Journal of Applied Nutritional Sciences
An International Journal

Original Article

Habitual food consumption of patients with COVID-19 infection from rural regions-preliminary, cross sectional study.

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doi:10.18576/jans/010102
Cite this as: Ismail MS, Hassan SM, Elmaadaw AA. Habitual food consumption of patients with COVID-19 infection from rural regions-preliminary, cross sectional study. *JANS* 2022; Jan 1(1):15-29.

Received: September 12, 2021
Accepted December 23 2021

Abstract

Eating sufficient amounts of specific foods and avoiding unhealthy foods is vital in the host defense against COVID-19 infection. This study aimed to explore the habitual consumption of different foods among rural Egyptians infected with COVID-19. This retrospective, cross-sectional study recruited 53 COVID-19 patients from rural regions. All patients were diagnosed with confirmed COVID-19 infection and quarantined at hospitals for 7 to 14 days. Data about frequency of consumption of vegetables, fruits, functional foods, animal protein and iron-containing foods, traditional foods, drinks, etc., prior to COVID-19 infection were collected. Patients were classified into three categories based on their habitual food consumption of selected food groups: (1) high (daily or more than three times/week), (2) moderate (3 times or less per week), and (3) low (3 times or less per month). The results revealed that the habitual food consumption pattern of studied patients is characterized by frequent high consumption of fresh and cooked vegetables, black tea, spices, and pickles; moderate consumption of fruits, fresh juices, onions, poultry, and eggs; low consumption of meats, organ meats, honeybee, processed meats, cow trotter, animals' offal, cow head meats, salted fish, fast foods, hot pepper, nigella sativa, raw garlic, olive oil, carbonated beverages, ginger tea, and ketchup. Despite the study limitations, which include collecting data by cell phone and small sample size, it could be concluded that habitual low consumption of meats and antiviral foods, and high consumption of spices, pickles, black tea, fresh and cooked vegetables may contribute to the severe symptoms of COVID-19 infection among rural patients.

Keywords: Coronavirus, Meat, Pickles, Spices, Tea, Salt, Antiviral Foods

1. Introduction:

CORONAVIRUS disease-2019 (COVID-19) is considered pandemic and caused by the severe acute respiratory syndrome coronavirus 2 (SARS CoV-2). This virus primarily originated from Wuhan city of Hubei province of China and spread around the world [1]. On 21 January 2021, the World Health Organization announced that globally, there are 95,612,831 confirmed cases of COVID-19, including 2,066,176 deaths. Among them, 158936 confirmed cases and 8747 deaths in Egypt [2].

THE WHO recorded immunocompromised and nutritional status as factors that increase person's susceptibility to infection [2]. Large and continuous evidence demonstrates that the intake of certain nutrients, specific food groups, and comprehensive dietary patterns positively influences health and enhances the prevention of diseases [3].

Regarding COVID-19, challenges arise concerning how to support the immune system. An optimal immune response relies on adequate diet and nutrition to keep infectious diseases aside [4]. For example, sufficient amounts of proteins in the diet are crucial for optimal antibody production. On the other hand, poor nutritional status is associated with inflammation and oxidative stress which has negative impact on immune functions [4].

Also, micronutrient deficiency, such as vitamin A or zinc, has been associated with increased risk of infectious diseases [4]. High fat diet-fed mice showed increased lung function impairment due to influenza infection and a delayed adaptive immune response [5]. Furthermore, dietary pattern deficient in copper makes humans susceptible to infections and COVID-19 is no exception. Several reports demonstrated that copper deficiency weakens human immune response [6].

Despite the lack of statistics and data about the exact numbers of persons infected with COVID-19 in Egypt's rural regions, several factors like illiteracy, personal hygiene, insufficient dietary intake etc., explode the spread of the disease in these regions. Also, most of the rural population in Egypt depends on folk medicine for treatments, while others tolerate the symptoms or ignore them. All of these factors may exacerbate the risks of COVID-19 among the rural population. This study is a retrospective study aimed at (1) explore the specific characteristics of food consumption patterns of rural persons who suffered from COVID-19 and (2) identify the foods that are usually consumed or not consumed and frequency of consumption among infected persons.

