Original Article

Dietary Supplement Use among Iranian Households during COVID-19 Epidemic Lockdown: Less Access in Those Who May Need More National Food and Nutrition Surveillance

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Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic elicited the general population to use various dietary supplements (DSs) and nutraceuticals as a protective means against the disease. The present study aimed to evaluate changes and certain determinants of DS intake during the COVID-19 lockdown among Iranian households. **Methods:** This nationwide cross-sectional study was conducted from April 4 to April 25, 2020, during which Iran was in lockdown. To collect data, a web-based electronic self-administered questionnaire was created. The data were compared among provinces based on their food security situations. **Results:** A total of 21,290 households were included in the analyses. Approximately 27% of the households were using DSs after the epidemic. The most common DSs used were vitamin D (42%) and vitamin C (20%), followed by multi-vitamin (16%), zinc (9%), omega-3 (6%), vitamin A (4%), and probiotics (3%). Logistic regression analysis revealed that DS intake was directly associated with the household income but inversely with household size and the food security status of the provinces. DS intake was positively associated with the presence of high-risk persons in the households, the education of the households' head, and the presence of a person with a history of COVID-19 within the household. **Conclusions:** During epidemic lockdown, DS use was remarkably increased among the Iranian households. Apart from the debatable usefulness of DSs against COVID-19, the inverse association of DS use with a household's income and provincial food security well indicates inequity in accessibility to DS. Actions to improve the nutritional status of the under-privileged populations including targeted supplementation are strongly recommended.

Keywords: *COVID-19, dietary supplements, public health surveillance, surveys and questionnaires*

Introduction

The epidemic of the novel coronavirus disease (COVID-19) was first reported in late December 2019, solely in the city of Wuhan, China.[1] Despite strategies adopted by the Chinese government to stop the infection, it continued to spread throughout the world. By the end of January 2020, the World Health Organization (WHO) declared COVID-19 as a public health emergency of international concern,[2] and on March 11, 2020, WHO characterized this epidemiological phenomenon as a pandemic.[3]

The first report of the epidemic in Iran was on February 19, 2020;[4] therefrom, the infection rapidly disseminated to all provinces of Iran within 15 days. During this time, many individuals sought additional protections, especially via the consumption of various dietary supplements (DSs) and nutraceuticals because of their reported beneficial effects. Although a patient's nutritional status does seem to play a role in COVID-19 susceptibility and outcomes,[5-9] the beginning of the pandemic was accompanied by a remarkable increase in sales of vitamins and other supplements despite the lack of any evidence supporting their use against COVID-19.[10] In the United States, for example, DS and nutraceutical sales have had the modest annual growth in recent years (approximately 5% or a $345 million increase in 2019), but during the 6-week period preceding April 5, 2020, they increased by 44% ($435 million) relative to the same period in 2019.[11]

DSs contain one or more dietary compounds, such as vitamins, minerals, amino acids, or other substances, with a nutritional or physiological effect. A number

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of micro-nutrients, including vitamins C and D and zinc, have been shown to play key roles in supporting immune functions[12,13] and in reducing the risk of respiratory infection.[10,12,14] A biologically plausible role exists for the use of certain DSs.[13,15] Vitamin D, for instance, has been suggested to reduce severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission by enhancing anti-viral immunity and to reduce mortality, mitigating the cytokine storm linked with severe COVID-19.[16,17] Zinc also supports the function of the immune system and may have specific anti-viral effects.[18] There are many other DSs available, including omega-3 fatty acids ("fish oil"), probiotics, and plant isolates, such as garlic.[19] The use of specific DSs in both prevention and treatment of infection with SARS-CoV-2 has been promoted since the beginning of the current coronavirus pandemic.[20] Nevertheless, robust evidence to support a role for DSs in preventing infection with SARS-CoV-2 is not available.[10,21] Considering the modest, but significant, effect of DSs against COVID-19,[15] this study was undertaken to evaluate the changes in DS use during the COVID-19 lockdown period among the Iranian population and their possible associations with some socio-economic variables.

