

Depression and Chronic Hemodialysis A Study of Associated Factors in Morocco

Oumayma Laassilia¹, Marouane Aouji¹, Samar AL Heteilah¹, Rim benhida², Hiba Benchehida¹, Samir Bikri³, Badr-Eddine Badi⁴, Amine Rkhaila⁵, Youness Taboz¹

ABSTRACT

Background and aim

End-stage chronic kidney disease is characterized by irreversible loss of kidney function requiring replacement therapy such as hemodialysis, which is considered the most commonly used treatment. Patients treated with hemodialysis face several nutritional, social, and psychological problems. This study was conducted to evaluate the various associations between depression and nutritional and biochemical parameters.

Methods

The study was conducted among 200 patients treated with hemodialysis in three cities (Kelaa des Sraghna, Kenitra, El Jadida), whose average age was $55,24 \pm 15,07$ years.

Results

The results show that 80% of patients suffer from depression, of whom suffer from mild to severe depression (33,5% of patients suffer from mild depression, 23% from moderate depression, and 23,5% from severe depression). The results showed significant associations between marital status, educational level, and occupation in relation to the level of depression ($p < 0,05$), as well as significant associations between fresh fish consumption and depression (0,022), an association between phosphorus intake on hemodialysis days and normal days ($p < 0,05$), and a significant association between hemoglobin levels and depression (0,005).

Conclusions

These results show the influence of sociodemographic, nutritional, and biochemical parameters on the psychological state of patients with end-stage renal disease, highlighting the importance of multidisciplinary care to ensure good survival and quality of life for these patients.

Keywords

end-stage renal disease, hemodialysis, depression, nutritional parameters, biochemical parameters, sociodemographic parameters

I. INTRODUCTION

Chronic kidney disease (CKD) is a major public health issue due to its clinical and social repercussions, high morbidity and mortality rates, and the need for regular and restrictive medical follow-up, which is often difficult for patients and their families to cope with ¹. It is currently one of the leading causes of death worldwide, ranking eleventh, with an estimated prevalence of between 8% and 16% ^{2,3}.

Without adequate treatment, CKD inevitably progresses to end-stage renal disease (ESRD), defined by severe and irreversible loss of kidney function and requiring replacement therapy such as chronic hemodialysis or kidney transplantation to ensure survival ⁴. Hemodialysis (HD) remains the most commonly used treatment modality today, but it is accompanied by medical, social, and psychological constraints that make the care pathway particularly challenging ^{5,6}.

1. Natural Resources and Sustainable Development Laboratory, Research unit in Nutrition, Metabolism and physiology, Departement of biology, Faculty of Sciences, IBN TOFAIL University, Kenitra, Morocco
2. Higher school of technology, IBN TOFAIL University, Kenitra, Morocco
3. Laboratory Health and Biology, Department of biology, Faculty of Sciences, IBN TOFAIL University, Kenitra, Morocco
4. Laboratory of Biotechnology, Agri-food, Materials and Environment, Department of Biology, Faculty of Science and Technology - Mohammedia, Hassan II University, Casablanca, Morocco

Correspondence

Badr-Eddine Badi, Advanced Systems Engineering Lab, National School of Applied Sciences, Ibn Tofail University, Kenitra, Morocco. Email: badreddine.dahou@gmail.com

The constraints associated with medication prescriptions and strict diets, particularly fluid and nutritional restrictions, are often difficult to comply with. Non-compliance compromises therapeutic management and complicates medical follow-up⁷. These limitations, by altering the sense of autonomy and personal control, also promote social isolation and contribute to the emergence of psychological disorders, particularly depression^{8,9}.

Depression plays a central role. It is characterized by persistent low mood, loss of interest, feelings of guilt or worthlessness, and is a poor prognostic factor, accelerating disease progression and increasing mortality in patients with CKD^{10,11}.

Depression and anxiety are the most common mental disorders in hemodialysis patients, with reported incidences of 19–60% and 12–52%, respectively¹². Depression is associated with a deterioration in quality of life, reduced therapeutic and nutritional compliance, an increased risk of cardiovascular complications, malnutrition, repeated hospitalizations, and higher mortality^{13,14}.

The World Health Organization (WHO) has published a report on the mental health of the Moroccan population indicating that 1.48 million Moroccans suffered from depressive disorders, or 4.5% of the total population, and that 1.47 million suffered from anxiety, also 4.5% of the population¹⁵. The prevalence of depression among hemodialysis patients in Morocco has been estimated at 40%¹⁶.

The present study was conducted in order to examine the associations between depression and various socio-demographic, nutritional and biochemical parameters, and to compare these parameters according to the level of depression.

II. MATERIALS AND METHODS

Sampling

A descriptive cross-sectional study was conducted in three cities: Kelaa des Sraghna, El Jadida, and Kenitra. In El Jadida, the study took place at Mohammed V Hospital and at a private hemodialysis center. In Kelaa des Sraghna and Kenitra, it was conducted at private hemodialysis centers.

The survey was conducted between March and September 2024 and involved 200 hemodialysis patients aged 18 and over who had been undergoing treatment for more than three months. All participants underwent dialysis two to three times a week, with each session lasting 3 to 5 hours. They were also informed of the purpose of the study.

Sociodemographic data and overall health status

The data collected was gathered using a structured questionnaire on sociodemographic characteristics (age, gender, level of education, household size, marital status, level of education), health status (medical coverage, number of dialysis sessions per week, residual diuresis, cause of the disease, duration of hemodialysis treatment and gastrointestinal symptoms)

Anthropometry

Weight is measured in light clothing, without shoes, using mechanical scales. Height is measured using a wall-mounted height gauge, with participants standing barefoot with their shoulders relaxed.

Body mass index (BMI) was calculated by dividing weight (kg) by height squared (m²). In accordance with World Health Organization (WHO) criteria, BMI was classified as follows: underweight (BMI < 18 kg/m²), normal weight (18 ≤ BMI ≤ 24.9 kg/m²), overweight (25 ≤ BMI ≤ 29.9 kg/m²), and obese (BMI ≥ 30 kg/m²) [17].

Dietary habits

Dietary data were collected using a food frequency questionnaire and three non-consecutive 24-hour recalls^{18,19}, one of which was conducted on a dialysis day and two on normal days without dialysis. The information collected focused mainly on the consumption of different food groups and the quantities consumed. These were estimated using a standardized portion manual^{20,21} and then converted into grams. Nutritional intakes were then analyzed using the CIQUAL 2020 food composition table. Estimates from the two 24-hour dietary recalls were used to reflect usual nutrient intake on both dialysis and non-dialysis days.

