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Nutrition Management in COVID-19 Quarantine: Hospital-Based Study

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Brief Report

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Abstract

Background: This hospital-based study aimed to evaluate the nutritional status and dietary habits, the amount of nutrients provided to the patients in the hospital and to detect the predictors of severity among COVID-19 patients in Jordan.

Methods: A hospital-based study ($N = 367$; mean age 42.3 y; SD 15.4; 66.0% men) was conducted between March 17 and July 25, 2020, in Prince Hamza Hospital. Data about socio-demographic, anthropometric, dietary habits, and macro- and micronutrients intake were collected from the patients' medical files, and some missing data were collected by phone directly from the patients.

Results: The results of the linear regression showed that only age was significantly and positively (ß = 0.454; $P = 0.001$) associated with severity of the disease among the study patients. Approximately 57% of the COVID-19 patients consumed 3 meals daily, while 31-34% consumed 1 to 2 snacks daily. The majority (64%) of the patients drank more than 5 cups of water daily. Around 24% of the patients complained of eating problems, such as taste and/or smell loss, low appetite, and swallowing difficulty. The intakes of the vitamins B1, B2, B3, B6, and C, as well as calcium, magnesium, phosphorus, selenium, and sodium, were within the recommended dietary allowances (RDA).

Conclusion: The servings of the 5 food groups as well as most of the macro- and micronutrient requirements were within the recommended intakes and RDA.

Coronavirus disease 2019 (COVID-19) has been confirmed as a pandemic by the World Health Organization (WHO), which primarily affects the human pulmonary system.[1] Age, diabetes, cardiovascular disease, immunosuppression, and organ failure are risk factors related to COVID-19 severity.[2] The host nutritional status has been considered as a key factor in the outcome of a variety of different infectious diseases.[2] In fact, a poor diet has been associated not only with physical but also mental health, while an adequate and balanced diet results in many health benefits.[3]

On an individual level, the main factor that drives most of the nutrition and dietary recommendations to combat COVID-19 is the link between diet and immunity. The existing evidence highlights the fact that nutritional status and diet modulate inflammation and immune function and may be adjusted to impact COVID-19 outcome.[2] It has been demonstrated that specific nutrients or nutrient combinations may affect the immune system through the activation of cells, modification in the production of signaling molecules, and gene expression.[4–6]

Nutritional deficiencies in energy, protein, and specific micronutrients are associated with depressed immune function and increased susceptibility to infection. An adequate intake of iron, zinc, and vitamins C, A, E, B6, D, and B12 is vital for the maintenance of immune function.[7,8] Therefore, the key to maintaining an effective immune system is to avoid deficiencies of the nutrients that play an essential role in immune cell triggering, interaction, differentiation, or functional expression.[9] There is evidence that fruits and vegetables provide micronutrients that can boost immune function.[9] This happens because some of these micronutrients, such as vitamin E, vitamin C, and beta-carotene, are antioxidants. Antioxidants have been found to increase the number of T-cell subsets, enhance lymphocyte response to mitogens, increase interleukin-2 production, potentiate natural killer cell activity, and increase response to the influenza virus vaccine.[10] Additionally, an adequate vitamin D status reduces the risk of developing several chronic diseases, such as cancers, cardiovascular disease, diabetes mellitus, and hypertension, which cause a significantly higher risk of death from respiratory tract infections than otherwise healthy individuals.[11] Furthermore, vitamin D protects the respiratory tract by preserving tight junctions, killing enveloped viruses through induction of cathelicidins and defensins, and

decreasing the production of proinflammatory cytokines by the innate immune system, therefore, reducing the risk of a cytokine storm leading to pneumonia.[12]

To the researchers' knowledge, no single study in Jordan evaluated the nutritional status and dietary habits of coronavirus patients. Therefore, this hospital-based study aimed to evaluate the nutritional status and dietary habits of COVID-19 patients, the amount of nutrients provided to those patients, and to detect the predictors of severity among COVID-19 patients in Jordan.

