Impact of SARS-CoV-2 Pandemic on food Security in Patients With chronic Kidney Disease

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Objective: The present study aims to determine the degree of Food Insecurity (FI) in adult patients with CKD during the COVID-19 pandemic, as well as the association between FI and food consumption.

Methods: A cross-sectional study was conducted on patients with chronic kidney disease (CKD), with and without substitutive treatment, and older than 18 years of age. Food security was measured using the Mexican Food Security Scale (MFSS). Sociodemographic data and a food frequency questionnaire were obtained. Multinomial logistic regression was performed using the 4 categories of food security (food security as reference); principal component analysis was also performed to assess the relationship between food consumption patterns and sociodemographic characteristics.

Results: The prevalence of FI in patients with CKD was 71.6%, the most prevalent degree of FI was moderate. As FI increased, a greater amount of beans, eggs, sweets/desserts, soft drinks, and artificial juices ($P < .001$) was consumed. The risk factors of FI were diabetes, hypertension, unpaid occupation, living in the country's capital, having children at home, or a decrease in income due to the pandemic. Four main components were identified that were associated with the different degrees of FI.

Conclusion: The present study allowed us to conclude that more than 70% of CKD patients in the study cohort had some type of FI, which makes it difficult to adhere to treatment and may increase the risk of advanced CKD. A less healthy food pattern is associated with greater FI.

Introduction

THE FOOD AND Agriculture Organization of the United Nations (FAO) defines food security as "a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life". It also defines food insecurity (FI) as "when people do not have adequate physical, social, or economic access to food as defined above".[1,2]

Low-income households tend to consume less healthy foods, which are associated with an increased prevalence of health problems that can lead to chronic diseases and an increased risk of morbidity and mortality.[3-5]

There is little evidence on the relationship between FI and Chronic Kidney Disease (CKD). Some studies that have focused on the subject, mention that FI, which is associated with low-income households, prevents people with CKD from following a diet suitable to their needs.[6-8] The presence of malnutrition at any stage of CKD continues to be a serious challenge to health professionals since the treatment of CKD usually involves the prescription of therapeutic diets and limited dietary exchanges to prevent renal load due to a decrease in the excretion of minerals such as sodium, potassium, and phosphorus. The levels of these minerals increases as renal function declines, leading to nutritional deficiencies, comorbidities, and shorter life expectancy.[6,9-12]

The prevalence of FI in adult patients on hemodialysis is 16%[13] and between 35% and 64% in children with chronic kidney disease.[14,15] The FI is associated with diets low in vegetables and fruits and high in energy-dense, high-sodium foods that are often more easily available and affordable.[16] Inadequate nutrition can negatively affect a patient with advanced kidney disease by affecting nutritional status,

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blood pressure, electrolyte disbalance, fluid status, acid/base balance, and growth.[16] It has been established that FI is a modifiable risk factor for kidney disease with 46% and 35% greater odds.[8]

The SARS-CoV-2 pandemic has substantially affected the way of life of the general population. The pandemic has affected the food distribution, availability, and access and even the food security of households around the world.[17] One of the main risks faced by households that comply with the necessary measures to contain the spread of the virus is not being able to regularly access food due to their lack of social support and/or savings.[18]

In this way, households that already suffer from FI may find themselves in an even more insecure situation as a result of the COVID-19 pandemic[17]; having less access to their jobs and, as a consequence, lower economic income, which makes these patients more susceptible to FI, and make it hard for them to comply with the nutritional recommendations for patients with CKD.[19,20]

The present study aims to determine the degree of FI in adult patients with CKD during the COVID-19 pandemic, as well as the association between FI and food consumption.

Methods

A cross-sectional study was carried out with patients with CKD who were invited to participate in the study through social networks and electronic media between May and October in 2021. The information provided by the patients was confidential and anonymous. All patients with CKD—with and without renal replacement therapy, older than 18 years of age—who agreed to provide information and gave their consent were included in the study. This study was approved by the Ethics and Research Committee of our institution.

Food security was measured using the Mexican Food Security Scale (MFSS), which categorizes 4 groups: food security, mild FI, moderate FI, and severe FI.[21] This scale measured the perceived experience of FI in households during the 3 months preceding the survey. The scale focused on households, and the questions aimed to distinguish between the access to food of adults and that of those under 18 years of age. The self-report scale consisted of 12 questions ordered from least to greatest severity. Each of the questions had two possible answers: yes and no. Affirmative responses were assigned a score of 1 and negative responses a score of 0. The degree of FI was estimated based on the sum of the affirmative responses. The scale had 2 sections: the first, included 6 questions; and in case of having people under 18 year old, it added 6 more questions.