Biochemical data

We collected the latest biological test results from each patient's medical records, including blood counts and calcium and phosphorus levels.

Psychological data

Psychological information was collected using two questionnaires. Depression was assessed using the Hamilton scale²². This scale is used to measure the degree of depression in hemodialysis patients. It is the most structured and internationally recognized method for assessing depression, useful in clinical research and medical practice.

Statistical analysis

Data analyses were performed using the SPSS statistical program, version 26.0. The variables were expressed as mean $\pm$ standard deviation, the chi-square test was used to study the associations between variables, the ANOVA test was used to compare the means between the different parameters, correlation was used to describe the relationship between variables, and regression was used to better represent the relationships between variables. A p-value < 0.05 was considered statistically significant.

III. RESULTS

1. Distribution of hemodialysis patients according to depression level

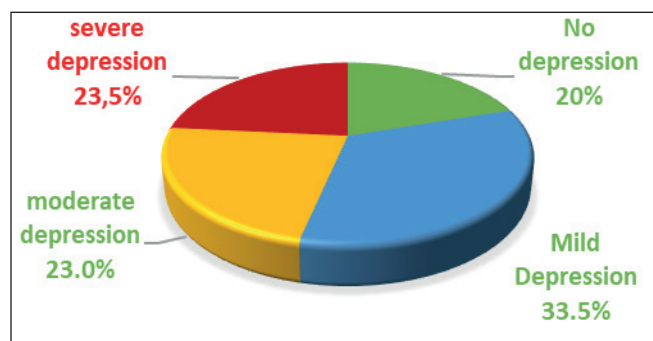


Figure 1: Distribution of hemodialysis patients according to depression level

Figure 1 shows the distribution of patients according to depression level, 20% of patients have no depressive symptoms, 33,5% have mild depression, 23% have moderate depression, and 23,5% have severe depression.

2. Association between different sociodemographic parameters and level of depression

Table 1 shows the associations between different sociodemographic parameters and level of depression.

Table 1: Distribution of sociodemographic data according to depression

parameters		Depression level				P value
		No depression N=40	Mild N=67	Moderate N=46	severe N=47	
Gendre	Male	23	38	25	17	0,118
	female	17	29	21	30	
Matrimonial situation	Single	7	2	6	8	0,015
	married	27	60	32	27	
	divorced	3	1	1	2	
	widower	3	4	7	10	
Region	Kelaa des sraghna	16	32	15	14	0,331
	El jadida	16	23	24	26	
	kenitra	8	12	7	7	
Private/hospital	private	37	61	41	31	0,001
	hospital	3	6	5	16	
Household size	1	2	2	4	2	0,486
	1 to 3	9	19	15	11	
	3 to 5	12	29	15	15	
	Over 5	17	17	12	19	
Professional status	Employee	2	3	4	1	0,033
	Self-employed	7	4	2	1	
	Seasonal work	0	0	2	0	
	Unemployed	31	60	38	45	
Education level	Illiterate	8	41	16	27	0,001
	Primary	15	10	9	12	
	Middle school	7	4	8	4	
	High school	5	4	8	4	
	Higher education	5	8	5	0	

The chi-square test showed significant associations between marital status ($p=0,015$), occupational status ($p=0,033$), and level of depression. Similarly, there was a highly significant association between type of institution ($p=0,001$), level of education ($p=0,001$) and level of depression. However, there were no significant associations between gender, region and household size ($p>0,005$).

3. Association between health status and level of depression

Table 2 shows the relationship between patients' health status and level of depression.

Table 2: Health status of hemodialysis patients according to level of depression

Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	severe N=47	
Medical coverage	Mutual	6	13	11	3	0,110
	Insurance	12	20	8	9	
	AMO	20	32	24	28	
	Without	2	2	3	7	
The duration of the illness	Less than 1 year	3	15	6	8	0,196
	Between 1 and 5 years	14	25	24	22	
	Between 5 and 10 years	7	10	5	2	
	More than 10 years	16	17	11	15	
Number of sessions /week	2 sessions	8	16	10	19	0,097
	3 sessions	32	51	36	28	
Residual diuresis	Yes	28	54	40	36	0,264
	No	12	13	6	11	
Cause of the disease	HTA	14	15	16	22	0,028
	Diabetes	6	19	18	10	
	Urological	0	6	1	2	
	Glomerular	3	11	3	3	
	Side effects of medications	1	1	0	2	
	Undetermined	14	13	5	4	
	Anemia	2	0	2	3	
	Intoxication	0	1	1	1	
Gastrointestinal symptoms	Lupus	0	1	0	0	0,056
	No symptoms	19	34	20	21	
	Gastroesophageal reflux disease	6	14	4	6	
	Heartburn	8	3	7	1	
	Gastric ulcer	3	12	8	8	
	Nausea and vomiting	4	4	6	9	
BMI	Irritable bowel syndrome	0	0	1	2	0,372
	Underweight	0	3	3	7	
	Normal weight	18	26	21	16	
	Overweight	14	24	13	15	
	Obesity	8	14	9	9	

The results of the chi-square test showed no significant association between disease duration, residual diuresis, medical coverage, and level of depression ($p = 0,196$; $p = 0,264$; $p = 0,110$, respectively). Similarly, the number of sessions, BMI, and gastrointestinal symptoms showed no significant association with depression ($p > 0,05$). However, a significant association was observed between the level of depression and the cause of the disease ($p = 0,028$).

4. Association between different nutritional parameters and depression

Table 3 shows the link between different nutritional parameters and depression.