2. Patients and methods

2.1. Patients

This study recruited adult men and women diagnosed with COVID-19 and was quarantined at hospitals till full recovery. In addition to severe symptoms mentioned in National Institutes of Health, all patients in this study suffered from common symptoms of COVID 19 that include cough, fever, sore throat, loss of smell. The definitions presented in the National Institutes of Health (NIH) COVID-19 Treatment Guideline was used for defining the severity of COVID-19 [7]. The eligible patients were RT-PCR positive for COVID-19, had SpO^2 <94% on room air at sea level, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO^2/FiO^2) <300 mm Hg, a respiratory rate >30 breaths/min, or lung infiltrates >50%. The inclusion criteria include: (1) adult population (age from 24 to 55 years), (2) living in rural regions, and (3) entered the quarantined for 7 to 14 days till their test of COVID-19 infection turned negative. The researchers excluded (1) persons with chronic disease (i.e. diabetes, renal diseases, liver disease, cardiovascular diseases, cancer), respiratory diseases, asthma, and immune disorders, (2) heavy exposure to direct contact with COVID-19 patients (e.g. physicians, nurses, etc.), (3) alcohol or drug consumers, and (4) pregnant and lactating women.

2.2 Methods

2.2.1 Design

This retrospective, cross-sectional study recruited 53 COVID-19 patients (23 males and 30 females) from rural Delta Nile, Egypt (Beheira, Gharbia, Menoufia, and Qalyubia Governorates). Because of official routines and time required to get the governmental approval, the researchers carried out this study on a small sample and funded it independently. To avoid infection and risk of direct contact with COVID-19 patients, all gathered data were obtained by cell phone calls (each phone call duration was 20 to 30 minutes). The researchers received the cell phone numbers of eligible patients by personal communications. Friends, relatives, colleagues, neighbors were asked to forward contact information of any recovered COVID-19 patients they may know. Phone numbers of about 74 patients were collected, and after applying the inclusion and exclusion criteria, 53 patients were recruited (30 females and 23 males). The eligible COVID-19 patients were informed about the research and its objectives, and consent for participation was obtained and confirmed on the first phone call.

2.2.2 Data collection

Special forms were used for collecting data about gender, age, self-reported body weight in kilograms, and body height in centimeters. In addition, BMI was calculated by dividing body weight (kg) by body height $(m)^2$, and then patients were accordingly classified into healthy weight (BMI 18.5 < 25 kg/m^2), overweight (BMI 25 < 30 kg/m^2), obesity grade II (BMI 30 < 35 kg/m^2), and obesity grade 3 (BMI 35 < 40 kg/m^2) [(8)].

The food frequency questionnaire (the frequency of consumption was classified into five main domains: (1) daily, (2) weekly, (3) monthly, (4) rare, and (5) never) was used for collecting data about the habitual consumption (prior to illness) of the following foods:

1- Vegetables (green leafy, fresh, salad, and cooked) and fruits (fresh and juice).
2- Functional foods; that might have antimicrobial, antiviral properties, and health benefits (i.e. Nigella sativa, onions, garlic, honeybee, and olive oil).
3- Foods containing animal protein and iron (red meats, poultry, fish, organ meats, processed meats, and eggs).
4- Some popular foods (i.e. cow trotter, animals' offal, animal head meats, and salted fish).
5- Western diet (fast foods, carbonated beverages, and sweets).
6- Caffeine-containing drinks (i.e. coffee and tea) and popular drinks (e.g. ginger tea).
7- Miscellaneous (e.g. spices, hot pepper, ketchup, pickles, and canned foods).
8- Dietary supplements and herbal remedies (take supplements, drink herbs, kind of consumed herbs).

Also, data about personal hygiene (meals eaten outside, hands washing, washing food items, and vendor foods consumption) were collected.