The cut-off points of the MFSS for adult-only households were 0 food security; 1 to 2 mild FI; 3 to 4 moderate FI; 5 to 6 severe FI. In households people under 18 year old, the cut-off points for FI were 1 to 3 mild FI; 4 to 7 moderate FI; 8 to 12 severe FI.

Food consumption: Information on food consumption was analyzed using a food frequency questionnaire covering 12 food groups: fresh fruits (not including fruit juices), vegetables, 100% natural juices of any fruit, beans, eggs, meat (including chicken, pork, beef, and fish), milk, yogurt or cheese, tortillas, cereals, bread, rice and/or pasta, sweets, and desserts, snacks (e.g., potato chips, Doritos, Fritos), bottled soft drinks, and artificial juices or orangeades. The questionnaire asked whether these foods were consumed every day (1D), 2 or 3 days a week (2-3S), 4 or 5 days a week (4-5S), 2 days a week or less (2S<), or never. For the present study, the frequency categories were grouped into: rarely (never-2S<), occasionally (2-3S), and frequently (4-5S-1D).

Sociodemographic data were obtained through a self-administered questionnaire that included questions about age, gender, marital status, education, etc.

Statistics

Qualitative variables were expressed as frequencies and percentages. Quantitative variables were reported as mean ± standard deviation (SD) or median values (interquartile range, IQ), depending on the distribution of the variables. The trend test (*P* for trend) was used to assess whether the differences between groups increased or decreased according to the degree of FI.

Multinomial logistic regression was performed using the 4 categories of food security (food security as reference). Logistic regression was then performed to compare the presence of food security as a protective factor versus all degrees of FI combined in a dichotomous variable to assess the association between FI and the sociodemographic characteristics of CKD patients.

A principal component analysis was also performed to assess the relationship between food consumption patterns and sociodemographic characteristics using a polychoric matrix. The number of components was determined based on the elbow graph. Linear regression models were used to evaluate the association between the components and the characteristics of the patients. Multinomial logistic regression models were used to evaluate the relationship between the components obtained and the different degrees of FI.

The covariables selected for use in the regression models were those with biological plausibility, potentially confounding variables, and/or those with a $P < .20$ in the bivariate analysis. A value of $P < .05$ was considered statistically significant. All statistical analyses were performed using SPSS v. 26 and Stata v.16. The images were created in R v. 4.1.0.

Results

A total of 588 participants who met the inclusion criteria were included in the study.

Table 1 shows the sociodemographic and clinical characteristics of the participants. More than half of the

Table 1. Sociodemographic and Clinical Characteristics of the Total Population According to the food Security Level of the Mexican Households

Variable	Total n = 588 (100%)	Food-Security n = 166 (28.2%)	Mild Food-Insecure n = 151 (25.6%)	Moderate Food-Insecure n = 188 (31.9%)	Severe Food-Insecure n = 83 (14.1%)	*P* for trend
Sex (Female), n (%)	347 (59.0)	102 (61.4)	91 (60-3)	108 (57.4)	46 (55.4)	.293
Age, (years)	41 (31-56)	39 (29-48)	38 (30-55)	46 (35-61)	45 (33.5-68.5)	<.001
Time of evolution (years)	4 (2.0-8.0)	4.5 (1-12)	5 (2-9)	4 (2-8)	4 (2-6)	.052
Civil status, n (%)						
Single/Divorced/widower	252 (42.9)	77 (46.4)	68 (45.0)	76 (40.4)	31 (37.3)	.11
Married/Engaged to	336 (57.1)	89 (53.6)	83 (55.0)	112 (59.6)	52 (62.7)	
Diabetes (yes), n (%)	209 (35.5)	26 (15.7)	51 (33.8)	94 (50.0)	38 (45.8)	<.001*
Hypertension (yes), n (%)	456 (77.6)	107 (64.5)	113 (74.8)	166 (88.3)	70 (84.3)	<.001*
Replacement therapy, n (%)	306 (52.0)	78 (47.0)	67 (44.4)	106 (56.4)	55 (66.3)	<.001*
Peritoneal Dialysis, n (%)	149 (48.7)	36 (46.2)	28 (41.8)	59 (55.7)	26 (47.3)	.339
Hemodialysis, n (%)	157 (51.3)	42 (53.8)	39 (58.2)	47 (44.3)	29 (52.7)	
Kidney Transplantation (yes), n (%)	93 (16.0)	44 (26.7)	29 (19.3)	16 (8.6)	4 (5.0)	<.001*
Occupation, n (%)						<.001
Non-remunerated*	292 (49.7)	55 (33.1)	70 (46.4)	105 (55.9)	62 (74.7)	
Remunerated†	296 (50.3)	111 (66.9)	81 (53.6)	83 (44.1)	21 (25.3)	
Education level, n (%)						<.001
Elementary school	240 (40.8)	32 (19.3)	50 (33.1)	105 (55.9)	53 (63.9)	
High school	167 (28.4)	43 (25.9)	46 (30.5)	58 (30.9)	20 (24.1)	
Bachelor's/Graduate degrees	181 (30.8)	91 (54.8)	55 (36.4)	25 (13.3)	10 (12.0)	
Health insurance, n (%)						<.001
None	182 (31.0)	33 (19.9)	45 (29.8)	67 (35.6)	37 (44.6)	
Public	382 (65.0)	120 (72.3)	102 (67.5)	116 (61.7)	44 (53.0)	
Private	24 (4.1)	13 (7.8)	4 (2.6)	5 (2.7)	2 (2.4)	
Residence, n (%)						<.001
Capital City	211 (35.9)	47 (28.3)	30 (19.9)	98 (52.1)	36 (43.4)	
Others	377 (64.1.5)	119 (71.7)	121 (80.1)	90 (47.9)	47 (56.6)	
Higher income contribution, n (%)						.088
Patient	170 (28.9)	53 (31.9)	51 (33.8)	44 (23.4)	22 (26.5)	
Others	418 (71.1)	113 (27.0)	100 (23.9)	144 (34.4)	61 (14.6)	
Social support, n (%) None	463 (78.7)	122 (73.5)	115 (76.2)	156 (83.0)	70 (84.3)	.011
Others‡	125 (21.3)	44 (26.5)	36 (23.8)	32 (17.0)	13 (15.7)	
House status, n (%)						<.001
Owned	395 (67.2)	131 (78.9)	107 (70.9)	113 (60.1)	44 (53.0)	
Others	193 (32.8)	35 (21.1)	44 (29.1)	75 (39.9)	39 (47.0)	
Decreased income due to COVID-19 pandemic, n (%)	504 (85.7)	106 (63.9)	137 (90.7)	179 (95.2)	82 (98.8)	<.001
Minor children, n (%)	323 (54.9)	73 (44.0)	75 (49.7)	117 (62.2)	58 (69.9)	<.001