Table 3: Distribution of nutritional parameters according to fluid intake and consumption of dairy products, red meat, poultry, fresh fish, and fish in relation to depression

Parameters		depression level				p value
		No depression N=40	mild N=67	moderate N=46	severe N=47	
THE AMOUNT OF ADDED SALT/ day	0g	1	11	5	9	0,240
	5g	23	43	29	25	
	10g	14	10	11	12	
	15g	2	3	1	11	
Water intake/ day	Less than 500 ml	3	7	8	7	0,510
	Between 500 ml and 1 L	26	45	28	27	
	Between 1l and 1,5l	3	9	7	8	
	Between 1,5l and 2l	8	6	3	5	
Dairy products	Less than 3 times a day	26	25	14	21	0,031
	More than 3 times a day	2	4	4	0	
	Less than 3 times a week	1	7	8	5	
	More than 3 times a week	4	22	14	13	
	Once a month	0	3	0	0	
	Twice a month	1	1	0	0	
	0 times	6	5	6	8	
Red meat	Less than 3 times a day	3	4	5	4	0,371
	Less than 3 times a week	19	28	16	12	
	More than 3 times a week	6	10	4	3	
	Once a month	3	5	2	6	
	Twice a month	1	3	4	1	
	Three times a month	1	0	0	1	
	0 times	7	17	15	20	
Poultry	Less than 3 times a day	13	30	20	23	0,523
	Less than 3 times a week	9	13	9	14	
	More than 3 times a week	17	19	15	8	
	Once a month	0	0	1	1	
	Twice a month	0	1	0	0	
	0 times	1	4	1	1	
Fresh fish	Less than 3 times a week	21	28	16	13	0,022
	More than 3 times a week	4	4	4	1	
	Once a month	6	12	4	5	
	Twice a month	3	8	5	7	
	Three times a month	1	4	0	0	
	0 times	5	11	17	21	

Parameters		depression level				p value
		No depression N=40	mild N=67	moderate N=46	severe N=47	
Canned fish	Less than 3 times a week	9	7	4	5	0,691
	More than 3 times a week	1	1	1	1	
	Once a month	5	8	3	3	
	Twice a month	2	4	5	1	
	Three times a month	0	1	0	1	
	0 times	23	46	33	36	
Liver and offal	Less than 3 times a week	4	4	2	2	0,419
	More than 3 times a week	0	0	1	1	
	Once a month	4	9	4	9	
	Twice a month	5	5	0	2	
	Three times a month	1	1	0	0	
	0 times	26	48	39	33	
Eggs	Less than 3 times a day	8	10	5	5	0,501
	Less than 3 times a week	13	23	12	20	
	More than 3 times a week	9	17	10	5	
	Once a month	0	2	1	1	
	Twice a month	1	4	1	4	
	Three times a month	1	0	1	0	
	0 times	8	11	16	12	

The results obtained highlighted several associations, significant or otherwise, between dietary habits and levels of depression. No statistically significant association was observed between the amount of salt added to food and levels of depression ($p = 0,768$), nor between daily water intake and levels of depression ($p = 0,594$). Similarly, consumption of red meat, poultry, liver, offal, eggs, or canned fish showed no significant association with depression levels ($p > 0,05$). However, a significant association was found between the consumption of fresh fish and dairy products and the level of depression ($p=0,022$; $p=0,031$).

Table 4: Distribution of nutritional parameters according to consumption of white bread, wholemeal bread, rice, couscous, legumes, oils, saturated fats, fruit, vegetables, and fruit juice in relation to depression

Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	high N=47	
Whole wheat bread and barley bread	Less than 3 times a day	8	15	12	10	0,590
	More than 3 times a day	15	19	8	12	
	Less than 3 times a week	1	2	2	1	
	More than 3 times a week	0	1	3	1	
	Once a month	1	0	0	2	
	0 times	15	30	21	21	



Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	high N=47	
Semolina bread and white bread	Less than 3 times a day	11	22	15	9	0,880
	More than 3 times a day	12	23	18	21	
	Less than 3 times a week	4	8	3	6	
	More than 3 times a week	7	9	8	7	
	Once a month	0	1	0	1	
	Twice a month	1	1	0	1	
	0 times	5	3	2	2	
Rice, pasta, couscous, potatoes, pulses	Less than 3 times a day	30	38	26	30	0,572
	More than 3 times a day	4	4	2	2	
	Less than 3 times a week	1	4	2	2	
	More than 3 times a week	5	20	16	11	
	Twice a month	0	1	0	1	
	Three times a month	0	0	0	1	
Olive oil and sunflower oil	Less than 3 times a day	26	31	28	25	0,520
	More than 3 times a day	14	32	16	18	
	Less than 3 times a week	0	1	1	1	
	More than 3 times a week	0	0	0	2	
	Three times a month	0	1	0	0	
	0 times	0	2	1	1	
Saturated fat (butter, smen)	Less than 3 times a day	5	8	6	2	0,152
	Less than 3 times a week	16	19	10	10	
	More than 3 times a week	3	6	6	3	
	Once a month	2	2	6	5	
	Twice a month	1	2	0	3	
	Three times a month	3	1	2	0	
	0 times	10	29	16	24	
Fruits	Less than 3 times a day	26	41	24	26	0,107
	More than 3 times a day	4	1	0	1	
	Less than 3 times a week	0	5	6	5	
	More than 3 times a week	10	18	12	12	
	Twice a month	0	0	0	1	
	0 times	0	2	4	2	
Olive	Less than 3 times a day	5	10	10	3	0,155
	Less than 3 times a week	15	23	11	13	
	More than 3 times a week	5	11	5	3	
	Once a month	3	1	1	6	
	Twice a month	2	4	3	1	
	0 times	10	18	16	21	

Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	high N=47	
Vegetable	Less than 3 times a day	23	43	31	25	0,148
	More than 3 times a day	2	7	0	3	
	Less than 3 times a week	6	2	5	5	
	More than 3 times a week	9	15	9	10	
	Once a month	0	0	0	1	
	0 times	0	0	1	3	
Fruit juice	Less than 3 times a day	9	10	7	2	0,175
	Less than 3 times a week	4	10	9	6	
	More than 3 times a week	3	4	3	3	
	Once a month	3	3	1	2	
	Twice a month	4	3	0	0	
	Three times a month	0	0	1	0	
	0 times	17	37	25	34	

No significant relationship was found between types of bread (white, whole wheat, semolina) and depression levels ($p > 0,05$). The same was true for the consumption of rice, couscous, potatoes, pasta, and legumes ($p > 0,05$). Furthermore, no significant association was observed for the consumption of saturated fats, olive oil, or vegetable oils ($p = 0,152$ and $p = 0,520$, respectively). The analyses did not reveal any significant link between the consumption of fruit, olives, vegetables, fruit juice, and the level of depression ($p > 0,05$).