All obtained data were statistically analyzed by SPSS version 20 and presented as frequency, percentage, mean and ±SD. The significant difference between males and females was calculated statistically by independent sample t-test and Chi^2. The results were considered significant when the p-value was less than 0.05.

2.2.3 Ethical considerations

COVID-19 patients recruited in this study were participated voluntarily and were fully informed about the objectives and methods of the study. Consent was obtained.

3. Results

Results in Table 1 showed no significant difference between males and females age and body weight. However, the body height of males was significantly higher than females (P<0.001), and the BMI of females' patients was significantly (P<0.01) higher than males. BMI showed that obesity was more prevalent among females as 43.3% had obesity grade II, and 23.2% had grade III compared with 21.7% and 4.3%, respectively of males. However, 3.3% of females had healthy body weight vs. 17.4% of males.

With regard to habitual vegetables (fresh and cooked) consumption (e.g., green peas, tomato, cucumber, etc.) (Table 2), the majority of females and males (73.3% and 60.9% respectively) consumed it daily (high level). As for leafy vegetables (e.g., watercress, parsley, radish, lettuce, etc.), most females (52.4%) consumed it daily (high level), while most males (47.8%) consumed them weekly (moderate level). For fruits (any kind), most females and males (66.7% and 82.6% respectively) consumed them weekly (moderate level). In parallel with habitual fruits consumption, fresh fruit juices – mainly lemonade - were consumed weekly (moderate level) by 73.7% of females and 56.5% of males.

Table 1: Age and anthropometric measurements of participants

	Gender	Mean	±SD	t. Value	P. Value
Age (yr.)	Female (n=30)	35.6	±9.9	-1.45	0.153 NS
	Male (n=23)	39.3	±8.2		
Body weight (kg)	Female (n=30)	84.0	±9.6	-1.40	0.168 NS
	Male (n=23)	87.5	±8.2		
Body height (cm)	Female (n=30)	161.4	±4.4	-7.98	0.000***
	Male (n=23)	175.3	±8.1		
BMI (kg/m^2)	Female (n=30)	32.4	±4.6	3.31	0.002**
	Male (n=23)	28.6	±3.4		
Gender	**BMI classes**	**Healthy weight**	**Overweight**	**Obesity grade II**	**Obesity grade III**
Female	no (%)	1(3.3%)	9(30.0%)	13(43.3%)	7(23.3%)
Male	no (%)	4(17.4%)	13(56.5%)	5(21.7%)	1(4.3%)
Total	no (%)	5(9.4%)	22(41.5%)	18(34.0%)	8(15.1%)
			Chi^2 value 9.83 (P=0.020)		

*SD: Standard deviation, NS: Not significant, ** P<0.01 and *** P<0.001*
Healthy weight: BMI= 18.5 < 25 kg/m2; Overweight (Obesity grade I): BMI= 25 < 30 kg/m2; Obesity grade II: BMI= 30 < 35 kg/m2; Obesity grade III: BMI= 35 < 40 kg/m2

As shown in Table 3, more than 83.0% of females and all males were not accustomed to consuming Nigella sativa. The habitual consumption of honeybee was low (73.3% of females and 60.89% of males). As for onion (yellow and green), half of the females and 43.5% of males had a high level of consumption. The level of consumption from garlic among the majority of subjects was low (76.7% of females and 73.9% of males). Olive oil had rarely been consumed by 90.0% of females and 91.3% of males. However, the results showed that about half of the patients were accustomed to adding vinegar to a vegetable salad.

Table 2: Distribution (%) of males and females according to level of food consumption of vegetables and fruits.