*Unemployed, student or houseworkers.
†Professional, pensioner, retired, employed, entrepreneur.
‡Family/Parents/Pensioner/RetiredGovernment Support.

participants were women on renal replacement therapy (RRT), which includes peritoneal dialysis and hemodialysis. More than a third of the participants had high blood pressure. Almost half reported being unemployed, students, or houseworkers. Most of them only had basic school education. More than half had social security, and 85.7% reported that their income had decreased due to the COVID-19 pandemic. The most prevalent degree of FI was moderate (31.9%).

Regarding the food frequency consumption, the households under study consumed a greater amount of beans, eggs, sweets/desserts, soft drinks, and artificial juices ($P < .001$) as FI increased, compared to households with food security, in which there was a higher consumption of vegetables, fruits, and meats ($P < .001$) (Table 2).

The sociodemographic variables were compared independently using multinomial logistic regression, taking food security as the reference value. Table 3 shows the probabilities according to the degree of FI.

To determine the risk or protective factors for general FI, all degrees of FI were grouped into a single category and compared with the presence of food security (protective

Table 2. Frequency food Group Intake per Week According to the food Security Level of the Mexican Households of the Population With CKD

Food-group	Consumption Frequency	Total n = 588 (100%)	Food-Security n = 160 (28.2%)	Mild Food-Insecure n = 151 (25.6%)	Moderate Food-Insecure n = 188 (31.9%)	Sever Food-Insecure n = 83 (14.1%)	*P* for trend
Fruits	Rarely	78 (13.3)	11 (6.6)	21 (13.9)	22 (11.7)	24 (28.9)	<.001
	Occasionally	164 (27.9)	25 (15.1)	45 (29.8)	64 (34.0)	30 (36.1)	
	Frequently	346 (58.8)	130 (78.3)	85 (56.3)	102 (54.3)	29 (34.9)	
Vegetable	Rarely	55 (9.4)	8 (4.8)	15 (9.9)	15 (8.0)	17 (20.5)	<.001
	Occasionally	200 (34.0)	30 (18.1)	56 (37.0)	80 (42.6)	34 (41.0)	
	Frequently	333 (56.6)	128 (77.1)	80 (53.0)	93 (49.5)	32 (38.6)	
Natural Juices	Rarely	398 (67.7)	92 (55.4)	98 (64.9)	147 (78.2)	61 (73.5)	<.001
	Occasionally	129 (21.9)	44 (26.5)	42 (27.8)	26 (13.8)	17 (20.5)	
	Frequently	61 (10.4)	30 (18.1)	11 (7.3)	15 (8.0)	5 (6.0)	
Beans	Rarely	142 (7.1)	64 (38.6)	42 (27.8)	21 (11.2)	15 (18.1)	<.001
	Occasionally	174 (29.6)	57 (34.3)	53 (35.1)	52 (27.7)	12 (14.5)	
	Frequently	272 (21.9)	45 (27.1)	56 (37.1)	115 (61.2)	56 (67.5)	
Egg	Rarely	77 (13.1)	31 (18.7)	23 (15.2)	10 (5.3)	13 (15.7)	<.001
	Occasionally	137 (23.3)	55 (33.1)	40 (26.5)	29 (15.4)	13 (15.7)	
	Frequently	374 (63.6)	80 (48.2)	88 (58.3)	149 (79.3)	57 (68.7)	
Meat	Rarely	129 (21.9)	15 (9.0)	47 (31.1)	35 (18.6)	32 (38.6)	<.001