Table 5: Distribution of nutritional parameters according to the consumption of herbs, dried fruit, added sugar, and salt in relation to depression

Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	severe N=47	
Thyme	Less than 3 times a day	2	4	2	4	0,412
	Less than 3 times a week	9	8	2	8	
	More than 3 times a week	3	6	2	0	
	Once a month	6	5	7	6	
	Twice a month	2	2	2	1	
	0 times	18	42	31	28	
Parsley	Less than 3 times a day	39	67	45	45	0,412
	Less than 3 times a week	0	0	0	1	
	More than 3 times a week	0	0	1	0	
	Twice a month	1	0	0	1	

Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	severe N=47	
Garlic	Less than 3 times a day	35	57	34	38	0,811
	Less than 3 times a week	2	3	4	2	
	More than 3 times a week	1	1	3	2	
	Once a month	0	0	1	0	
	Twice a month	0	1	0	0	
	0 times	2	5	4	5	
Mint	Less than 3 times a day	19	25	26	24	0,449
	More than 3 times a day	2	3	0	0	
	Less than 3 times a week	3	9	3	3	
	More than 3 times a week	0	4	4	2	
	Once a month	1	1	0	0	
	Twice a month	0	2	1	0	
	0 times	15	23	12	18	
Almond, pistachio, walnut	Less than 3 times a day	1	2	3	0	0,542
	More than 3 times a day	0	0	0	1	
	Less than 3 times a week	9	8	4	10	
	More than 3 times a week	3	6	6	2	
	Once a month	4	8	4	4	
	Twice a month	2	1	0	3	
	Three times a month	0	1	1	0	
	0 times	21	41	28	27	
Apricots, figs, dates, raisins	Less than 3 times a day	4	11	11	7	0,224
	Less than 3 times a week	12	11	11	8	
	More than 3 times a week	7	13	5	3	
	Once a month	4	4	3	8	
	Twice a month	1	5	4	3	
	Three times a month	0	0	0	2	
	0 times	12	23	12	16	
Sugar	Less than 3 times a day	31	43	33	35	0,074
	More than 3 times a day	5	4	0	0	
	Less than 3 times a week	0	5	2	1	
	More than 3 times a week	0	1	0	0	
	0 times	4	14	11	11	

Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	severe N=47	
Cake and pastries	Less than 3 times a day	8	12	4	10	0,870
	Less than 3 times a week	11	22	13	9	
	More than 3 times a week	5	6	3	3	
	Once a month	5	7	10	8	
	Twice a month	3	3	4	3	
	Three times a month	0	2	2	1	
	0 times	8	15	10	13	
Fried food	Less than 3 times a day	0	0	2	0	0,043
	Less than 3 times a week	16	14	14	12	
	More than 3 times a week	7	11	4	2	
	Once a month	4	7	2	6	
	Twice a month	5	3	2	6	
	Three times a month	0	2	0	2	
	0 times	8	30	22	19	
Coffee	Less than 3 times a day	15	15	10	10	0,602
	More than 3 times a day	1	0	0	0	
	Less than 3 times a week	9	12	8	5	
	More than 3 times a week	6	7	6	7	
	Once a month	1	4	3	4	
	Twice a month	0	2	1	1	
	0 times	8	27	18	20	
Tea	Less than 3 times a day	30	55	41	43	0,600
	More than 3 times a day	3	3	1	1	
	Less than 3 times a week	2	3	2	0	
	More than 3 times a week	3	3	2	0	
	Once a month	1	0	0	1	
	0 times	1	3	0	2	

Parameters		depression level				P value
		No depression N=40	mild N=67	moderate N=46	severe N=47	
Sweets	Less than 3 times a day	8	9	4	8	0,788
	More than 3 times a day	0	1	0	0	
	Less than 3 times a week	5	13	11	6	
	More than 3 times a week	2	9	2	6	
	Once a month	5	6	3	3	
	Twice a month	4	4	2	3	
	Three times a month	1	1	0	1	
	0 times	15	24	24	20	

A significant association was found between fried foods and depression levels ($p = 0,043$). No significant relationship was reported for aromatic herbs such as thyme, mint, parsley, and garlic ($p > 0,05$). The consumption of dried fruit (dates, figs, raisins), added sugar, sweetened products, coffee, tea, salt, and fried foods showed no significant association with depression levels ($p > 0,05$).

Table 6: Distribution of calorie, protein, calcium, phosphorus, and potassium intake according to depression

Parameters		depression level				P value
		No depression	mild	moderate	severe	
		N=40	N=67	N=46	N=47	
Caloric intake on dialysis day	Hypocaloric	31	47	37	29	0,210
	Normocaloric	8	16	7	11	
	Hypercaloric	1	4	2	7	
Caloric intake on normal day	Hypocaloric	34	55	42	28	0,002
	Normocaloric	6	6	4	12	
	Hypercaloric	0	6	0	7	
Protein intake on dialysis day	Insufficient intake	29	51	39	32	0,649
	Normal intake	3	4	1	3	
	Excessif intake	8	12	6	12	
Protein intake on normal day	Insufficient intake	31	55	41	29	0,016
	Normal intake	2	5	1	2	
	Excessif intake	7	7	4	16	
Phosphore intake on dialysis day	Excessif intake	16	13	5	17	0,003
	Normal intake	24	54	411	30	
Phosphore intake on normal day	Excessif intake	13	14	3	18	0,002
	Normal intake	27	53	43	29	

Parameters		depression level				P value
		No depression	mild	moderate	severe	
		N=40	N=67	N=46	N=47	
Potassium intake on dialysis day	Excessif intake	6	3	2	8	0,048
	Normal intake	34	64	44	39	
Potassium intake on normal day	Excessif intake	6	5	5	7	0,551
	Normal intake	34	62	41	40	
Calcium intake on dialysis day	Insufficient intake	38	64	43	45	0,957
	Normal intake	2	3	3	2	
Calcium intake on normal day	Insufficient intake	40	66	46	44	0,092
	Normal intake	0	1	0	3	

With regard to nutritional intake, a significant association was observed between caloric intake and protein intake on a normal day and the level of depression ($p = 0,002$; $p = 0,016$, respectively). In addition, a significant association was found between phosphorus intake on hemodialysis days and normal days ($p = 0,003$; $p = 0,002$) and potassium intake on hemodialysis days ($p = 0,048$) and depression levels. However, the chi-square test revealed no significant association between the

level of depression and calorie and protein intake on hemodialysis days, nor with potassium intake on normal days ($p > 0,05$). Similarly, no significant relationship was found between calcium intake on a normal day, on hemodialysis days, and depression levels ($p > 0,05$).

5. Association between different biochemical parameters and depression levels

Table 7 shows the relationship between different biochemical parameters according to depression levels.