Food	Gender	Level of Food Consumption				
		High	Moderate	Low	Chi^2 value	P-value
Vegetables (Fresh and cooked)	Female	22(73.3%)	5(16.7%)	3(10.0%)	1.41	0.494^{NS}
	Male	14(60.9%)	7(30.4%)	2(8.7%)		
Leafy vegetable	Female	17(56.7%)	9(30.0%)	4(13.3%)	3.62	0.164^{NS}
	Male	7(30.4%)	11(47.8%)	5(21.7%)		
Fruits (any kind)	Female	6(20.0%)	20(66.7%)	4(13.3%)	2.87	0.239^{NS}
	Male	1(4.3%)	19(82.6%)	3(13.0%)		
Fresh Juices (any kind)	Female	0(0.0%)	22(73.7%)	8(26.7%)	2,49	0.288^{NS}
	Male	1(4.3%)	13(56.5%)	9(39.1%)		

NS: Not significant. High (daily or more than 3 times per week); Moderate (3 times or less per week); Low (3 times or less per month)

Table 3: Distribution (%) of males and females according to level of food consumption pattern of functional foods.

Food	Gender	Level of Food Consumption				
		High	Moderate	Low	Chi^2 value	P-value
Nigella Sativa	Female	3(10.0%)	2(6.7%)	25(83.3%)	4.23	0.120^{NS}
	Male	0(0.0%)	0(0.0%)	23(100.0%)		
Honeybee	Female	6(20.0%)	2(6.7%)	22(73.3%)	3.52	0.173^{NS}
	Male	9(39.1%)	0(0.0%)	14(60.9%)		
Onions (yellow and green)	Female	15(50.0%)	10(33.3%)	5(16.7%)	5.61	0.061^{NS}
	Male	10(43.5%)	3(13.0%)	10(43.5%)		
Raw garlic	Female	2(6.7%)	5(16.7%)	23(76.7%)	0.69	0.708^{NS}
	Male	3(13.0%)	3(13.0%)	17(73.9%)		
Olive oil	Female	0(0.0%)	3(10.0%)	27(90.0%)	4.91	0.086^{NS}
	Male	2(8.7%)	0(0.0%)	21(91.3%)		

NS: Not significant. High (daily or more than 3 times per week); Moderate (3 times or less per week); Low (3 times or less per month)

As shown in Table 4, the consumptions of red, organ and processed meats (e.g., luncheon, hamburger, etc.) were low, especially for red meats (80.0% of females and 95.7% of males) and organ meats (86.7% of females and 100.0% of males). However, cow meats were the most preferred meat among studied patients. Although most females (76.2%) have moderate consumption (weekly) of fish, 53.3% of males have low consumption ($P<0.05$). However, no one has consumed seafood, and Tilapia fish was the most consumed among 86.1% of patients. As for salted and herring fish, the majority of females (93.3%) and all males (100.0%) had low consumption levels. The majority of females and males (90.0% and 82.6%, respectively) consumed poultry moderately. The most exciting findings of this study were that 86.7% of females and 95.7% of Males were consuming eggs moderately.

Table 4: Distribution (%) of males and females according to food consumption pattern of animal protein and iron-containing foods.

Food	Gender	Level of Food Consumption				
		High	Moderate	Low	Chi^2 value	P-value
Red Meat	Female	0(0.0%)	6(20.0%)	24(80.0%)	2.78	0.095^{NS}
	Male	0(0.0%)	1(4.3%)	22(95.7%)		
Organ meats	Female	1(3.3%)	3(10.0%)	26(86.7%)	3.20	0.190^{NS}
	Male	0(0.0%)	0(0.0%)	23(100.0%)		
Processed meats	Female	2(6.7%)	9(30.0%)	19(63.3%)	1.67	0.433^{NS}
	Male	4(17.4%)	5(21.7%)	14(60.9%)		
Fish	Female	0(0.0%)	22(73.3%)	8(26.7%)	4.85	0.028^{*}
	Male	0(0.0%)	10(43.5%)	13(56.5%)		
Herring & Salted fish	Female	0(0.0%)	2(6.7%)	28(93.3%)	1.59	0.207^{NS}
	Male	0(0.0%)	0(0.0%)	23(100.0%)		
Poultry (Chicken)	Female	0(0.0%)	27(90.0%)	3(10.0%)	0.62	0.431^{NS}
	Male	0(0.0%)	19(82.6%)	4(17.4%)		
Eggs (Chicken)	Female	4(13.3%)	26(86.7%)	0(0.0%)	1.23	0.267^{NS}
	Male	1(4.3%)	22(95.7%)	0(0.0%)		

NS: Not significant. High (daily or more than 3 times per week); Moderate (3 times or less per week); Low (3 times or less per month)

Table 5 revealed that cow trotters, animal's offal, and cow head meats had not been preferred by all COVID-19 patients in this study, as all patients had low consumption levels.

