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The Correlation between Nuts Consumption and Severity and Symptoms of COVID-19

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ABSTRACT

Background: The global population has been under threat of ongoing COVID-19 pandemics. Diet was shown to significantly impact the severity of the disease. The primary focus of this research is to explore the potential correlation between consuming nuts and the severity of COVID-19 symptoms.

Methods: Totally, 684 individuals who recovered from COVID-19 were enrolled; while 168-item frequency questionnaire (FFQ), International Physical Activity Questionnaire (IPAQ), were used to assess dietary intakes of participants. The severity of COVID-19 was assessed based on the COVID-19 Treatment Guidelines (CTG). Satisfaction with Life Scale (SWLS) questionnaire was utilized to determine the level of life satisfaction. Outcomes including severity of COVID-19 symptoms, hospitalization, hypoxia, lung infection, need to respiratory support, duration of disease, recovery after hospitalization, serum levels of C reactive protein (CRP) and erythrocyte sedimentation rate (ESR) and saturation of peripheral oxygen (SpO_2) level were evaluated.

Results: Among those recovered from COVID-19, there was an association between increased intake of nuts and reduction in CRP level (p=0.007), increase in life satisfaction score (p<0.001), decreased risk of severe infection of COVID-19 (p=0.036), decline in the need to respiratory support (p=0.002), decreased duration of disease (p=0.004), reduction in duration of recovery after hospitalization (p=0.001), declined risk of fever (p=0.048), lowered risk of weakness (p<0.001), chest pain (p<0.001), headache (p=0.028), dizziness (p=0.002) and anorexia (p=0.015).

Conclusion: Higher intake of nuts was shown to be correlated with a decreased risk of severe infection, hospitalization, and duration of illness, along with improvements in COVID-19 symptoms.

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Introduction

SARS-CoV-2 is a member of the coronavirus family, characterized by its single-stranded RNA that has the ability to endanger the respiratory system and various other organs within the body (1). Common signs associated with infection to this virus are headache, muscular pains, nausea, vomiting, fever, dry cough, and feeling tired (2). Symptoms can range from mild to severe forms, including critical conditions like systemic inflammation, sepsis, and organ dysfunction (3, 4). In extreme situations, the concentrations of cytokines like interleukins and C-reactive protein (CRP) rise, and might continue to a cytokine storm. This storm plays a crucial role in the development of acute respiratory syndrome and failure of organs beyond the lungs (5, 6).

Even though the COVID-19 vaccine is now accessible, it is still crucial to understand the significance of natural remedies and preventive methods (7). Dietary intake can be related to the likelihood of developing severe illness in some cases, and in contrary to a lower severity of COVID-19 among others (8). Consuming nuts as a part of our daily diet can have a positive impact on our overall health. Nuts contain essential nutrients such as fiber, B vitamins, vitamin E, magnesium, selenium, omega-3 fatty acids, and beneficial phytochemicals like phenolic compounds and phytosterols (9). Association between these substances and COVID-19 severity has been documented previously; for instance, vitamin E and omega-3, both well-known for their ability to enhance the immune system and reduce inflammation (10). Despite these theories, the rare available studies about the association of nuts consumption with COVID-19 severity and symptoms have reached conflicting results. A recent study indicated that the intake of nuts and seeds could potentially be linked to a decrease in the severity of COVID-19 among healthcare professionals in six different nations (11). In contrast, another study has suggested that consuming nuts may be linked to an increased risk of death or delayed recovery in patients with COVID-19 (12).

As mentioned, few studies have explored the link between eating nuts and the impact on COVID-19 outcomes. Important factors like socioeconomic status and physical activity were not taken into consideration when examining the correlation between nuts consumption and the likelihood of experiencing COVID-19 complications. As most researches on the relationship between nuts consumption and health outcomes have been carried out in Western nations, limited data are available from Middle Eastern countries, where dietary habits are completely different from Western nations. So this study investigated the correlation between nuts consumption and severity of COVID-19 symptoms among a group of Iranian adults recently recovered from the disease.