Table 7: Results of biochemical analyses in hemodialysis patients according to depression levels

Parameters		depression level				P value
		No depression N=40	Mild N=67	moderate N=46	severe N=47	
Hemoglobin	No anemia	7	2	3	2	0,005
	Mild anemia	11	17	7	6	
	Moderate anemia	15	40	34	28	
	Severe anemia	7	8	2	11	
Calcium	Normal	21	25	22	16	0,194
	Deficiency	16	41	22	30	
	Excess	3	1	2	1	
Phosphorus	Normal	11	17	15	17	0,156
	Dificiency	1	12	3	4	
	Excess	28	38	28	26	

The results of the biochemical analyses showed that there is no significant association between calcium, phosphorus, and depression levels ($p=0,194$; $p=0,156$), but there is a significant association between hemoglobin levels and depression levels ($p=0,005$).

6. Comparison of the means of sociodemographic, nutritional, and biochemical parameters according to depression levels (one-way ANOVA).

Table 7 shows the comparison of the means of sociodemographic, nutritional, and biochemical parameters according to the level of depression (one-way ANOVA).

Table 7: Comparison of the means of sociodemographic, nutritional, and biochemical parameters according to the level of depression (one-way ANOVA).

Variables	No depression	Mild	moderate	high	F	P value
Age	43.90± 13.395	61.10± 12.412	54.89± 14.260	56.89± 15.655	13,173	0,000
BMI	25,4153±4,98302	26,0304±4,82886	25,2802±4,83117	25,2309±5,84336	0,310	0,818
Illness duration	62.5000±45.98104	46.3881±49.71097	45.6739±49.23190	62.1702±81.04623	1,289	0,279
Hemoglobin	10,5750±2,19016	9,8060±1,59762	10,0196±1,42152	9,0264±1,88364	5,813	0,001
Phosphore	52,3445±14,23361	47,3530±14,99505	49,0641±12,45044	48,5543±13,31886	1,101	0,350
Calcium	90,1875±10,13820	85,9607±9,45720	89,4517±7,91217	85,1738±10,71651	3,178	0,025
Energy requirement	2143,40±404,098	2133,99±421,231	2076,95±396,514	1989,54±481,363	1,324	0,268
Recommended protein intake	85,736±16,1639	85,360±16,8492	83,078±15,8605	79,582±19,2545	1,324	0,268
Caloric intake on dialysis day	1611,88±443,155	1552,39±481,707	1469,35±357,081	1573,68±460,188	0,814	0,488
Caloric intake on normal day	1411,0500±371,07211	1476,7910±464,13946	1266,7609±335,36509	1538,2128±560,04394	3,239	0,023
Protein intake on dialysis day	69,040±20,1606	64,922±34,2566	59,967±18,2303	69,196±19,5171	1,336	0,264
Protein intake on normal day	64,8273±22,12359	56,4103±21,45319	54,4683±18,93007	63,5672±26,73457	2,462	0,064
Phosphore intake on dialysis day	737,5750±252,48619	618,5373±240,00381	577,0652±207,97889	750,1064±277,09512	5,836	0,001
Phosphore intake on normal day	664,7250±257,92654	585,7910±282,38613	499,3913±193,27671	694,2979±334,71304	4,688	0,003**
potassium intake on dialysis day	2,0733±0,69187	14,1346±101,55785	1,7998±0,55491	53,5618±273,24053	1,312	0,272
potassium intake on normal day	1,9645±0,66823	1,7365±0,63656	1,8680±0,71763	1,9385±0,82313	1,162	0,326
calcium intake on dialysis day	426,1250±237,61078	389,4537±246,83648	347,6783±247,90511	356,6596±220,61153	0,958	0,413
calcium intake on normal day	289,3250±181,25720	278,7612±204,61102	216,7609±152,81346	298,7872±271,47295	1,456	0,228

Analysis of the different variables according to the level of depression reveals several statistically significant associations. First, there is a clear difference in age between the groups ($p = 0,000$), with patients without depression being younger than those with mild, moderate, or severe depression.

Biologically, hemoglobin also shows a very significant difference according to the degree of depression ($p = 0,001$). The lowest values are observed in patients with severe depression, indicating a possible relationship between anemia and depressive state. Blood calcium also varies between groups ($p = 0,025$), with slightly lower values in the depressive groups.

The assessment of nutritional intake highlights other significant differences. Caloric intake on a normal day is reduced in patients with moderate depression ($p = 0,023$), suggesting a decrease in food intake related to mental state. Consistently, phosphorus intake, both on dialysis days ($p = 0,001$) and on normal days ($p = 0,003$), is significantly lower in depressed patients, particularly in the moderate group. However, other variables such as BMI, duration of illness, blood phosphorus, energy requirements, protein intake, dietary potassium, and dietary calcium did not show significant differences between the groups ($p > 0,05$).

7. Correlation of biochemical and nutritional parameters according to depression

Table 8 shows the correlation between the various biochemical and nutritional parameters according to the level of depression.

Table 8: Pearson correlation of biochemical and nutritional parameters according to depression

Variables	Depression level	
	Pearson coefficient	P value
Clinical parameters		
Age	0,186	0,008
BMI	-0,034	0,631
Illness duration	0,011	0,882
HB	-0,249	0,000
Calcium	-0,111	0,117
Phosphore	-0,060	0,401
Nutritionnal parameters		
Energy requirements	-0,133	0,060
Recommended protein intake	-0,133	0,060
Caloric intake on dialysis day	-0,043	0,549
Caloric intake on normal day	0,036	0,613
Protein intake on dialysis day	-0,011	0,876

Variables	Depression level	
	Pearson coefficient	P value
Protein intake on normal day	-0,009	0,895
Phosphore intake on dialysis day	0,022	0,757
Phosphore intake on normal day	0,016	0,826
Potassium intake on dialysis day	0,105	0,139
Potassium intake on normal day	0,024	0,737
Calcium intake on dialysis day	-0,108	0,127
Calcium intake on normal day	-0,015	0,836

Pearson's correlation analysis revealed, overall, insignificant relationships between several nutritional and biological variables and the level of depression. A non-significant negative correlation was observed between Body Mass Index (BMI) and depression levels ($p = 0,631$), and serum calcium ($p = 0,117$) and phosphorus ($p = 0,401$) levels also showed a non-significant negative correlation with depression levels. Furthermore, a non-significant positive correlation was found between the duration of the disease and the level of depression ($p=0,882$). On the other hand, a highly significant negative correlation was found between hemoglobin levels and the level of depression ($p=0,002$). Similarly, a significant positive correlation was found between age and level of depression ($p=0,008$).

In terms of nutrition, a non-significant negative correlation was found between recommended energy requirements, recommended protein intake, and depression levels ($p = 0,060$). The same was true for caloric intake on hemodialysis days, protein intake on hemodialysis days and normal days, calcium intake on hemodialysis days and normal days. Non-significant negative correlations were found in relation to depression levels ($p>0,05$). On the other hand, non-significant positive correlations were found between caloric intake on a normal day, phosphorus intake on a normal day and on hemodialysis days, and potassium intake on hemodialysis days and normal days in relation to the level of depression.