Regarding western foods consumption, the results of Table 6 showed that fast foods were not preferred by rural COVID-19 patients in this study, as all patients had low consumption levels except for sweets that were consumed moderately by 70.0% of females and 35.0% of males. As for carbonated beverages, it was clear that most females and males (80.0%% and 73.9%, respectively) drank it monthly (low level).

As for hot drinks, the results in Table 7 showed that on the one hand, most of the studied females and males highly consumed black tea daily (93.3% and 82.6% respectively), and moderate concentration tea was preferred by 91.7% of patients. On the other hand, no one was drinking green tea. As for coffee, most subjects had low consumption (90.0% of females and 69.6% of males). Subjects who drank coffee preferred Turkish coffee and Nescafe. Ginger tea was not common among studied subjects, as 86.7% of females and 87.0% of them had a low level of consumption. Although most subjects had low consumption of relaxing drinks (e.g., anise, hibiscus, .etc.), but 30.0% of females and 34.5% of males had moderate consumption, and no one consumed it daily.

As for water, the results showed that more than two-thirds of studied females and males (71.4% and 67.7% respectively) drink water when they remember, and only 28.6% of females and 33.3% of males drink it regularly.

Table 5: Distribution (%) of males and females according to food consumption pattern of traditional foods.

Food	Gender	Level of Food Consumption				
		High	Moderate	Low	Chi² value	P-value
Cow trotter	Female	0(0.0%)	0(0.0%)	30(100.0%)	0.0	NS
	Male	0(0.0%)	0(0.0%)	23(100.0%)		
Animals' offal	Female	0(0.0%)	0(0.0%)	30(100.0%)	0.0	NS
	Male	0(0.0%)	0(0.0%)	23(100.0%)		
Cow head meats	Female	0(0.0%)	0(0.0%)	30(100.0%)	0.0	NS
	Male	0(0.0%)	0(0.0%)	23(100.0%)		

NS: Not significant. High (daily or more than 3 times per week); Moderate (3 times or less per week); Low (3 times or less per month)

Table 6: Distribution (%) of males and females according to food consumption pattern of fast foods, sweets, and carbonated beverages

Food	Gender	Level of Food Consumption				
		High	Moderate	Low	Chi² value	P-value
Fast foods	Female	0(0.0%)	0(0.0%)	30(100.0%)	0.0	NS
	Male	0(0.0%)	0(0.0%)	23(100.0%)		
Sweets	Female	1(3.3%)	21(70.0%)	8(26.7.%)	6.82	0.033*
	Male	3(13.0%)	8(34.8%)	12(52.2%)		
Carbonated beverages	Female	0(0.0%)	6(20.0%)	24(80.0%)	2.72	0.257 NS
	Male	2(8.7%)	4(17.4%)	17(73.9%)		

*NS: Not significant, * P<0.05*
High (daily or more than 3 times per week); Moderate (3 times or less per week); Low (3 times or less per month)

Table 7: Distribution (%) of males and females according to food consumption pattern of teas.

Food	Gender	Level of Food Consumption				
		High	Moderate	Low	Chi² value	P-value
Black tea	Female	28(93.3%)	1(3.3%)	1(3.3%)	3.66	0.160NS
	Male	19(82.6.%)	0(0.0%)	4(17.4%)		
Coffee	Female	1(3.3%)	8(26.7%)	21(90.0%)	2.12	0.346NS
	Male	3(13.0%)	4(17.4%)	16(69.6%)		
Ginger tea	Female	1(3.3%)	3(10.0%)	26(86.7%)	0.06	0.971NS
	Male	1(4.3%)	2(8.7%)	20(87.0%)		
Relaxing drinks¥	Female	1(3.3%)	9(30.0%)	20(66.7%)	2.1.15	0.563NS
	Male	1(4.3%)	10(34.5%)	12(52.2%)		