Methods

Study design

This was a cross-sectional descriptive-analytical study using a web-based electronic self-administered questionnaire. The protocol of this study has already been fully described elsewhere.[22] Briefly, several virtual sessions were held to design a questionnaire that aimed to detect any changes in the dietary habits of the Iranian households including DS use following the coronavirus epidemic. The content validity of the questionnaire was assured by a panel of seven internal (involved in the compilation of the questionnaire) and three external (not involved in the compilation of the questionnaire) nutrition experts. The questionnaire was uploaded to a previously created link (https://panel.rabit.ir/s/c1NEPPXL483.html). Then, an official letter from the Community Nutrition Office, Deputy of Health, Iran Ministry of Health (MOH), was sent to the vice chancellors in health affairs and the Community Nutrition Offices of the medical universities of all provinces. In the letter, the objectives of the project and the related link to be followed by the respondents were mentioned. The provincial health and nutrition workers were also requested to notify the community under their service coverage. In addition, the link was distributed widely to Telegram and WhatsApp. This phase of the survey was conducted from April 4 to April 25, 2020, during which Iran was experiencing the coronavirus epidemic lockdown. The variables of interest were compared among provinces based on their food security status, according to the latest national report in which provinces were categorized as food insecure, semi-secure, and secure.[23]

Each respondent was directed to complete the questionnaire on behalf of his/her household. The questionnaires were anonymous to ensure the privacy and independence of the participants. Questions were asked pertaining to socio-economic status (SES) and any DS use by the household members during the epidemic. SES section included data regarding the gender, education, and occupation of the heads of the households, households' size, province and region of the residency (urban/rural), presence of a high-risk person in the household (i.e., under-5 children, pregnant or lactating women, elderly), and any changes in the households' income. The presence of a person with a history of COVID-19 within the household was also asked.

Ethical issues

Completion of the questionnaire was voluntary and anonymous. Furthermore, the respondents were assured about the confidentiality of information and privacy. This study was approved by the Ethics Committee of the National Nutrition and Food Technology Research Institute (IR.SBMU.NNFTRI.REC.1399.066).

Statistical analyses

The descriptive analysis was conducted to assess the distribution of SES among respondents. Logistic regressions were fitted to examine which factors contributed to the DS intake. A two-tailed $P < 0.05$ was, a priori, considered significant. The dependent variable in regression models was supplement intake.

The gender of the households' heads (male, female), living in urban/rural areas (urban, rural), the households' size (one to two, three to five, six and more), presence of the high-risk member(s) in the households (none, under 5 years old, pregnant/lactating, elderly, more than one member), occupation of the heads (employee, freelance, retired, health worker, teacher, driver, other), the educational status of the heads [master and higher, bachelor, associate degree, diploma, high school, theological education (preacher)], changes in the income of the household (no changes, small decrease, half, cut), infection of any member of the family with COVID-19 (no, yes), and the food security status of the provinces (secure, semi-secure, insecure) were the independent variables assessed. In all analyses, sampling weights were used to account for the complex sampling design and to allow inferences valid for the population. All analyses were performed using Stata version 16.0 (StataCorp LLC).

Results

A total of 21,290 households were included in the analyses. Table 1 shows the socio-demographic characteristics of the studied households. The mean age of the households' heads was 44.7 [95% confidence interval (CI)=44.2–44.9] years, and the data indicated that

26.2% of the households (weighted percentage) resided in rural areas.

Approximately 27% of the households were taking DSs after the COVID-19 epidemic. The most used DSs during the COVID-19 lockdown were vitamin D (42%), vitamin C (20%), and multi-vitamin (16%), followed by zinc (9%), omega-3 (6%), vitamin A (4%), and probiotics (3%) [Figure 1].

Table 2 represents the association between DS intake and socio-economic characteristics. The logistic regression analysis revealed that DS intake was significantly associated with the size of the households, the presence of high-risk persons in the households, the education of the households' head, changes in the households' income, presence of a person with the history of COVID-19 within the household, and food security status of the province.

Table 1: Characteristic of the households participating in the survey

Variable	*n* (%)[1]
Urban/rural	
Urban	14191 (73.8)
Rural	7099 (26.2)
Households' size	
1-2	2883 (15.7)
3-5	16798 (78.2)
>6	1609 (6.1)
Presence of high-risk members in the households	
None	11511 (52.6)
Under 5 years old	4881 (21.8)
Pregnant/lactating	660 (2.8)
Elder	2110 (0.4)
More than one member	2128 (8.7)
Sex of the household heads	
Male	19255 (89.8)
Female	2035 (10.2)
Occupation of the households' heads	
Officer	3942 (20.5)
Freelance	7755 (34.3)
Retired	1988 (11.7)
Health workers	572 (2.7)
Teacher	715 (3.1)
Driver	883 (3.9)
Other	5435 (23.8)
Education of the households' heads	
Under diploma	7981 (32.6)
Diploma	5277 (24.1)
Associate	1540 (7.3)
Bachelor	4022 (21.2)
Master/higher	2338 (14.4)
Theological (preacher)	132 (0.5)

[1]Percentages are weighted

Compared with households who had no high-risk members, the odds ratios (ORs) of DS use in households with high-risk members were significantly higher (elderly: OR = 1.45, 95% CI = 1.24–1.27; under 5-year children: OR = 1.45, 95% CI = 1.24–1.27, pregnant/lactating mother: OR = 1.1, 95% CI = 1.01–1.62). Households with COVID-19-affected member (s) had over two times increased odds of using DSs (OR = 2.1; 95% CI, 1.72–2.57, $P < 0.001$) as compared with the households with no infected person. A decrement of the household income was directly associated with lesser use of DSs, compared with the households with no income change during the lockdown. Similarly, DS use in the households living in food-insecure provinces was significantly lower compared with those residing in the secure provinces (OR = 0.32; 95% CI, 0.28–0.37).