Methods

Data Collection

To meet the aim of this investigation, a hospital-based study was conducted between March 17 and July 25, 2020, in Prince Hamza Hospital. This has been the major hospital for the quarantining of patients infected with COVID-19 in Amman-Jordan. A total of 367 coronavirus patients were recruited in this study. The Ethics Committee of Prince Hamza Hospital approved the study protocol (1630/1/(ش م ح, and verbal consent was obtained through a phone call. Socio-demographic (age, educational level, smoking status, etc) and anthropometric (weight and height) data were collected from the patients' medical files and some missing data were collected by phone directly from the patients. Body mass index (BMI) was calculated by dividing the weight (in kg) by height (in square meters)

Information about the dietary habits was collected and included the following: the number of main meals intake, number of snacks, amount of water, health problems, dietary supplement intake, dependency on hospital meals, and the actual intake of these meals. Meals introduced to the patients at the hospital were calculated based on the Exchange List System.[13] Dietary intakes were analyzed using dietary analysis software (ESHA Food Processor SQL version 10.1.1; ESHA, Salem, OR) with additional data on foods consumed in Jordan.[14] The intakes were calculated and compared with the recommended dietary allowances (RDA) (USDA, 2015).[15]

Statistical Analysis

The data were coded, entered, and analyzed using the Statistical Package for the Social Sciences (IBM SPSS, version 26). Data are presented as mean (standard deviation: SD) and with percentages for descriptive statistics. Linear regression was used to find the association between COVID-19 severity and some variables. *P*-value significance was set at < 0.05.

Results

All socio-demographic and anthropometric results are summarized in Table 1. Approximately 66% of the recruited patients were men, and the mean age of the sample size was 42.3 (15.4). While approximately 48% of the male patients were between 30 and 49 y, 33.6% of female patients were between 18 and 29 y. Both male and female patients were overweight with BMI values of 44.7% and 32%, respectively. However, approximately 70% of the males and 63% of the females were overweight and obese, respectively. Approximately 39% of males and 6.6% of the females were cigarette smokers, respectively. Health problems in males (41.6%) were higher than in females (34.3%), where most of these problems were diabetes mellitus (18.1%) and hypertension (19.7%). The length of stay in hospital was 15.7 (7.7) d for males and 17.9 (9.9) d for females. Approximately 53%, 30%, and 36% of the patients were supplemented with vitamin C, vitamin-B complex, and zinc sulfate, respectively. Vitamin D, iron, multivitamins with minerals, and vitamin B12 or folic acid supplements were given with lesser frequency than the aforementioned supplements.

The results of the linear regression to determine the predictors of severity among COVID-19 patients are shown in Table 2. Among the tested predictors, which included age, BMI, education, number of cigarettes, and length of stay in the hospital, only age was significantly and positively ($ß = 0.454$; $P = 0.001$) associated with severity of the disease among the study patients.

Table 3 shows that more than half (57%) of the patients consumed 3 meals daily, while approximately one-third consumed 1 (31%) or 2 (34%) snacks daily. Regarding water consumption, the majority (64%) of the patients drank more than 5 cups of water daily. Around 24% of the patients complained of eating problems, such as taste and/or smell loss, low appetite, and swallowing difficulty. Around 14% of the patients depended completely on the hospital meals. However, approximately 59% of the patients ate the meals provided by the hospital and 3% did not consume anything from the meals except for fruit and yogurt. Approximately 65% of patients declared that they received several food items and meals from outside the hospital. The other patients stated that fruit and vegetables, as well as snacks and juices, were the main food items brought to them.

The contents of meals introduced to the patients at the hospital based on the exchange list system are shown in Table 4. All the meals were composed of the recommended number of servings from each food group. The number of servings from the starch group was approximately 12 servings; the fruit group was 3 servings; the vegetable group was 5 servings; the meat and meat product group were 7-8 servings; the milk and milk products group were 1 serving; and fat was 7-10 servings.

Table 5 shows that the mean (SD) energy intake was 2409 (297) kcal for the 3 d from meals that had been provided for all the patients, with some differences in those who consumed the whole introduced meals. Adequate amounts of protein and carbohydrates were also provided to COVID-19 patients. The intakes of the vitamins B1, B2, B3, B6, and C, as well as calcium, magnesium, phosphorus, selenium, and sodium, were within the RDA.

Discussion

The WHO declared COVID-19 to be a pandemic on March 11, 2020.[16] The mortality of critically ill patients with COVID-19 has risen to 61.5%, which is considered alarming.[17] Therefore, implementing the appropriate treatment and adequate nutrition may reduce mortality of severe and critical illnesses. This study is the first to describe the nutrition intervention introduced to patients with COVID-19 in Jordan.

Most of the reports demonstrate that adequate nutrition and healthy foods will help to alleviate the impact of COVID-19 infection on a patients' health. These reports showed that the nutritional requirement of a person with COVID-19 is 2000-2500 kcal/day, protein 75-100 gm/day, and 3L fluid/day.[18,19] In our study, the intake of calories, protein, and fluid was within the recommended requirement. The average calorie intake was 2409.2 (SD: 296.6) kcal; the mean protein intake was 87.6 (SD: 30.3) gm; and the fluid intake was more than 5 cups daily.