Materials and Methods

This cross-sectional study was conducted from June 2021 to May 2022 on 683 COVID-19 patients aged 18-70 years. The study was conducted at the Referral Hospital of Shahid Beheshti, and among all urban health centers in Kashan, Iran. Patients were included in the study by convenient sampling and provided a written consent after being informed about the protocol of the study that was approved by the Ethics Committee of Kashan University of Medical Sciences, Kashan, Iran and Tehran University of Medical Science, Tehran, Iran (registration no.: IR.KAUMS.MEDNT.REC.1403.072 and IR.TUMSMEDICINE.REC.1400688).

Individuals with COVID-19 that were confirmed by a positive polymerase chain reaction test and completely recovered from the disease were enrolled. The patients who were diagnosed with COVID-19 during the last three months were selected. Patients with chronic diseases including cardiovascular diseases, diabetes, HIV infection, being under chemotherapy, organ transplanted, smoking, pregnancy or breastfeeding, those who were taking drugs that could affect the respiratory system, patients with a body mass index (BMI) more than 40 kg/m^2; as well as those who followed a special dietary pattern were excluded from the study.

Out of 3191 people who referred to Shahid Beheshti Hospital and all health centers, 1218 met the inclusion criteria. Finally, 684 individuals agreed to participate in the study. An expert dietician collected the required information through telephone interviews with the participants. Participants completed a demographic questionnaire, food frequency questionnaire (FFQ), COVID-19 symptoms and severity assessment questionnaire, Satisfaction Life Scale questionnaire (13), and a short form of the International Physical Activity Questionnaire (IPAQ). Furthermore, the medical records of participants were reviewed to obtain necessary data about disease history.

Dietary intake of participants in the year before being infected with COVID-19 was evaluated using a 168-item FFQ, while its validity and reliability were previously approved (14-16). Participants were asked to report their dietary intake based on daily, weekly, monthly, or annual frequencies. Then, the dietary reports were transformed into daily grams using the Iranian household measurements (17). Daily intake of energy and essential nutrients for each participant were estimated using the food composition database from the US Department of Agriculture (18). The Nutritionist IV software was used to determine the daily intake of essential nutrients, for both macro- and micronutrients. To assess the total nuts consumption, the intake of each nut such as mixed nuts, walnuts, almonds, peanuts, pistachios, and hazelnuts was summed up.

COVID-19 severity, symptoms, hospitalization, hypoxia, need for respiratory support, any severe respiratory infection, total duration of disease, recovery after hospitalization, and serum levels of inflammatory biomarkers such as C reactive protein (CRP) and erythrocyte sedimentation rate (ESR) were examined for the participants. The severity of COVID-19 was assessed based on the COVID-19 Treatment Guidelines (CTG) (19). Patients were divided into five groups of (i) Asymptomatic or pre-symptomatic infection: Individuals who had positive laboratory test for COVID-19, but in absence of any symptoms; (ii) Mild illness: Patients who had at least one of the typical COVID-19 symptoms (such as cough, fever, chills, weakness, myalgia, sore throat, headache, loss of taste and smell, diarrhea, nausea and vomiting), but did not show abnormal chest imaging or serious respiratory symptoms like dyspnea or shortness of breath; (iii) Moderate illness: Patients with lower respiratory disease during clinical examinations or imaging and had (SpO_2)≥94% in room air at sea level; (iv) Sever illness: Patients with a respiratory rate (RR)>30 breath/minute or SpO_2<94% in room air at sea level or arterial partial oxygen pressure to a fraction of inspired oxygen (PaO_2/FiO_2)<300 or more than 50% lung infiltration; and (v) Critical illness: Occurrence of respiratory failure, dysfunction of multiple organs or septic shock [most of the patients in this category were in the intensive care unit (ICU)]. Patients in the last two groups (severe and critical illness) were considered to have severe COVID-19.

A standard questionnaire was used to evaluate the disease symptoms including dyspnea, cough, fever, chills, myalgia, headache, chest pain, sore throat, runny nose, weakness, nausea and vomiting, diarrhea, loss of taste and smell, sneezing, and anorexia. Saturation of peripheral oxygen (SpO_2) levels, with SpO_2 less than 94% was considered as hypoxia. The need for respiratory support was evaluated based on the use of any respiratory support, such as nasal cannula, oxygen mask, ventilator, etc. Satisfaction with Life Scale (SWLS) questionnaire was utilized to determine the level of life satisfaction. The validity and reliability of the Persian version of the questionnaire have been reported previously (13). The SWLS included five questions. The questionnaire score ranged from 5 to 35. A higher score indicated higher life satisfaction (13).