	Occasionally	194 (33.0)	42 (25.3)	44 (29.1)	75 (39.9)	33 (39.8)	
	Frequently	265 (45.1)	109 (27.1)	60 (39.7)	78 (41.5)	18 (21.7)	
Dairy products	Rarely	174 (29.6)	49 (29.5)	55 (36.4)	37 (19.7)	33 (39.8)	.119
	Occasionally	169 (28.7)	53 (31.9)	54 (35.8)	44 (23.4)	18 (21.7)	
	Frequently	245 (41.7)	64 (38.6)	42 (27.8)	107 (56.9)	32 (38.6)	
Tortilla/Bread	Rarely	26 (4.4)	3 (1.8)	12 (7.9)	3 (1.6)	8 (9.6)	.778
	Occasionally	61 (10.4)	21 (12.7)	19 (12.6)	13 (6.9)	8 (9.6)	
	Frequently	501 (85.2)	142 (85.5)	120 (79.5)	172 (91.5)	67 (80.7)	
Sweet/Dessert	Rarely	256 (43.5)	81 (48.8)	83 (55.0)	58 (30.9)	34 (41.0)	<.001
	Occasionally	174 (29.6)	61 (36.7)	44 (29.1)	48 (25.5)	21 (25.3)	
	Frequently	158 (26.9)	24 (14.5)	24 (15.9)	82 (43.6)	28 (33.7)	
Snack	Rarely	356 (60.5)	106 (63.9)	105 (69.5)	100 (53.2)	45 (54.2.9)	<.001
	Occasionally	139 (23.6)	47 (28.3)	34 (22.5)	38 (20.2)	20 (24.1)	
	Frequently	93 (15.8)	13 (7.8)	12 (7.8)	50 (26.6)	18 (21.7)	
Sweets beverages	Rarely	288 (49.1)	106 (64.2)	90 (59.6)	59 (31.4)	33 (39.8)	<.001
	Occasionally	129 (22.0)	42 (25.5)	41 (27.2)	30 (16.0)	16 (19.3)	
	Frequently	170 (29.0)	17 (10.3)	20 (13.2)	99 (52.7)	34 (41.0)	
Processed Juices	Rarely	363 (61.8)	110 (66.7)	99 (65.6)	102 (54.3)	52 (62.7)	.020
	Occasionally	138 (23.5)	41 (24.8)	37 (24.5)	42 (22.3)	18 (21.7)	
	Frequently	86 (14.7)	14 (8.5)	15 (9.9)	44 (23.4)	13 (15.7)	

Rarely: 2 days a week or less or never, Ocasionally: 2 or 3 days a week and Frequently: 4 or more f days a week.

factor). It was found that the presence of diabetes, hypertension, unpaid occupation, living in the country's capital, having children at home, or a decrease in income due to the pandemic were risk factors for FI, while being a patient who had received a transplant and having social security and a higher educational level were protective factors (Figure 1).

The variables of food frequency questionnaire (Table 2) were used in the principal components analysis to evaluate consumption patterns using a polychoric matrix. Four main components were identified (see fsup1-fsup3) based on the elbow plot (Figure S1). These components explain 65.1% of the variability of the model. After identifying these 4 components, a multinomial logistic regression was performed according to the degrees of FI. Component 1 was associated with higher consumption of soft drinks, desserts, snacks, dairy products, beans, artificial juices, and eggs. This allowed the identification of subjects with moderate FI. Component 2 allowed to identify subjects with a lower probability of having any degree of FI (they consumed more fruits, vegetables, meat, and natural juices). Component 3 was associated with a lower probability of having severe FI. Component 4 was associated with a higher probability of having any degree of FI (Table 4).