Regarding the intake of the food groups, the amount provided from the 5 food groups was shown to be adequate to

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Table 1. Socio-demographic and anthropometric characteristics of all patients

Variable	Males (*N* = 242)	Females (*N* = 125)	Total (*N* = 367)
Age (y) [mean (SD)]	44.0(14.7)	39.0(16.1)	42.3(15.4)
Age group *N*(%):			
- 18-29 y	43(17.8)	41(33.6)	84(23.1)
- 30-39 y	51(21.1)	23(18.9)	74(20.3)
- 40-49 y	64(26.4)	26(21.3)	90(24.7)
- 50-59 y	44(18.2)	17(13.9)	61(16.8)
- 60-69 y	29(12.0)	9(7.4)	38(10.4)
- 70-79 y	9(3.7)	3(2.5)	12(3.3)
- >85 y	2(0.8)	3(2.5)	5(1.4)
Height (cm) [mean (SD)]	175.1(7.7)	163.8(6.7)	171.6(9.1)
Weight (kg) [mean (SD)]	84.3(14.3)	73.7(16.2)	81.0(15.7)
BMI (kg/m^2) [mean (SD)]	27.5(4.6)	27.6(6.3)	27.5(5.1)
BMI categories *N*(%):			
- Underweight	0.0(0)	2(2.7)	2(0.8)
- Normal weight	48(29.8)	26(34.7)	74(31.4)
- Overweight	72(44.7)	24(32.0)	96(40.7)
- Obese	41(25.5)	23(30.6)	64(27.1)
Education level *N*(%):			
- Illiterate	1(0.6)	0(0.0)	1(0.5)
- Primary	32(19.4)	15(18.8)	47(19.1)
- High school	54(32.5)	35(43.8)	89(36.2)
- Diploma	15(9.0)	7(8.8)	22(8.9)
- Bachelor	52(31.3)	23(28.6)	75(30.5)
- Masters degree	10(6.0)	0(0.0)	10(4.1)
- Doctorate	2(1.2)	0(0.0)	2(0.8)
Cigarette smoking *N*(%)			
- Yes	75(38.7)	6(6.6)	81(28.4)
- No	111(57.2)	83(91.2)	194(68.1)
- Past smoker	3(4.1)	2(2.2)	10(3.5)
No. of cigarettes [mean (SD)]	9.3(14.5)	0.72(3.3)	6.5(12.7)
Duration of smoking (y) [mean (SD)]	6.6(11.5)	0.73(3.5)	10.0(4.6)
Nargillah smoking *N*(%)			
- Yes	22(13.4)	7(9.6)	29(12.2)
- No	139(84.8)	66(90.4)	205(86.5)
- Past smoker	3(1.8)	0(0.0)	3(1.3)
Health problem N(%)			
- Yes	77(41.6)	35(34.3)	112(39.0)
- No	108(58.4)	67(65.7)	175(61.0)
Type of health problem N(%)			
- Diabetes mellitus	41(20.2)	15(14.0)	56(18.1)
- Hypertension	43(21.2)	18(16.8)	61(19.7)
- Cardiovascular diseases	17(8.4)	6(5.6)	23(7.4)
- Renal problem	4(2.0)	1(0.9)	5(1.6)
- Asthma\allergy	8(3.9)	8(7.5)	16(5.2)
- Hypothyroidism	4(2.0)	1(0.9)	5(1.6)
- Gastrointestinal tract disease	3(1.5)	3(2.8)	6(1.9)
Length of stay in hospital (days) [mean (SD)]	15.7(7.1)	17.9(9.9)	16.4(8.2)
Severity			
- Mild	145(72.1)	77(71.3)	222(71.8)
- Moderate	46(22.9)	27(25.0)	73(23.6)
- Severe	7(3.5)	3(2.8)	10(3.2)
- Fatal	3(1.5)	1(0.9)	4(1.3)
Vitamin C supplement *N*(%)			
- Yes	124 (56.1)	62(48.1)	185(52.9)
- No	97(43.9)	66(51.2)	163(46.6)

(*Continued*)

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Table 1. (*Continued*)

Variable	Males (*N* = 242)	Females (*N* = 125)	Total (*N* = 367)
Vitamin B complex supplement *N*(%)			
- Yes	73(33.0)	34(26.4)	107(30.6)
- No	148(67.0)	95(73.6)	243(69.4)
Zinc sulfate supplement *N*(%)			
- Yes	91(41.2)	35(27.1)	126(36.0)
- No	130(58.8)	94(72.9)	224(64.0)
Other supplements *N*(%)			
- Vitamin D	14(61.0)	3(21.4)	17(45.9)
- Iron	0(0.0)	4(28.6)	4(10.8)
- Multivitamin with minerals	6(26.0)	4(28.6)	10(27.1)
- Vitamin B12 or folic acid	3(13.0)	3(21.4)	6(16.2)