NS: Not significant,
High (daily or more than 3 times per week); Moderate (3 times or less per week); Low (3 times or less per month)
¥ e.g. anise, mint, etc

Results in Table 8 revealed that the spices consumption was enormous, as 96.7% of females and 100% of males added it daily to their regular meals. Similarly, the consumption of pickles was notably high among 80.0% of females and 91.3% of males, and they consumed it daily. However, hot pepper was not preferred as most subjects (76.7% of females and 82.6% of males) had low consumption levels. Ketchup was not favorable among the rural population, as 96.7% of females and 87.0% of males were not consume it. Finally, canned foods consumption was low, and those who consumed them preferred canned fish (e.g., tuna, sardines, and salmon). Also, the none tabulated results showed that most patients from both genders did not take any dietary supplements. The herbs' consumption was very low, as only 11.1% irregularly consumed them. In addition, more than ninety percent of patients washed their hands before eating, and more than eighty percent of patients were very keen to wash vegetables and fruits before consumption. Finally, more than half of the patients did not eat vendor foods, and some of them ate it once a day (mainly falafel and foul medames).

Table 8: Distribution (%) of males and females according to food consumption pattern of miscellaneous foods

Food	Gender	Level of Food Consumption				
		High	Moderate	Low	Chi^2 value	P-value
Spices	Female	29(96.7%)	0(0.0%)	1(3.3%)	0.78	0.377 NS
	Male	23(100.0%)	0(0.0%)	0(0.0%)		
Hot pepper	Female	0(0.0%)	7(23.3.0%)	23(76.7%)	0.28	0.597 NS
	Male	0(0.0%)	4(17.4%)	19(82.6%)		
Ketchup	Female	1(3.3%)	0(0.0%)	29(96.7%)	2.09	0.350 NS
	Male	2(8.7%)	1(4.3%)	20(87.0%)		
Pickles	Female	24(80.0%)	4(13.3%)	2(6.7%)	2.87	0.239 NS
	Male	21(91.3%)	1(4.3%)	1(4.3%)		
Canned foods	Female	0(0.0%)	3(10.0%)	27(90.0%)	0.12	0.729 NS
	Male	0(0.0%)	3(13.0%)	20(87.0%)		

NS: Not significant,
High (daily or more than 3 times per week); Moderate (3 times or less per week); Low (3 times or less per month)

4. Discussion:

A healthy diet and balanced meals might decrease the risk of severe COVID-19 as one published article on patients with influenza virus revealed that a healthy diet could decrease the hospitalization rate of patients[9]. Therefore, this study studied the relationship between food consumption patterns and severe symptoms of COVID-19 among infected people living in rural regions in Egypt. Also, the authors tried in this preliminary study to identify the most preferred foods and drinks among infected people with severe symptoms of COVID-19.

More than 95% of females and more than 80% of males in this study suffered from different degrees of obesity. These findings coincided with several studies which provide unbeatable pieces of evidence that obesity is a fundamental risk factor for adverse COVID-19 outcomes [10]. Therefore, obesity becomes a strong ‘upstream’ risk factor for an acute viral pandemic. Furthermore, some studies [11, 12] proved that BMI is a strong linear risk factor for severe COVID-19 outcomes. Most recent study [13] suggested a 5-10% higher risk for COVID-19 hospitalization per every kg/m^2 higher. According to a meta-analysis [14] published in July 2020, patients with obesity are at high risk of mortality from COVID-19 infection. Also, a study among the Chinese indicated that obesity, particularly in males, could raise the risk of severe pneumonia in COVID-19 patients [15].

The food consumption pattern of both genders of COVID-19 patients in this study can be characterized by high consumption of (1) fresh and cooked vegetables, (2) black tea, (3) spices, and (4) pickles.