Participants' age, gender, weight, height, material status, education, occupation, ethnicity, disease history, medication and supplementation intake, vaccine injection, and drug and dietary supplement use during COVID-19 infection were collected by standard demographic checklists. We also evaluated participants' physical activity by using the abbreviated version of the IPAQ, which had been validated for the Iranian population in a prior research (20). The physical activity level of each participant was converted into metabolic equivalents (minutes per week) (21). Socio-economic status was assessed based on three criteria of number of family members, home ownership, and educational level. If a family had four or fewer members, owns a home, and had a university degree, they received a score of 1. On the other hand, if the family had more than four members, did not have their own home, and had no university degree, they received a score of 0. All scores were added up and the total scores of 0, 1, and 2 indicated low, moderate, and high socioeconomic status, respectively.

IBM SPSS software (Version 26, Chicago, IL, USA) was used for statistical analyses. To assess normality, we used Kolmogorov-Smirnov test. The participants were divided into tertiles based on their nuts consumption. Qualitative variables were compared among tertiles of nuts consumption by Chi-Square test. Quantitative variables such as age, BMI, physical activity, etc. were compared among tertiles of nut consumption with One-Way Analysis of Variance (22). Additionally, analysis of covariance (ANCOVA) was used to compare dietary intake and level of inflammatory biomarkers among tertiles of nuts consumption after adjusting for age and energy intake. Binary logistics regression was used to evaluate association between nuts consumption and COVID-19 outcomes; including disease severity, hospitalization, symptoms, and duration. *P* value<0.05 was considered as the significance level.

Results

General characteristics of participants across tertiles of nuts consumption were shown in Table 1 revealing no significant differences between tertiles of nut consumption regarding age, BMI, physical activity, marital status, educational level, socio-economic status, history of disease, and use of dietary supplements during COVID-19; but, significant differences were noticed in relation to gender (p<0.001), likelihood of overweight/obesity (p=0.031), COVID-19 vaccination (p<0.001), use of antiviral drugs (p<0.001), and income (p=0.017).

Table 1: General characteristics of participants according to tertiles of nuts intake.

Variable		Tertile 1	Tertile 2	Tertile 3	*P* value
Sample size (n)		225	231	228	-
Age (y)*		40.6±14.5	40.4±14.4	43.1±12.4	0.063
BMI (kg/m²)*		26.0±4.6	26.5±4.4	26.8±3.9	0.177
Physical activity (MET-min/week)*		883.9±1359.5	1143.2±3622.8	752.2 ±1181.3	0.193
Female (%)		69.3	71.4	51.8	<0.001
Overweight and obesity (%)		52.9	61.9	64.5	0.031
Married (%)		71.6	72.0	65.4	0.778
University education (%)		37.2	46.1	50.0	0.132
Income (%)		35.8	47.2	57.7	0.017
Socio-economic status(%)	Low	4.7	3.1	3.8	0.149
	Moderate	24.2	17.1	34.6	0.149
	High	71.2	79.8	61.5	0.149
History of disease (%)		27.0	30.6	19.2	0.421
Usual dietary supplements intake (%)		31.2	36.8	30.8	0.462
COVID-19 vaccination (%)		65.8	62.3	7.0	<0.001
Anti-viral drugs treatment (%)		52.0	48.5	86.4	<0.001
Take dietary supplements during treatment (%)		89.3	91.3	93.4	0.308

*Values are mean±standard deviation. MET: Metabolic Equivalent Task.

Table 2: Dietary intake of participants across tertiles of nuts intake.