Simple linear regression models were used to evaluate the relationship between the sociodemographic variables of the participants and the components identified. Component 1 was associated with older age, diabetes, hypertension, living with people under 18 year old, and decreased income due to the pandemic. Component 2 was associated with younger age, female sex, having a kidney transplant, not having diabetes or hypertension, not living with people

Table 3. Multinomial Logistic Regression Models to Evaluate the Risk Factors Associated With food Insecurity Level in CKD

		Mild Food-Insecurity			Moderate Food-Insecurity			Severe Food-Insecurity		
Model 1	Food-Security	OR	IC95%		OR	IC95%		OR	IC95%	
Parameters										
Age, years	Ref	1.06	0.99	1.02	1.03	1.01	1.04	1.02	0.99	1.03
Diabetes (yes)	Ref	2.74	1.60	4.7	5.38	3.24	8.93	4.54	2.49	8.30
Hipertension (yes)	Ref	1.64	1.01	2.67	4.16	2.40	7.18	2.96	1.51	5.81
Ocupation Non-remunerated	Ref	1.74	1.11	2.75	2.55	1.66	3.94	5.96	3.23	10.76
Minor Children at home	Ref	1.26	0.81	1.96	2.10	1.37	3.12	2.96	1.69	5.18
Decreased income due to COVID-19 pandemic	Ref	5.34	2.93	10.45	11.26	5.37	23.61	46.42	3.30	341.98
Renal Transplantation (yes)	Ref	0.66	0.39	1.12	0.26	0.14	0.48	0.14	0.05	0.42
Education level	Ref	0.29	0.22	0.39	0.29	0.23	0.39	0.25	0.17	0.36
Health insurance	Ref	0.58	0.35	0.98	0.45	0.28	0.73	0.31	0.17	0.55
Capital City	Ref	0.63	0.37	1.06	2.76	1.77	4.29	1.93	1.11	3.36

under 18 year old, and not having reported a decrease in income due to the pandemic. Component 3 was associated with older age, diabetes, not being in renal replacement therapy, and depending for their income on another family member. Component 4 was associated with female sex, not being on renal replacement therapy, living with people under 18 year old, having a decreased income due to the pandemic, and depending on another family member (Table 5).

Discussion

The SARS-CoV-2 pandemic has substantially affected the way of life of the general population. The distribution, availability, and access to food and even the food security of households around the world have all changed.[17] The present study evaluates the prevalence of different degrees of FI and their association with sociodemographic and dietary factors, as well as their impact during the SARS-CoV-2 pandemic. To our knowledge, this is one of the first

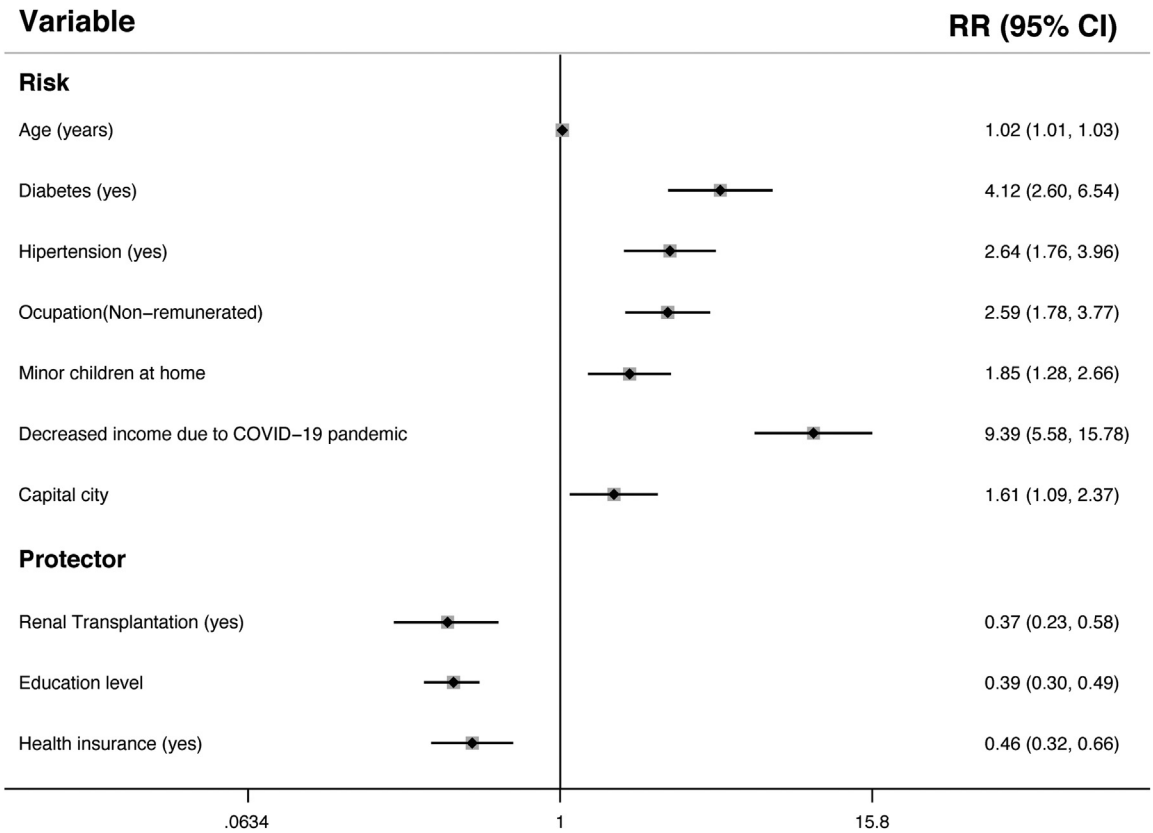

Figure 1. Logistic regression analysis to associate food security versus all the foot insegurity categories.