Table 2. Predictors of severity among COVID-19 patients

Variable	R2	ANOVA	Model	B	ß	*P*-Value
Severity	0.164	F = 2.946, P-Value <0.011	- Constant	0.152		0.716
			- Age (year)	0.013	0.454	**0.001***
			- BMI	-0.008	-0.079-	0.435
			- Education	0.065	0.165	0.097
			- Smoking	0.003	0.085	0.395
			- Length of stay in hospital	0.011	0.152	0.127

**P*-Value was <0.05.

sufficiently enhance immune system efficiency in protecting against COVID-19 infection. The intake of fruit (3 servings) and vegetable (5 servings) by patients of the present study was within the recommended amounts stated by WHO.[20] The consumption of meat was approximately 7-8 servings (210-240 gm/day), while the intake of milk and milk products was 1 serving per day. The results of our study showed that the intakes of the vitamins B1, B2, B3, B6, and C, as well as calcium, magnesium, phosphorus, selenium, and sodium, were within the RDA. However, patients who complained of some micronutrient deficiency were given supplements of vitamin C, vitamin B-complex, and zinc sulfate, as recommended by many studies.[20,21]

The results of the linear regression to determine the predictors of severity among COVID-19 patients showed that age was significantly and positively (ß = 0.454; $P = 0.001$) associated with the severity of the disease among the study patients. This is also what Liu with his co-workers (2020) revealed in their recent study.[22] The authors reported that patients over 60 y showed heavier clinical signs, greater severity, and longer disease courses compared with those who were younger than 60 y. Therefore, closer monitoring and intensive medical interventions may be needed for the elderly.[22] This could be attributed to the fact that older patients were affected more seriously, leading to a higher frequency of adjuvant therapies, including corticosteroids and assisted ventilation among this group of patients. In addition, older patients presented significantly lower levels of lymphocytes than young patients.[22] Silverio et al. (2021) reported that the elderly and patients who suffered from obesity, diabetes, and/or hypertension show a higher risk of hospitalization, severe disease, and mortality by acute respiratory syndrome coronavirus infection. This was attributed to the exacerbated secretion of proinflammatory cytokines associated with an overreaction of the immune system, the so-called cytokine storm.[2]

The percentage of death among the enrolled patients was approximately 1.3%, which could be partially due to the average patient age (42.3 ± 15.4 y). Additionally, the nutritional intervention introduced to the patients could be a major contributor to their recovery and low rate of death.

The main limitation of this study was the inability to accurately determine the quantity of food consumed at each meal by the patients. Due to safety precautions, it was impossible to contact the patients and collect his/her actual intake from each meal and record the amount of food eaten from outside the hospital. Our nutrition analysis depended only on the meals provided by the hospital. This study was not evaluating the impact of the nutrition program implemented in the hospital. yet, it described the nutrition program applied in the hospital to manage COVID-19.

Conclusions

Providing healthy nutrition intervention is 1 pillar of the protocols adopted by the Price Hamza Hospital to treat patients with COVID-19. Vitamin and mineral supplements were also provided to prevent any further deficiencies. The recommended number of servings from the 5 food groups was taken into consideration to cover all the macro- and micronutrient requirements for patients with COVID-19. Age was positively associated with the severity of the condition and morbidity.

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Table 3. Number of meals eaten inside and outside the hospital

Variable	Male	Female	Total
Main meals			
- One	7(5.6)	5(8.2)	12(6.5)
- Two	41(33.1)	21(34.4)	62(33.5)
- Three	73(58.9)	32(52.5)	105(56.8)
- More than 3	3(2.4)	3(4.9)	6(3.2)
Snacks			
- One	37(30.3)	18(32.1)	55(30.9)
- Two	40(32.8)	21(37.5)	61(34.3)
- Three	11(9.0)	5(8.9)	16(9.0)
- More than 3	4(3.3)	1(1.8)	5(2.8)
- No snacks	30(24.6)	11(19.6)	41(23.0)
Amount of water			
- 1-3 cups	13(10.1)	11(16.9)	24(12.4)
- 3-5 cups	26(20.2)	13(20.0)	39(20.1)
- > 5 cups	85(65.9)	39(60.0)	124(63.9)
- Don't know	5(3.9)	2(3.1)	7(3.6)
Eating problems			
- Yes	28(22.2)	16(29.6)	44(24.4)
- No	98(77.8)	38(70.4)	136(75.6)
Dependency on hospital meals			
- Yes	19(14.6)	9(13.8)	28(14.4)
- No	111(85.4)	56(86.2)	167(85.6)
The amount eaten from meal			
- I eat the whole meal	71(61.2)	29(53.7)	100(58.9)
- I eat ¾ of the meal (or didn't eat part from the meals as the rice or chicken)	18(15.5)	6(11.1)	24(14.1)
- I eat ⅔ of the meal\s (2 meals or ⅔ the quantity)	13(11.2)	11(20.4)	24(14.1)
- I eat ⅓ of the meal\s (1 meal only)	11(9.5)	6(11.1)	17(10.0)
- I didn't eat anything from the meal (or only fruit and yogurt)	3(2.6)	2(3.7)	5(2.9)
Type of food eaten from outside			
- Several items\meals	26(68.4)	7(53.8)	33(64.7)
- Fruits and vegetables	8(21.1)	4(30.8)	12(23.5)
- Snacks\juices	4(10.5)	2(15.4)	6(11.8)