Variable	Tertile 1	Tertile 2	Tertile 3	*P* value
Energy (kcal/day)	1758.2±612.1	2068.7±640.1	2864.7±479.2	<0.001
Protein (g/day)	78.4±9.5	78.6±11.2	88.1±17.1	<0.001
Carbohydrate (g/day)	324.9±32.0	327.4±33.5	338.1±50.7	<0.001
Fat (g/day)	75.6±15.2	76.6±13.9	84.4±20.5	<0.001
Fiber (g/day)	16.1±3.9	16.3±3.4	19.9±5.5	<0.001
Cholesterol (mg/day)	293.2±92.9	290.4±102.2	361.1±151.9	<0.001
SFA (g/day)	21.5±5.4	21.8±4.7	23.4±8.5	<0.001
MUFA (g/day)	21.1±6.1	21.7±5.5	24.4±7.8	<0.001
PUFA (g/day)	19.9±7.5	19.7±8.5	22.1±6.6	<0.001
Vitamin D (µg/day)	1.30±0.73	1.48±0.90	1.70±0.75	<0.001
Vitamin A (RAE/day)	955.8±527.3	1105.4±542.2	1133.0±393.4	<0.001
Beta-carotene (µg/day)	531.2±533.2	624.0±474.4	794.8±395.4	<0.001
Vitamin E (mg/day)	3.99±1.34	4.09±1.69	5.54±2.31	<0.001
Vitamin C (mg/day)	113.1±42.8	125.1±48.0	130.9±49.5	<0.001
Vitamin B1 (mg/day)	1.84±0.28	1.80±0.26	2.01±0.39	<0.001
Vitamin B2 (mg/day)	1.47±0.36	1.52±0.32	1.63±0.39	<0.001
Vitamin B3 (mg/day)	21.1±2.8	20.7±2.8	21.9±3.9	<0.001
Vitamin B6 (mg/day)	1.29±0.32	1.39±0.33	1.51±0.33	<0.001
Vitamin B9 (mg/day)	276.4±75.2	280.8±69.1	351.7±100.5	<0.001
Vitamin B12 (mg/day)	4.29±2.77	4.62±3.20	3.59±1.81	<0.001
Zinc (mg/day)	7.45±1.60	7.70±1.63	8.64±1.84	<0.001
Calcium (mg/day)	752.3±204.6	776.9±179.0	764.7±174.4	0.373
Magnesium (mg/day)	215.8±42.4	227.8±38.0	227.5±56.5	<0.001
Iron (mg/day)	20.9±5.9	21.2±6.6	22.2±6.9	0.004
Selenium (mg/day)	42.6±23.4	40.8±20.9	51.9±18.1	<0.001

Values are residual mean±standard deviation. SFA: saturated fatty acids, MUFA: Monounsaturated fatty acids, PUFA: polyunsaturated fatty acids

Dietary intake of participants across tertiles of nut consumption was presented in Table 2 demonstrating that patients who were at the highest tertile of nuts consumption had a significantly higher intake of protein, carbohydrate, fat, fiber, cholesterol, saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), vitamin D, vitamin A, vitamin E, beta-carotene, vitamin C, vitamin B1, vitamin B2, vitamin B3, vitamin B6, vitamin B9, zinc, iron and selenium comparing to those at the lowest tertile. Individuals at the highest tertile of nuts consumption reported a significantly lower intake of vitamin B12 when compared to those at the bottom.

As shown in Table 3, a significant association was visible between a high intake of nuts and reduction in CRP (p=0.007), and also between a high intake of nuts and an increased life satisfaction (p<0.001). However results for ESR (p=0.295) and respiratory rate (p=0.210) were not statistically significant. As illustrated in Table 4, a high nut consumption was significantly associated with lower risk (64%) of severe form of COVID-19 (p=0.036), lower risk (73%) of the need to respiratory support (p=0.002), lower risk (70%) of disease duration (p=0.004) and lower risk (71%) of recovery duration (p=0.001). No significant association was noticed between nuts consumption and risk of hospitalization (p=0.866), hypoxia (p=0.143), respiratory infection (p=0.813) and hospitalization duration (p=0.093). According to Table 5, a higher intake of nuts was significantly linked with lower risk (66%) of fever (p=0.048), lower risk (85%) of weakness (p<0.001), lower risk of (76%) chest pain (p<0.001), lower risk (56%) of headache (p=0.028), lower risk (73%) of dizziness (p=0.002), and lower risk (64%) of anorexia (p=0.015). There was not any significant relationship between nuts consumption and the risk of dyspnea, cough, chill, myalgia, sore throat, nausea and vomiting, diarrhea, loss of taste and smell, sneezing and runny nose.