Table 4. Multinomial Logistic Regression Models to Evaluate the Principal Components Associated With food Insecurity Level in CKD

Components	Food Insecurity Level	OR	IC95%	*P*
1	Food-Security (reference)			
Sweers beverages (+)	Mild Food-Insecure	0.904	0.798-1.023	.109
Sweer/Dessert (+)	Moderate Food-Insecure	1.299	1.148-1.470	<.001
Snack (+)	Severe Food-Insecure	1.034	0.891-1.200	.660
Dairy products (+)				
Beans (+)				
Processed juices (+)				
Egg (+)				
2	Food-Security (reference)			
Vegetables (+)	Mild Food-Insecure	0.454	0.354-0.580	<.001
Fruits (+)	Moderate Food-Insecure	0.358	0.279-0.460	<.001
Meat (+)	Severe Food-Insecure	0.254	0.189-0.341	<.001
Natural juices (+)				
3	Food-Security (reference)			
Tortilla/Bread (+)	Mild Food-Insecure	0.883	0.715-1.091	.250
Natural juices (-)	Moderate Food-Insecure	1.048	0.848-1.296	.664
Processed juices (-)	Severe Food-Insecure	0.762	0.593-0.980	.034
Egg(+)				
Snack (-)				
4	Food-Security (reference)			
Meat(-)	Mild Food-Insecure	1.367	1.055-1.772	.018
Vegetables (+)	Moderate Food-Insecure	1.356	1.050-1.751	.020
Fruits (+)	Severe Food-Insecure	1.629	1.180-2.24	.003
Tortillas/Bread (-)				
Beans (+)				

The OR values were obtained from a model adjusted by age, sex, replacement therapy, households with minors and decreased income due to COVID-19 pandemic.

studies to evaluate all these factors as possible determinants of adherence to nutritional treatment in patients with CKD.

It was found that more than 70% (n = 422) of the study population presented some degree of FI, with moderate insecurity being the most prevalent (31.9%; n = 188). Previous studies on the general population of Mexico reported a prevalence of 55.5% for any degree of FI[22] before the SARS-CoV-2 pandemic. However, a recent study with a similar population showed a prevalence of 59.4% for FI during the pandemic.[23] Similarly, Wolfson et al.[24] reported in general population, that only 44% of United States households had FI at the beginning of the pandemic.

There are few studies on FI in people with CKD. In Jordan, Elsahoryi et al.[25] reported a prevalence of food security of 40.7% and a 59.2% prevalence of moderate-severe FI, which is lower than the percentage found in the present study. Regarding the population on RRT, the reported prevalence of FI in the adult population was 16%,[6] far below of the present study. In a cohort of children on replacement therapy from Seattle, USA, 64% reported FI; there was a higher prevalence of FI among the younger children who attended medical care more frequently and had a lower health-related quality of life.[15] In low-income patients with the cardiorenal syndrome in the USA, the prevalence of FI was 37.8%.[26]

The prevalence of FI among our patients is greater than what has been reported in other studies. This suggests that, at least in our environment, CKD could be a factor that affects access to food, and it could also make it even more difficult for these patients to comply with specific dietary prescriptions.

Ávila et al. reported that households with FI had a greater presence of children under 18 years of age, members with less schooling, and members who were more likely to be unemployed.[23] In contrast, a cohort study in the USA found[4] that households with food security consisted of younger people, members with higher income and educational level, and members with a lower prevalence of diabetes and hypertension[4]; these results are similar to those of the present study. Also, the study by Wolfson et al.[24] reported that those with FI had a lower educational level and did not have social security, similar results to those reported in the present study. It has also been reported that people who experience some degree of FI and have low income are more likely to develop terminal CKD, mainly in patients with diabetes and hypertension.[8] Similarly, Benerjee et al.[4] showed that people with some degree of FI were 2.8 times more likely to develop end-stage CKD compared to the food secure group. They considered FI as a risk factor for developing end-stage CKD.