8. Correlation of nutritional and psychological parameters with depression

Table 9 shows the correlation between the various psychological and nutritional parameters according to the level of depression.

Table 9: Spearman's correlation of nutritional parameters according to depression

Variables	Depression level	
	Spearman coefficient	P value
Nutritional parameters		
The amount of added salt	-0,107	0,132
Water intake	-0,060	0,401
Dairy products	0,113	0,111
Red meat	0,165	0,019
Poultry	-0,127	0,074
Fresh fish	0,265	0,000
Canned fish	0,142	0,046
Liver and offal	0,054	0,444
Eggs	0,092	0,197
Whole wheat bread and barley bread	0,040	0,577
Semolina bread and white bread	-0,007	0,917
Rice, pasta, couscous, potatoes, pulses	0,086	0,226
Olive oil and sunflower oil	0,045	0,524
Saturated fat (butter, smen)	0,171	0,016
Olive	0,140	0,048
Fruit	0,097	0,172
Vegetable	0,051	0,471
Fruit juice	0,173	0,014
Thyme	0,087	0,222
Parsley	0,065	0,359
Garlic	0,092	0,196
Mint	-0,047	0,505
Almond, pistachio, walnut	0,022	0,756
Apricots, figs, dates, raisins	0,020	0,777
Sugar	0,024	0,738
Cake and pastries	0,085	0,229
Fried food	0,125	0,079
Coffee	0,173	0,014
Tea	-0,158	0,025
Sweets	0,054	0,444

The results obtained from Spearman's correlation analysis revealed several relationships between dietary habits and depression levels. A non-significant negative correlation was observed between the amount of salt added to food ($p = 0,132$) and water intake (p

$= 0,401$) and depression levels. The consumption of dairy products showed a non-significant positive correlation with depression levels ($p = 0,113$), as did the consumption of liver and offal ($p = 0,444$). However, a highly significant positive correlation was noted between the consumption of fresh fish ($p = 0,000$), a significant correlation for the consumption of red meat and canned fish ($p = 0,019$; $p = 0,046$) and the level of depression. On the other hand, poultry consumption showed a non-significant negative correlation ($p = 0,074$), while eggs showed non-significant positive correlations ($p = 0,197$).

With regard to cereal products, wholemeal bread and barley bread showed non-significant positive correlations with depression levels ($p = 0,577$). Similarly, consumption of potatoes, rice, couscous, and legumes showed non-significant positive correlations ($p = 0,226$), while consumption of white bread and semolina bread showed a non-significant negative correlation ($p = 0,917$).

For fats, a significant positive correlation was found between saturated fat consumption and depression levels ($p = 0,016$), while unsaturated oils showed non-significant positive correlations ($p = 0,524$).

Fruit and vegetable consumption was associated with non-significant positive correlations ($p = 0,172$ and $p = 0,471$, respectively). In contrast, significant positive correlations were observed with olive consumption ($p = 0,048$) and fruit juice consumption ($p = 0,014$). Among herbs and condiments, thyme, parsley, and garlic showed non-significant positive correlations ($p = 0,222$; $p = 0,359$; $p = 0,196$), while mint showed a non-significant negative correlation ($p = 0,505$).

Oilseeds were associated with non-significant positive correlations with depression levels ($p = 0,756$), and even dried fruits (dates, figs, raisins) showed non-significant positive correlations ($p = 0,777$). A non-significant positive correlation was also found between added sugar consumption and depression levels ($p = 0,738$), while consumption of sweets, pastries, and cakes showed non-significant positive correlations ($p = 0,444$ and $p = 0,229$, respectively), as did fried foods ($p = 0,079$).

Finally, a significant negative correlation was observed between tea consumption and depression levels ($p = 0,025$), while coffee consumption showed a significant positive correlation ($p = 0,014$).

9. Analysis of the regression of biochemical, nutritional, and psychological parameters according to the level of depression

Table 10 shows the linear regression between the various biochemical and nutritional parameters in relation to depression.

Table 10: Regression of biochemical and nutritional parameters according to depression

Parameters	B	Standard error	p value	Confidence interval	
				Lower bound	Upper bound
Age	0,015	0,006	0,015	0,003	0,027
BMI	0,000	0,032	0,992	-0,064	0,063
Illness duration	0,002	0,002	0,234	-0,001	0,005
Hemoglobin	-0,129	0,048	0,008	-0,223	-0,035
Calcium	-0,005	0,008	0,566	-0,021	0,012
Phosphore	-0,003	0,006	0,569	-0,014	0,008
The amount of added salt	-0,107	0,124	0,388	-0,353	0,138
Water intake	0,152	0,110	0,169	-0,065	0,369
Dairy product	0,024	0,036	0,511	-0,048	0,096
Red meat	0,039	0,039	0,314	-0,037	0,115
poultry	-0,040	0,052	0,441	-0,143	0,063
Fresh fish	0,117	0,041	0,004	0,037	0,197
Canned fish	0,068	0,046	0,140	-0,023	0,160
Liver and offal	-0,063	0,056	0,263	-0,173	0,048
eggs	0,036	0,034	0,298	-0,032	0,104
Whole wheat bread and barley bread	0,013	0,027	0,630	-0,040	0,066
Rice, pasta, couscous, potatoes, pulses	-0,004	0,058	0,947	-0,119	0,111
Olive oil and sunflower oil	-0,028	0,071	0,694	-0,169	0,113
Saturated fat (butter, smen)	0,015	0,034	0,658	-0,052	0,083
Olive	0,026	0,033	0,434	-0,039	0,090
fruits	0,045	0,049	0,366	-0,053	0,142
Vegetable	0,089	0,057	0,122	-0,024	0,202
Fruit juice	0,013	0,032	0,681	-0,050	0,077
Persaly	-0,069	0,147	0,638	-0,359	0,221
Thyme	-0,015	0,039	0,691	-0,092	0,061
Garlic	0,057	0,040	0,158	-0,022	0,136
Mint	-0,002	0,027	0,930	-0,055	0,050