Discussion

The results of this study highlighted a strong link between consumption of nuts and the severity of COVID-19 infection, as well as its related symptoms and outcomes. A significant negative relationship was found between eating nuts and the likelihood of severe COVID-19 infection, hospitalization, CRP level, the need for respiratory support, fever, weakness, chest pain, headache, dizziness, anorexia, and the duration of disease and hospitalization. Furthermore, a significant improvement in life satisfaction score was correlated to higher nuts consumption. These findings are in consistent with a prior study indicating that nuts play a positive role in lowering the likelihood of respiratory infections and inflammatory issues. SAPALDIA Cohort study by Steinemann and colleagues supported this finding and revealed an increased nuts intake to be linked with a lowered risk of chronic respiratory disease (23).

Table 3: Association between tertiles of nuts consumption and levels of CRP and ESR, respiratory rate and life satisfaction score.

Variable	Tertile 1	Tertile 2	Tertile 3	*P* value*
CRP	40.4±45.1	28.7±30.3	18.3±22.7	0.007
ESR	31.1±23.7	31.8±25.6	24.1±25.4	0.295
Respiratory rate	18.3±2.3	18.1±2.3	16.0±5.1	0.210
Life satisfaction score	21.6±6.7	24.3±6.1	27.7±5.1	<0.001

Values are mean±standard deviation. *Adjusted P value was reported for adjustment of age, sex, energy intake, marital status, physical activity, educational level, job, socioeconomic status, COVID-19 vaccine injection, anti-viral treatment drugs use, and BMI. CRP: C Reactive Protein, ESR: Erythrocyte Sedimentation Rate.

Table 4: The association between dietary intake of nuts and risk of severe infection of COVID-19, hospitalization, hypoxia, lung infection, need to respiratory support, duration of disease, and recovery after hospitalization.

Out come	Model	Tertile 1	Tertile 2	Tertile 3	*P* value
Severe COVID-19 infection	Crude	1	1.15 (0.78–1.69)	1.38 (0.94–2.03)	0.098
	Adjusted	1	1.05 (0.66–1.68)	0.36 (0.19–0.80)	0.036
Hospitalization	Crude	1	0.81 (0.56–1.18)	8.62 (4.78–15.53)	<0.001
	Adjusted	1	0.94 (0.48–1.84)	0.93 (0.21–4.17)	0.866
Hypoxia	Crude	1	1.51 (0.94–2.42)	0.98 (0.63–1.51)	0.710
	Adjusted	1	1.37 (0.79 – 2.39)	0.48 (0.22–1.06)	0.143
Need to respiratory support	Crude	1	0.78 (0.54–1.13)	0.61 (0.42–0.89)	0.010
	Adjusted	1	0.84 (0.51–1.37)	0.27 (0.13–0.58)	0.002
Lung infection	Crude	1	0.75 (0.52–1.09)	0.70 (0.48–1.01)	0.055
	Adjusted	1	1.10 (0.66–1.84)	1.07 (0.51–2.23)	0.813
Duration of disease	Crude	1	0.95 (0.65–1.38)	1.33 (0.91–1.93)	0.136
	Adjusted	1	0.79 (0.49–1.26)	0.30 (0.14–0.62)	0.004
Hospitalization duration	Crude	1	1.25 (0.77–2.04)	1.14 (0.92–2.18)	0.122
	Adjusted	1	0.96 (0.53–1.73)	0.49 (0.19–1.03)	0.093
Duration of recovery after hospitalization	Crude	1	1.00 (0.69–1.45)	1.36 (0.93–1.97)	0.106
	Adjusted	1	0.76 (0.50–1.17)	0.29 (0.14–0.58)	0.001

Values are odds ratio (95% confidence interval: CI). Adjusted: adjusted for age, sex, energy intake, marital status, physical activity, educational level, job, socioeconomic status, covid-19 vaccine injection, anti-viral treatment drug use, and BMI.

Table 5: The association between Dietary intake of nuts and symptoms of COVID-19.