Discussion

This is the first national report on DS use in Iranian households during the COVID-19 lockdown period. The mean households' size and the ratio of urban to rural households were in agreement with the information of the latest population census in Iran,[24] suggesting that the study population was representative (~1%) of the whole country households. We have already reported the effects of COVID-19 lockdown on certain dietary habits of the Iranian households.[25,26] In this piece of work, COVID-19 epidemic-induced changes of DS use were evaluated.

We found that vitamins D and C were the most common supplements used during the COVID-19 epidemic. In accord with our findings, another study reported that the intake of vitamins D and C during the COVID-19 epidemic was higher than that before the pandemic.[27] Also, another study from Saudi Arabia found that vitamin C was used during the COVID-19 pandemic by almost all DS users.[28] According to a survey carried out in Poland, 56% of respondents were consuming vitamin D pills.[27] Overall,

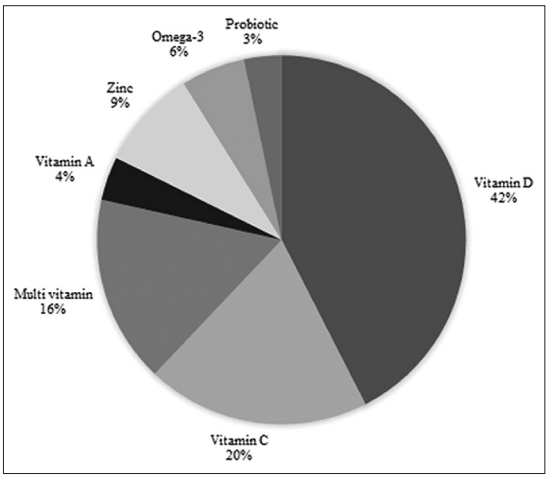

Figure 1: The most commonly used dietary supplements in Iranian households during the lockdown period

Table 2: Logistic regression models of changes in intake of supplement after COVID-19 epidemic

Variables	DS intake		
	Odds Ratio	(95% CI)	*P*
Sex of the households' heads			
Male	-	-	-
Female	1.01	0.87, 1.19	0.809
Urban/Rural			
Urban	-	-	-
Rural	0.96	0.86, 1.07	0.511
Households' size			
1-2	-	-	-
3-5	0.82	0.71, 0.94	0.005
>6	0.75	0.60, 0.93	0.010
High-risk members			
No	-	-	-
<5 years old	1.03	0.80, 0.98	0.031
Pregnant/lactating mothers	1.1	1.01, 1.62	0.037
Elderly	1.45	1.24, 1.70	<0.001
More than one	1.02	0.87, 1.20	0.732
Occupation of the households' heads			
Employee	-	-	-
Freelance	0.92	0.79, 1.08	0.328
Retired	0.95	0.79, 1.13	0.605
Health workers	0.99	0.76, 1.28	0.953
Teacher	0.74	0.58, 0.94	0.015
Driver	0.78	0.60, 1.03	0.082
Other	0.91	0.78, 1.07	0.285
Changes in the households' income			
No changes	-	-	-
Low decrease	0.85	0.75, 0.97	0.015
Half	0.75	0.66, 0.86	<0.001
Cut	0.56	0.48, 0.65	<0.001
COVID-19 in family			
No	-	-	-
Yes	2.10	1.72, 2.57	<0.001
Education of the households' heads			
Master/higher	-	-	-
Bachelor	0.77	0.66, 0.89	0.001
Associate	0.63	0.51, 0.77	<0.001
Diploma	0.5	0.42, 0.59	<0.001
High school	0.48	0.4, 0.57	<0.001
Food security status of the province			
Secure	-	-	-
Semi-secure	0.87	0.79, 0.97	0.013
insecure	0.32	0.28, 0.37	<0.001

vitamin C,[29-31] vitamin D,[31] and omega-3 fatty acids[29,31] were among the most frequently taken DSs in the pandemic. Previous provincial studies from Iran demonstrated that iron, calcium, vitamin D, and multi-vitamin were the most commonly used DSs.[32] Therefore, the pattern of DS use in Iran is likely to have changed because of the epidemic.