Although some studies proved that people with COVID-19 are less adherent to a diet rich in vegetables and fruits [16], the results of the current study revealed that the majority of studied patients had a high consumption level of fresh and cooked vegetables and had moderate consumption of fruits and fruits juices. These findings seemed to disagree with data published by Vu et al. [17], who claimed that vegetable consumption among the UK population was favorably associated with a lower risk of COVID-19. On the other hand, these findings seemed to be agreed with data preprinted by Fonseca et al. [18], who claimed that consumption of broccoli and lettuce increased COVID-19 mortality.

The food consumption pattern of both genders of COVID-19 patients in this study had characterized by high consumption of (1) fresh and cooked vegetables, (2) black tea, (3) spices, and (4) pickles.

Spices were highly consumed among COVID-19 study patients (most of these spices were black pepper, chili, and cumin). Some published articles assumed that spices consumption plays a role in persons' ability to combat the cytokine storm [19], fight [20,21], and cure [22] COVID-19 infection. Moreover, Bousquet et al. [20] claimed that the antioxidant from spices could be beneficial in controlling many diseases, including COVID-19. A recent bioinformatics report [23] assumed that some spices could exhibit antiviral mechanisms. However, we have two issues in this regard; first, because people usually consume few grams of spices, we believe that natural antioxidant activity in consumed spices is insufficient for managing COVID-19. Secondly, despite spices being common ingredients of Chinese and Indian foods, there are still many severe COVID-19 cases in these areas, which disclaims the assumptions that spices can prevent or cure COVID-19.

The tendency to consume pickles among study subjects was huge, as most COVID-19 patients in this study were consuming it daily. The authors admitted with the conclusion obtained by Brown [24], who stated that increased SARS-CoV-2 infections in some people were associated with the consumption of foods processed with high amounts of sodium chloride. Moreover, one published article proved that Chinese people are among the highest consumers of sodium chloride worldwide [25]. Fu et al. [26] found that excessive consumption of rich-sodium foods led to sodium toxicity, adversely affecting the nasal mucosal immune system and leading to respiratory viral infection. Sodium toxicity could inhibit mucociliary clearance and increase the accumulation of viruses in patients' nasal passages, as detected in specimens collected during COVID-19 testing [27]. Patients with COVID-19 were found to have prolonged mucociliary clearance [28].

Black tea was very common among subjects, and nearly all COVID-19 patients in this study drank it daily, and no one was drinking green tea. Also, coffee and ginger were rarely or not consumed by the majority. These findings seemed to disagree with other studies, as most compelling evidence proved that black tea consumption might prime specific types of human T cells that can then provide natural resistance to microbial infections [29]. Moreover, data obtained by Vu et al. [16] demonstrated that modest consumption of black tea (3-4 cups/day) was significantly associated with lower odds of COVID-19 positivity among the UK population. In the current study, high consumption of black tea neither prevented studied patients from COVID-19 infection nor diminished its severity. In agreement with our findings, a study [30] among the Iranian population emphasized that severe COVID-19 manifestations seemed to be higher in patients who drink black tea.

The food consumption pattern of rural COVID-19 patients in this study was very low in red, organ, and processed meats. Therefore, combined with moderate consumption from poultry and eggs, this food consumption pattern is deficient in animal protein, heme-iron, copper, zinc, and essential amino acids. However, meats are important food for optimizing human growth and development, and moderate consumption (less than three times/week) would benefit humans [31]. In addition, meats are the richest source of protein, heme iron, zinc, and copper, and these nutrients are essential for immune competence [32,33,34]. Moreover, published studies found that T and B cell counts were significantly lower in patients with severe COVID-19 [35]. Thus, there could be a potential interaction between low animal protein, heme-iron, zinc, and copper intake and COVID-19 on adaptive immunity impairment [36].