Outcome	Model	Tertile 1	Tertile 2	Tertile 3	*P* trend
Dyspnea	Crude	1	1.33 (0.92–1.92)	1.69 (1.16–2.45)	0.006
	Adjusted	1	1.22 (0.80–1.85)	0.56 (0.29–1.10)	0.326
Cough	Crude	1	1.75 (1.19–2.58)	0.83 (0.57–1.20)	0.299
	Adjusted	1	1.52 (1.01–2.30)	0.51 (0.27–0.97)	0.377
Fever	Crude	1	1.37 (0.89–2.03)	1.08 (0.72–1.62)	0.688
	Adjusted	1	1.12 (0.72–1.74)	0.34 (0.17–0.71)	0.048
Chill	Crude	1	1.77 (1.21–2.57)	2.11 (1.44–3.10)	<0.001
	Adjusted	1	1.42 (0.95–2.12)	0.54 (0.27–1.07)	0.569
Weakness	Crude	1	0.41 (0.26–0.63)	0.08 (0.06–0.14)	<0.001
	Adjusted	1	0.35 (0.21–0.57)	0.15 (0.07–0.30)	<0.001
Myalgia	Crude	1	0.82 (0.56 – 1.19)	0.39 (0.26–0.56)	<0.001
	Adjusted	1	0.77 (0.51–1.16)	0.59 (0.32–1.11)	0.088
Chest pain	Crude	1	1.07 (0.71–1.60)	0.98 (0.65–1.48)	0.922
	Adjusted	1	0.81 (0.52–1.28)	0.24 (0.12–0.48)	<0.001
Headache	Crude	1	0.96 (0.66–1.39)	0.32 (0.22–0.47)	<0.001
	Adjusted	1	0.87 (0.58–1.30)	0.44 (0.24–0.83)	0.028
Dizziness	Crude	1	0.77 (0.53–1.12)	0.16 (0.10–0.26)	<0.001
	Adjusted	1	0.76 (0.51–1.14)	0.27 (0.13–0.56)	0.002
Sore throat	Crude	1	0.97 (0.67–1.40)	0.54 (0.37–0.80)	0.002
	Adjusted	1	0.85 (0.57–1.28)	0.68 (0.36–1.29)	0.237
Nausea and vomiting	Crude	1	1.05 (0.70–1.59)	0.32 (0.19–0.54)	<0.001
	Adjusted	1	1.16 (0.75–1.81)	0.40 (0.18–0.87)	0.189
Diarrhea	Crude	1	1.03 (0.57–1.86)	0.29 (0.04–2.23)	0.492
	Adjusted	1	1.05 (0.56–1.97)	0.21 (0.02–1.82)	0.457
Anorexia	Crude	1	1.12 (0.77–1.63)	0.52 (0.35–0.78)	0.002
	Adjusted	1	1.00 (0.69–1.49)	0.36 (0.19–0.67)	0.015
Loss of taste and smell	Crude	1	1.42 (0.94–2.23)	1.66 (0.70–3.94)	0.075
	Adjusted	1	1.22 (0.76–1.98)	1.07 (0.38–3.05)	0.528
Sneezing	Crude	1	1.18 (0.76–1.86)	0.99 (0.38–2.60)	0.633
	Adjusted	1	1.16 (0.71–1.88)	1.01 (0.33–3.06)	0.678
Runny nose	Crude	1	1.67 (1.11–2.53)	1.10 (0.45–2.65)	0.081
	Adjusted	1	1.66 (1.04–2.66)	1.02 (0.35–3.00)	0.131

Values are Odds ratio (95% confidence interval). Adjusted: adjusted for age, sex, energy intake, marital status, physical activity level, education, job, socioeconomic status, covid-19 vaccine injection and anti-viral treatment drug use, treatment and BMI.

In the same way, Coco *et al.* showed that regular consumption of nuts in a daily diet was linked to a lower likelihood of chronic pulmonary obstructive disease (COPD) (24). We found that individuals who consumes higher amounts of nuts were less likely to experience symptoms such as fever, weakness, chest pain, headache, dizziness, and anorexia. These findings are consistent with the potential immune-boosting and anti-inflammatory properties of nutrients found in nuts, such as omega-3 fatty acids and antioxidants (25, 26). It seems that higher intake of nuts in a healthy dietary pattern might reduce body inflammation and impact disease severity and symptoms (27).