It has been reported that once a patient has CKD, the main factors that prevent compliance with the necessary

Table 5. Lineal Regression Models to Evaluate the Relationship Between the Principal Components With sociodemographic Characteristics in Patients With CKD

Components	Sociodemographic Characteristics	β	IC95%	*P*
1	Age	0.255	0.097-0.414	.001
Sweers beverages (+)	Diabetes	0.632	0.302-0.961	<.001
Sweer/Dessert (+)	Hypertension	0.518	0.138-0.898	.007
Snack (+)	Minor children	0.369	0.051-0.688	.023
Dairy products (+)	Decreased income due to COVID-19 pandemic	0.668	0.215-1.120	.003
Beans (+)				
Processed juices (+)				
Egg (+)				
2	Age	−0.225	−0.330 to −0.118	<.001
Vegetables (+)	Sex	−0.199	−0.417 to 0.018	.073
Fruits (+)	Renal transplant	0.632	0.343-0.922	<.001
Meat (+)	Diabetes	−0.588	−0.808 to −0.369	<.001
Natural juices (+)	Hypertension	−0.476	−0.729 to −0.221	<.001
	Minor children	−0.226	−0.441 to −0.011	.038
	Decreased income due to COVID-19 pandemic	−0.827	−1.127 to −0.528	<.001
3	Age	0.227	0.181-0.364	<.001
Tortilla/Bread (+)	Diabetes	0.481	0.288-0.672	<.001
Natural juices (−)	Sustitutive therapy	−0.301	−0.486 to −0.115	.001
Processed juices (−)	Higher income contribution	−0.266	−0.472 to −0.061	.011
Egg (+)				
Snack (−)				
4	Sex	−1.81	−0.334 to −0.029	.019
Meat(−)	Remplacement therapy	−0.157	−0.307 to −0.008	.039
Vegetables (+)	Higher income contribution	−0.234	−0.399 to −0.069	.005
Fruits (+)	Decreased income due to COVID-19 pandemic	0.359	0.146-0.577	<.001
Tortillas/Bread (−)	Minor children	0.161	0.011-0.311	.036
Beans (+)				

Impact of SARS-CoV-2 pandemic on food security in patients with chronic kidney disease.

therapeutic measures are the change from the usual diet to a therapeutic diet and the presence of FI, further impeding adherence to dietary treatment.[5]

Chronic kidney disease, diabetes, and/or hypertension have been associated with socioeconomic and geographic factors that could be changed to allow for an efficient treatment.[27-29] Bergmans et al.[30] showed that there is an association between FI and poor diabetes control (OR = 1.7; CI95% = 1.1-2.5), in addition to increased kidney problems due to diabetes (OR = 1.6; CI95% = 1.1-2.5). The results of the present study showed that having diabetes is a risk factor for FI in households.

An alarming finding of the present study was the increased risk of FI due to the decrease in income resulting from the SARS-CoV-2 pandemic. In Mexico, high poverty and inequality levels result in greater vulnerability to economic problems that affect the quality of life. In Mexican households that depend on their earned income, the available data shows that working poverty increased from 37.3 to 45.8% in the first 2-quarters of 2020.[31] These results corroborate what was reported by Avila et al., who concluded that food security was not only affected by the pandemic through decreased income or job loss, but also through other factors such as poor education and the fact that a large part of the population lives in precarious conditions.[23]

As already mentioned, CKD seems to be associated with greater social vulnerability, depending on the age of the patient and the availability of family support—factors that influence FI and limit the possibility of carrying out a dietary treatment. Conditions of vulnerability and limited access to social rights such as rights to health, food, education, housing, and social security[31] predispose households to FI. Melo et al.[32] found that there is an association between FI and the difficulty of accessing medical care, both of which are in turn associated with a lower quality of life and low socioeconomic conditions. The present study showed that not having access to social security increases the probability of patients suffering from different degrees of FI.

Education allows people to access better-paid jobs and better understand health and nutrition recommendations and, in general, make better decisions about the important aspects of their lives. Accordingly, low levels of schooling are associated with unsafe living and health conditions, as well as a higher risk of mortality.[33] The present study showed that higher levels of schooling were associated with a lower risk of FI, and therefore a better prognosis for patients with CKD.

The FI is known to affect the nutritional quality of the diet, which affects the prevalence of chronic noncommunicable diseases (CNCDs). These diseases are closely related to higher medical expenses due to necessary

visits to emergency rooms and/or hospitalization.[34] Given the importance of this problem, the degree of FI in patients should be investigated, since it can become an impediment to treatment and a risk factor for developing CNCDs, as in the case of CKD.

Regarding the frequency of food consumption, the study by Elsahoryi et al.[25] showed that there was no relationship between FI and the different foods consumed, except for the group of cereals and meats. The authors suggest that their findings are associated with patients who have limited access to fruits and vegetables, either due to geographic or sociodemographic factors.[25] The present study found an association between lower consumption of fruits, vegetables, and meats in patients with FI. These patients probably have a lower economic income that prevents them from buying those foods. Only in the cereals, dairy products, and artificial juices, there were no statistically significant differences between the 3 FI degrees.