Table 4. Meals introduced to COVID-19 patients at the hospital, based on exchange list system

Meal	Day 1	Day 2	Day 3
Breakfast	4 MFM	2 MFM+1 HFM	4 MFM
	3 fat	5 fat	3 fat
	4 starch	3½ starch	4 starch
	1 vegetable	1 vegetable	1 vegetable
		1 other CHO	
Lunch	4 starch	4 starch	4 starch
	2 MFM	2 MFM	2 MFM
	1 milk	1 milk	1 milk
	1 ½ fruit	1 ½ fruit	1 ½ fruit
	2 ½ other CHO	3 ½ other CHO	2 ½ other CHO
	3 ½ fat	5 ½ fat	3 ½ fat
	2 vegetables	2 vegetables	2 vegetables
Dinner	½ fat +4 ½ starch	5 ½ starch + 2 MFM	½ fat +4 ½ starch
	2 MFM	1 vegetable+ 1 fat	2 MFM
	2 vegetable	2 LFM	2 vegetable
	1 ½ fruit	1 ½ fruit	1 ½ fruit

Abbreviations: CHO, carbohydrate; HFM, high-fat meat; LFM, low-fat meat; MFM, medium-fat meat.

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Table 5. Energy and amount of macro- and micronutrients consumed for 3 days by almost all patients diagnosed with COVID-19 in Hamza Hospital

	Amount of nutrients consumed		
Nutrient	Mean	SD	RDA or AI Male/female
Calorie (kcal)	2409.2	296.6	–
Calorie from fat (kcal)	495.7	206.5	–
Calorie from sat fat (kcal)	201.6	30.4	–
Protein (gm)	87.6	30.3	–
Carbohydrate (gm)	346.1	49.9	–
Fiber (gm)	25.2	8.6	–
Total sugar (gm)	139.3	15.2	–
Other carbohydrate (gm)	164.5	38.9	–
Fat (gm)	60.7	23.3	–
Saturated fat (gm)	22.7	3.8	–
Vitamin A (IU)	6443.0	6032.9	3000
Vitamin B1 (mg)	1.3	0.3	1.2/1.1
Vitamin B2 (mg)	1.4	0.6	1.3/1.1
Vitamin B3 (mg)	13.7	3.6	16/14
Vitamin B6 (mg)	1.2	0.3	1.3
Vitamin B12 (mg)	2.5	1.6	2.4
Vitamin C (mg)	88.2	20.7	90/75
Vitamin D (IU)	9.9	8.7	15
Vitamin E (mg)	7.1	6.9	15
Vitamin K (mcg)	62.2	48.2	120/90
Calcium (mg)	3621.0	3261.7	1000
Chromium (mcg)	17.0	15.4	35/25
Iron (mg)	11.5	3.1	8/18
Magnesium (mg)	1120.7	1012.8	400/310
Phosphorus (mg)	868.7	478.7	700
Potassium (mg)	3065.3	1522.8	3400/2600
Selenium (mcg)	66.4	21.4	55
Sodium (mg)	6486.7	5988.4	1500

Abbreviation: AI, adequate intake.

Authors' Contributions. R.T., A.E.A.S. and M.A. conceived designed and supervised the study. A.E.A.S., Z.A., M.G.A., and M.A. collected patients' data. R.T., M.G.A. and Z.A. were responsible for data entry, analysis, and interpretation. R.T. drafted the manuscript. All authors critically reviewed the manuscript and approved the final.

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Conflict(s) of interest. The authors declare that they have no conflicting interests.

Ethical standards. The study was approved by the Institutional Review Board at Prince Hamza Hospital, and all participants were formally consented to participate in the study.

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