Parameters	B	Standard error	p value	Confidence interval	
				Lower bound	Upper bound
Almond, pistachio, walnut	-0,044	0,042	0,298	-0,128	0,039
Apricots, figs, dates, raisins	-0,037	0,034	0,272	-0,104	0,029
Sugar	0,032	0,031	0,303	-0,029	0,093
Cake and pastries	-0,009	0,035	0,789	-0,079	0,060
Fried food	-0,013	0,041	0,748	-0,094	0,068
Coffee	0,018	0,032	0,560	-0,044	0,081
Tea	-0,071	0,060	0,235	-0,190	0,047
Sweets	0,007	0,033	0,842	-0,058	0,071
Caloric intake on normal day	5,920	0,000	0,981	0,000	0,001
Caloric intake on dialysis day	0,000	0,000	0,237	-0,001	0,001
Protein intake on dialysis day	0,004	0,004	0,388	-0,005	0,012
Protein intake on normal day	2,817	0,006	0,996	-0,012	0,012
Phosphore intake on dialysis day	0,000	0,000	0,562	-0,001	0,001
Phosphore intake on normal day	0,001	0,001	0,113	0,000	0,002
Potassium intake on dialysis day	0,001	0,001	0,061	0,000	0,002
Potassium intake on normal day	0,095	0,152	0,533	-0,205	0,394
Calcium intake on dialysis day	-0,001	0,000	0,199	-0,001	0,000
Calcium intake on normal day	0,000	0,001	0,558	-0,001	0,001

Linear regression analysis applied to depression levels examined the effect of various anthropometric, biochemical, dietary, and nutritional variables. The results show contrasting effects, with significant associations for certain parameters only.

Regarding general health data, Body Mass Index (BMI) did not show a significant effect on depression levels ($B = 0,000$; $p = 0,992$). The p-value, well above the significance threshold, suggests a weak or non-existent effect. In contrast, age showed a significant positive effect ($B = 0,015$; $p = 0,015$) on depression, and hemoglobin levels showed a significant negative effect on depression levels ($B = -0,129$; $p = 0,008$), a result supported by a confidence interval that did not include zero. In contrast, phosphorus ($B = -0,003$; $p = 0,569$) and calcium ($B = -0,005$; $p = 0,566$) levels showed no

significant effect.

With regard to dietary habits, no significant effects were observed for the amount of salt added to food preparations ($B = -0,107$; $p = 0,388$), water intake ($B = 0,152$; $p = 0,169$), or consumption of dairy products ($B = 0,024$; $p = 0,511$). Similarly, consumption of red meat ($B = 0,039$; $p = 0,314$), chicken ($B = -0,040$; $p = 0,441$), canned fish ($B = 0,068$; $p = 0,140$), liver and offal ($B = -0,063$; $p = 0,263$) had no significant effect on depression. However, the consumption of fresh fish has a very significant positive effect ($B = 0,082$; $p = 0,004$), confirmed by a confidence interval excluding zero.

The consumption of eggs ($B = 0,036$; $p = 0,298$), wholemeal bread and barley bread ($B = 0,013$; $p = 0,630$), white bread and semolina bread ($B = 0,013$; $p = 0,630$), as well as rice, pasta, potatoes, and legumes ($B = -0,004$; $p = 0,947$) had no effect on the level of depression. The same was true for olive oil and sunflower oil ($B = -0,028$; $p = 0,694$), as well as saturated fats ($B = 0,015$; $p = 0,658$).

No significant effect was found for fruit consumption ($B = 0,045$; $p = 0,366$), vegetables ($B = 0,089$; $p = 0,122$), olives ($B = 0,026$; $p = 0,434$), and fruit juice ($B = 0,013$; $p = 0,681$). With regard to aromatic herbs, thyme ($B = -0,015$; $p = 0,691$), garlic ($B = 0,057$; $p = 0,158$), mint ($B = -0,002$; $p = 0,930$), and parsley ($B = -0,069$; $p = 0,638$) showed no significant effect. Similarly, consumption of dried fruit ($B = -0,037$; $p = 0,272$), oilseeds ($B = -0,044$; $p = 0,298$), added sugar ($B = 0,032$; $p = 0,303$), cakes and pastries ($B = -0,009$; $p = 0,789$), sweets ($B = 0,007$; $p = 0,842$), fried foods ($B = -0,013$; $p = 0,748$), coffee ($B = 0,018$; $p = 0,560$), and tea ($B = -0,071$; $p = 0,235$) was not significantly associated with depression levels.

With regard to nutritional intake on the day of hemodialysis, none of the variables studied showed a significant effect on depression levels: calorie intake ($B = 0,000$; $p = 0,237$), protein intake ($B = 0,004$; $p = 0,388$), phosphorus intake ($B = 0,000$; $p = 0,562$), potassium intake ($B = 0,001$; $p = 0,061$), and calcium intake ($B = -0,001$; $p = 0,199$).

No significant effect was found for fruit consumption ($B = 0,045$; $p = 0,366$), vegetables ($B = 0,089$; $p = 0,122$), olives ($B = 0,026$; $p = 0,434$), and fruit juice ($B = 0,013$; $p = 0,681$). With regard to aromatic herbs, thyme ($B = -0,015$; $p = 0,691$), garlic ($B = 0,057$; $p = 0,158$), mint ($B = -0,002$; $p = 0,930$), and parsley ($B = -0,069$; $p = 0,638$) showed no significant effect. Similarly, consumption of

dried fruit ($B = -0,037$; $p = 0,272$), oilseeds ($B = -0,044$; $p = 0,298$), added sugar ($B = 0,032$; $p = 0,303$), cakes and pastries ($B = -0,009$; $p = 0,789$), sweets ($B = 0,007$; $p = 0,842$), fried foods ($B = -0,013$; $p = 0,748$), coffee ($B = 0,018$; $p = 0,560$), and tea ($B = -0,071$; $p = 0,235$) was not significantly associated with depression levels.

With regard to nutritional intake on the day of hemodialysis, none of the variables studied showed a significant effect on depression levels: calorie intake ($B = 0,000$; $p = 0,237$), protein intake ($B = 0,004$; $p = 0,388$), phosphorus intake ($B = 0,000$; $p = 0,562$), potassium intake ($B = 0,001$; $p = 0,061$), and calcium intake ($B = -0,001$; $p = 0,199$).

Similarly, the estimated intakes for a normal day did not show a significant effect on the level of depression: calorie intake ($B = 5,920$; $p = 0,981$), protein intake ($B = 2,817$; $p = 0,996$), phosphorus intake ($B = 0,001$; $p = 0,113$), potassium intake ($B = 0,095$; $p = 0,533$), and calcium intake ($B = 0,000$; $p = 0,558$).