A study conducted by Zhao *et al.* in 2023 found that individuals in the highest quintile of DII had 10-17% higher risk of contracting COVID-19 and a 40% higher risk of developing severe COVID-19 when compared to those in the lowest quintile. The researchers concluded that a diet that contributes to inflammation may increase the risk of severe COVID-19 outcomes, including death (28). A randomized controlled trial conducted by Calder *et al.* showed that taking omega-3 fatty acids, which are commonly found in nuts, led to a decrease in inflammation and an improved lung function in patients with COPD (29). Furthermore, the study conducted by Bezerra and colleagues revealed that consuming more antioxidants, like the ones found in nuts, was linked to a decrease in the likelihood of contracting respiratory infections (30).

Despite the consistent results seen in various studies, it is crucial to recognize possible limitations and discrepancies. While certain studies have shown that consuming nuts can protect against respiratory infections; other studies have not provided conclusive evidence. Saint *et al.* found no significant association between nut consumption and the likelihood of upper respiratory tract infections in older individuals (31). The discrepancies in research findings could be attributed to various methodological differences, including variations in the implementation of dietary assessments and the unique characteristics of the study populations. The beneficial effects of nut consumption on the severity of COVID-19 and its related symptoms can be attributed to several molecular mechanisms. Nuts are rich in bioactive compounds, including omega-3 fatty acids, antioxidants, vitamins, and minerals, which play critical roles in modulating the immune response (27, 32).

Omega-3 fatty acids, such as alpha-linolenic acid, possess anti-inflammatory properties by reducing the production of pro-inflammatory cytokines (33, 34). These fatty acids influence immune cell functions, including T-cells and macrophages, thereby reduce the overall inflammatory response (35, 36). Antioxidants, such as vitamin E and polyphenols, mitigate oxidative stress by neutralizing reactive oxygen species (ROS), protecting cellular components from oxidative damage, and supporting immune function (37, 38). Additionally, micronutrients such as zinc and selenium found in nuts are essential to maintain immune competence, and are crucial for an effective response to viral infections (39). These combined effects can reduce systemic inflammation and enhance the body ability to manage respiratory pathogens, potentially lead to milder disease courses and improve clinical outcomes of COVID-19.

Our study provided compelling evidences regarding the potential benefits of nuts consumption in mitigating severity and symptoms of COVID-19, but there may be some limitations. The reliance on convenient sampling method and retrospective data collection technique may introduce bias, such as selection bias and recall bias, which could impact the accuracy and generalizability of the results. Additionally, the exclusion of individuals with chronic diseases or high BMI, as well as those following special dietary patterns, may limit the applicability of the findings to a broader population. Moreover, the reliance on self-reported symptoms and medical records for assessment of clinical outcome may lead to outcome misclassification, potentially influencing the observed associations. Furthermore, the study geographic focus on a specific region in Iran may limit the generalizability of the findings to populations with different dietary habits, lifestyles, or healthcare systems. While the studys strengths, such as its large sample size and comprehensive assessment methods, bolds the reliability of the results, addressing these limitations and employing more rigorous methodologies in future research endeavors would be critical to confirm and extend the observed associations between nuts consumption and COVID-19 outcomes.

Conclusion

Our findings revealed an association between consuming nuts and a decrease in the COVID-19 severity and symptoms. Also, a higher consumption of nuts wass correlated with a lower likelihood of severe infection, hospitalization, and duration of illness, as well as enhancements in different symptoms of COVID-19. Moreover, nuts consumption was correlated with a lower CRP level and a better life satisfaction of afflicted patients. These findings emphasized the positive impacts of nuts in lowering the risk of respiratory infections and its antiinflammatory property.

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Authors' Contribution

FA, MN contributed in conception, design, search, statistical analyses, data interpretation and manuscript drafting. RR and MMH contributed in design and data interpretation. AM and AE contributed in conception, design, statistical analyses. AM supervised the study. All authors approved the final manuscript for submission.

Conflict of Interest

None declared.

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