In addition, red meat is a valuable dietary source of functional amino acids (e.g., taurine and hydroxyproline), dipeptides (e.g., carnosine and anserine), and creatine (a metabolite of amino acids) [37]. These five nutrients may raise the immune defense of humans against infections by bacteria, fungi, parasites, and viruses (including coronavirus) by improving the metabolism and functions of monocytes, macrophages, and other cells of the immune system [31]. Dietary taurine, creatine, carnosine, anserine and 4-hydroxyproline are abundant in all animal-source foods, especially beef [38]. On the contrary, plants' diets are deficient in taurine, carnosine, anserine, and creatine [37]. However, pneumonia is the most common high-risk complication of COVID-19 [39]. The UK Biobank study (collected information on meat intake for 474985 adults) revealed that persons who consumed red or processed meat three times or more per week had a higher risk of pneumonia than those who consumed less than three times per week [40]. Finally, and in agreement with current findings, Tavakol et al. [30] results indicated that patients with lower consumption of poultry in their regular diet had more severe symptoms of COVID-19.

As for foods with antiviral properties except for onion (yellow and green), which was highly consumed, the consumption level from other foods was low (i.e., honeybee, Nigella sativa, raw garlic, and olive oil). Such functional foods optimize the immune system's ability to prevent pathogenic viral infections [36].

The world health organization (WHO) stated that onion is harmless to everyone. However, onions remain an essential home medicine and could play a role in self-medication in the early stages of COVID-19 [41]. The authors affirm the hypothesis of Dorsch [41], who suggested that there is three primary evidence for onions for the treatment of COVID-19 patients: (1) anti-inflammatory, (2) anti-thrombotic, and (3) antiviral effects [42,43]. Dorsch [41] recommends daily consumption of onions to get such medicinal benefits. Almost half of the patients in this study consumed onion weekly. Therefore, they did not consume sufficient amounts to provide them with designated medicinal benefits.

To the best of our knowledge, there is no published data about the effect of Nigella sativa or its derivatives on COVID-19 patients. However, the preliminary data of various studies suggest that Nigella sativa and thymoquinone (TQ) might have beneficial effects on the treatment or control of COVID-19. These beneficial effects may be due to antiviral, anti-inflammatory, and immuno-modulatory properties, as well as broncho-dilatory effects of Nigella sativa and thymoquinone (TQ) [44].

Nonetheless, the antiviral potential of garlic against several viruses like influenza B was earlier demonstrated [45]. Thuy et al. [43] identified eighteen active substances in

garlic essential oil. They suggested that garlic oil is a valuable natural antivirus source, which inhibits the invasion of coronavirus into the human body.
According to Alkhatib [36], olive oil has antiviral properties and may prevent respiratory viral infections and COVID-19. Olive oil's components have potent anti-inflammatory activities and thus restrict the progress of various inflammation-linked diseases [46].

The most interesting findings were that COVID-19 patients in this study were rarely or not consuming traditional foods (i.e., cow trotters, animal offal's, cow head meats, smoked herring, and salted fish). Except for sugar and sweets, the COVID-19 patients in this study were not interested in consuming fast foods and carbonated beverages.

5. Conclusion:

In conclusion, the food consumption pattern of COVID-19 rural Egyptian patients is characterized on the one hand by low consumption of foods rich (i.e., red meats, organ meats, and processed meats) in heme iron, animal protein, and antiviral foods and on the other hand by high consumption of fresh and cooked vegetables, black tea, spices, and pickles.

6. Limitations

Along with conflicts that accompanied the first wave of the COVID-19 pandemic and as a result of some cautions and fear of infection, the researchers faced significant difficulties in approaching COVID-19 patients. Therefore, the study sample size was relatively small. It is not possible by using such numbers to obtain an accurate perception of the food consumption pattern. However, these data may still able to highlight some of the potential nutritional problems that COVID-19 patients may encounter and further investigations will be needed in a larger sample size to make firm conclusion.

Acknowledgment

The author is very thankful to all the associated personnel in any reference that contributed to/for this research, especially the patients and physicians in mentioned hospitals.

Conflict of interest

The authors declare that they have no conflict of interest regarding this study.

Author contribution

All authors have contributed to collecting and analyzing data and writing the manuscript. Ismail MS was responsible for revising and editing the manuscript.

Funding: There is no funding source for this study.

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