Regarding the principal component analysis, component 1 was associated with higher consumption of processed foods in patients with FI. The CRIC study carried out in different centers in the USA reported that men who live in places with access to food (numerous food stores, supermarkets, fast-food restaurants) consumed higher amounts of sodium and phosphorus, while women who lived in areas with less access to food reported a lower average intake of calories, sodium, and phosphorus. The population that had greater access to food and lower economic income reported a higher caloric intake[35] and also a higher intake of sodium and phosphorus. Suarez et al.[36] mention that having a low income is associated with lower levels of carotenoids and higher blood pressure, as well as a higher probability of CKD (OR = 1.76).

It has been found that FI is closely related to the presence of type 2 diabetes since people with this condition consume fewer fruits and vegetables and a greater amount of processed and high-calorie foods. These dietary factors increase a person's risk of developing diabetes and make disease management more difficult.[37,38] Furthermore, it has been shown that the consumption of sweetened beverages (mainly based on fructose) or ultra-processed beverages increases the risk of developing CKD.[39] In the present study, component 1 (artificial juices, desserts, sugar-sweetened beverages, eggs) was associated with a greater risk of diabetes and hypertension, as well as reduced income due to the pandemic.

Children with CKD have a higher energy intake and consume a diet with a higher acid load, and children with FI are more likely to be thin. However, no significant association has been found between dietary energy load, renal acid load, and food security status.[40]

It is known that the high cost of managing CKD due to the price of medications and treatments, as well as the difficulty of maintaining a stable job while suffering from this disease, predisposes patients to have a reduced income and/or economically depend on another family member. They also have extra expenses, which reduces the amount of money they can allocate to the purchase of food with good nutritional quality. Thus, the negative effects of CKD not only depend on the disease or the lack of adherence to medical or dietary treatment, but also on the living conditions of the patients; this shows that poor health is both a cause and a consequence of socioeconomic conditions, highlighting the importance of considering the social determinants of illness and health.

Renal health professionals need to include an assessment of the presence of FI of their patients in their daily professional practice. The results of these assessments could help improve the implementation of programs that provide food and/or nutritional support to vulnerable populations, which include patients with CKD.

This study shows a first approach to give importance to households with CKD patients who have some degree of FI.There is little evidence on the relationship between food security and CKD in Mexico, and even less during the pandemic. The existing studies have focused on the general population.

The main limitation of the present study is that it is cross-sectional in nature, which does not provide information on the status of patients before the pandemic to assess to what extent this situation affected their current state of food security, another important limitation is the lack of information about eGFR or stage of CKD even when an inclusion criteria of participants is that they have been diagnosed with kidney disease by a physician. One of the main strengths of the present study is that it considers the association of sociodemographic and dietary characteristics with the degree of FI of a population; not many studies have researched this angle before.

In conclusion the present study allowed us to conclude that more than 70% of CKD patients in the study cohort had some type of FI, which makes it difficult to adhere to treatment and may increase the risk of advanced CKD. The data showed that the presence of diabetes and/or hypertension, an unpaid occupation, having children at home, and reduced income due to the pandemic are factors that influence FI. By contrast, having social security, having received a transplant, being employed, and having higher education qualifications are factors that favor food security. Regarding eating patterns, the foods that are most consumed by patients with CKD suffering from FI are cereals, beans, eggs, milk, but also soft drinks, desserts, artificial juices, and fried foods and less fruits and vegetables. These results make it clear that access to food should be considered to understand the ability of CKD patients to adhere to dietary treatment. It should also be noted that FI is more than a nutritional risk factor in healthy patients and patients with CKD; it is a social injustice and a breach of the human right to food.

Practical Application

The SARSC-Cov2 pandemic has brought consequences that affect the household economy, leaving deleterious consequences in the medium and long term, that could be affecting food consumption and therefore the food safety of patients.

Health professionals must know the degree of FI of their patients in order to adapt a nutritional treatment according to their individual possibilities and needs.

Credit Authorship Contribution Statement

Vargas-Vázquez Cristina: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Approval of the final version of the manuscript. **González-Ortiz Ailema:** Conceptualization, Formal analysis, Data curation, Methodology, Supervision, Writing - original draft, Writing – review & editing, Approval of the final version of the manuscript. **Beltrán-Vilá Miriam:** Data curation, Conceptualization, Resources, Supervision, Approval of the final version of the manuscript. **Espinosa-Cuevas Ángeles:** Conceptualization, Methodology, Data curation, Investigation, Resources, Supervision, Writing - review & editing, Approval of the final version of the manuscript.

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Supplementary Data

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