. It is recommended to conduct similar studies, focusing on hospitals and health centers to further examine the associations between food insecurity and COVID-19 infection status. An interesting future research direction may aim to collect data on disease severity, too.

Conclusion

In the current study, food insecurity scores were higher among infected vs. non-infected individuals. This indicates the higher vulnerability of food-insecure households to COVID-19. Therefore, in addition to reducing food insecurity and hunger, which is the No. 2 UN sustainable development goal [47], policymakers and planners should plan and implement short-term policies (financial or food assistance) to reduce social vulnerability to COVID-19, and increase social resilience to the pandemic.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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