The effects of various micro-nutrients in COVID-19 have been investigated in several studies since the beginning of the pandemic.[16,33,34] Nevertheless, the results have been equivocal. It has been documented that adequate circulating concentrations of 25-hydroxycalciferol (25(OH) D) and vitamin C may reduce the incidence of coronavirus-induced "cytokine storm",[35,36] which is strongly associated with lung injury and poor prognosis of the disease.[37]

Currently, the large-scale administration of vitamin D supplements to populations at risk of COVID-19 is widely recommended.[16,38,39] However, some recommendations seem to be more of a commercial opportunity, rather than fulfilling real nutritional requirements. Indeed, a recent study reported a significant increase in the number of advertisements in favor of dietary supplementation for the recent pandemic compared with before.[40] The UK supplement market, for instance, increased by 19.5% in the period, leading up to the national "lockdown" in early March 2020,[41] with a 110% rise in sales of vitamin C and a 93% rise in sales of multi-vitamin supplements.[41] Likewise, zinc supplement sales increased by 415% over the 7-day period ending March 8 at the peak of COVID-19 concern in the US.[19] Although the pandemic continues, the urgent need for correct information about the beneficial doses of DSs is clear. Accordingly, information that is supported by rigorous trials could offset misleading claims for DSs, and in this regard, consumer education and development of related regulations are suggested.

According to the current study, DS intake was inversely related to the households' size. In other words, it seems that the size of the households may limit access to all facilities including DSs. In a recent study, households' size was reported to be a potential determinant of the COVID-19 pandemic,[42,43] and another study revealed that the COVID-19 death rate among the upper quintile of house crowding was almost 3 times as much as household crowding of the lowest quintile.[44] This indicates that more crowded Iranian households who may need more DSs probably have less access to them.

We found a direct association between education and DS use. The relationship between education level and DS use has already been reported from Iran[32,45] and other countries,[30] suggesting that a higher level of education may be conducive to greater knowledge about the positive effect of adequate nutrition in boosting the immune system and prevention of infection.

Our findings demonstrated a direct association between the decrement of income during lockdown and DS use. Given that dietary intakes are often influenced by income, low-income households are more likely to have lower

quality and lower nutrient-rich diets.[46] Nutrient adequacy in adults is incontrovertibly income-related,[47,48] and adults in poor socio-economic status are reported to have a higher prevalence of micro-nutrient inadequacies based on total nutrient intakes from both diet and DS.[47] Dietary supplements, on the other hand, can contribute in nutritional adequacy, especially in low-income sub-populations.[49] In addition, our study revealed that the food insecurity status of the provinces was inversely related with DS use in the households, again indicating that more needy households may have less access to DS. These findings well confirm the fact that household welfare and food security are strongly correlated with each other.[50]

To the best of our knowledge, this was the first nationwide survey on changes of dietary habits, including DS use, among Iranian households. As the questionnaires were IT-based, analysis and reporting to the policy-makers could be performed at the earliest. Nevertheless, some limitations of this study are acknowledged. First, the questionnaire was self-administrated so that only people interested in the subject might have participated in the survey. Second, those people without internet access were inevitably excluded. However, these limitations are common in online surveys,[36,51,52] but as they provide the possibility to gather data without the need for face-to-face interview and a high risk of viral transmission, online surveys are preferable, especially during the COVID-19 epidemic.[53,54] Moreover, the conformity of our data on the mean household size and the ratio of urban to rural households with the latest report of population census in Iran[24] indicates that the study population could be regarded as the representative of the whole country households.

Conclusions

We found that 27% of the studied population was taking DS during COVID-19 lockdown. Vitamins D and C were the mostly used supplements. DS intake was less among households with a lower income, and the food insecurity status of the provinces was inversely related to DS intake of the households, which implies the impact of prosperousness on the well-being of the populations. DS intake was explored in the context of socio-economic determinants, namely, households' size and the educational level of the households' heads. Considering the noticeable contribution of DS in nutritional adequacy[49] and hence immuno-competence against human diseases including coronavirus infection,[55,56] early interventions to improve the nutritional status (including targeted supplementation) of the low-income households is strongly recommended.

Abbreviations

COVID-19: Coronavirus disease of 2019

DSs: Dietary Supplements

NNFTRI: National Nutrition and Food Technology Research Institute

SES: Socio-economic status

WHO: World Health Organization.

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Availability of data and materials

Data described in this manuscript will be made available upon reasonable request to the project's main supervisor

Ethics approval and consent to participate

All procedures were approved by Ethics Committee of the National Nutrition and Food Technology Research Institute (IR.SBMU. NNFTRI.REC.1399.066). All participants were properly instructed and gave online their informed consent to participate.

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Conflicts of interest

There are no conflicts of interest.

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