IV. DISCUSSION

The relationship between psychological status and various sociodemographic, nutritional, anthropometric, and biochemical parameters in hemodialysis patients is complex and multifaceted. Research indicates that depression is common in these patients and is closely related to malnutrition, sociodemographic factors, and biochemical markers^{23,24,25}.

This study aims to analyze the associations between the level of depression and nutritional and biochemical parameters, as well as overall health status in patients with end-stage renal disease treated with hemodialysis.

In our study, among the 200 patients, we found varying levels of depression ranging from mild to severe. Twenty percent of the subjects were not depressed. Thirty-three point five percent of the participants had mild depression, 23% had moderate depression, and 23.5% had severe depression. In contrast, a study conducted in Pakistan reported different proportions, with 13.64% mild depression, 34.09% moderate depression, and 25% severe depression²⁶. Furthermore, *Khadka and al.* observed that 84.8% of patients had depression, with 21.7% having mild depression, 30.8% having moderate depression, and 32.6% having severe depression.²⁷

With regard to sociodemographic data, the results showed a significant positive correlation between age and level of depression, highlighting a significant

difference in averages, with patients without depression being younger than those with mild, moderate, or severe depression, as well as a significant positive effect of age on depression. These results are consistent with a study conducted in Egypt, which showed that symptoms of depression were positively correlated with advanced age, indicating that older patients tend to have more depressive symptoms²⁸. In contrast, a study conducted in Saudi Arabia showed no significant difference in depression between different age groups among hemodialysis patients²⁹.

No significant association was observed between gender and level of depression. Among men, 11,5% were found to be not depressed, 19% had mild depression, 12,5% had moderate depression, and 8,5% had severe depression. In contrast, 8,5% of women were not depressed, 14,5% had mild depression, 10,5% had moderate depression, and 15% had severe depression. Similarly, a study conducted in Turkey indicates that although the prevalence of depression is higher in women, the severity of symptoms does not always differ significantly between the sexes, suggesting that psychological experiences can vary considerably from one individual to another³⁰. These results differ from those of a study conducted in Yemen, which found a marked difference between the sexes, with 82,4% of women being depressed compared to 56,4% of men, thus highlighting a significant correlation between gender and the severity of depression³¹. Similarly, a study of 1,504 adult patients with chronic kidney disease included in the PROHEMO prospective cohort conducted in Salvador, Brazil, showed that women on hemodialysis had a more impaired health-related quality of life and more pronounced depressive symptoms, particularly in the older age groups³².

A significant association was also observed between the type of facility (private or public), professional status, and depression. According to a study conducted in Yemen, the type of healthcare facility can indirectly influence depression rates, particularly through the quality of care, the availability of psychological support, and various socioeconomic factors such as insurance coverage³¹. Socioeconomic status, particularly employment, is closely linked to depression, with unemployed and uninsured patients more likely to experience depressive symptoms³¹.

In our study, we found a significant association between marital status and level of depression. Similarly, a

study conducted in Pakistan reported a significant link between single status and higher rates of depression, suggesting that marital status may influence patients' psychological state³³.

With regard to dietary habits, a significant association was observed between the consumption of fresh fish, fried foods, and levels of depression, highlighting a significant positive correlation between the consumption of fresh fish, saturated fatty acids, and olives in relation to levels of depression, as well as a positive effect of fresh fish consumption on levels of depression. These results are similar to studies that have shown that higher omega-3 consumption is correlated with a decrease in depressive symptoms in various populations, including hemodialysis patients. Fresh fish is a major source of omega-3 polyunsaturated fatty acids (PUFAs), which have been associated with a reduction in depressive symptoms^{34,35}. However, consumption of breaded fish has been associated with an increase in depressive symptoms, suggesting that preparation methods may influence the results³⁴. The Mediterranean diet, which includes olives, has been associated with better mental health. Adherence to this diet is linked to lower rates of depression and anxiety in hemodialysis patients^{36,37}. In addition, a study conducted in China showed that higher total fatty acid intake, particularly saturated fatty acids (SFAs), was linked to worsening depressive symptoms in chronic hemodialysis patients³⁸. Thus, adherence to the MIND diet was associated with better nutritional quality and a reduction in inflammatory markers, thereby contributing to a decrease in psychological disorders, particularly depression³⁶.

With regard to nutritional intake, the results showed significant associations between daily calorie, protein, phosphorus, and potassium intake and the level of depression, as well as a significant association between phosphorus and potassium intake on hemodialysis days and the level of depression. On a normal day, 79,5% of patients have an insufficient calorie intake, while 14% of patients have a normal intake and 6,5% of patients have a high calorie intake. In terms of protein intake, 78% of patients have an insufficient intake, while 5% of patients have a normal intake and 17% of patients have a high protein intake. For potassium intake, 11,5% of patients have a normal intake, while 88,5% of patients have an excessive intake. For phosphorus intake, 24% of patients have a normal intake, while 76% of patients had excessive intake. On hemodialysis days, our

results showed that 72% of patients had an insufficient calorie intake, while 21% of patients had a normal intake and 7% of patients had a high calorie intake. For protein intake, we found that 75,5% of patients had an insufficient intake, while, 5,5% of patients have a normal intake and 19% of patients have a high protein intake. For potassium intake, 9,5% of patients were found to have a normal intake, while 90,5% of patients had an excessive intake. For phosphorus intake, 25,5% of patients were found to have a normal intake, while 74,4% of patients have excessive intake.

Generally, the majority of hemodialysis patients have insufficient calorie and protein intake, both on normal days and on hemodialysis days, reflecting a restrictive energy and protein diet. These results are consistent with those of the systematic review by Gebrie and Ford, which found a significant correlation between depressive symptoms and poor compliance with nutritional restrictions in patients with end-stage renal disease undergoing hemodialysis ³⁹. In addition, malnutrition and inflammation appear to be major predictors of depression ³³.

With regard to phosphorus intake, the majority of participants had excessive intake, with a statistically significant association with the level of depression. These observations are consistent with the results of a study conducted in Japan, which showed that controlling phosphorus levels through appropriate nutritional management and medication could not only improve overall health, but also alleviate depressive symptoms. Thus, targeted interventions aimed at optimizing nutritional status and maintaining an adequate phosphorus balance could help reduce the risk of depression in hemodialysis patients ⁴⁰.

According to the results obtained, a significant association was observed between anemia and the level of depression, characterized by a negative correlation highlighting a very significant difference depending on the degree of depression, with the lowest values observed in patients with severe depression, indicating a possible relationship between anemia and depressive state. These observations are consistent with those of a study conducted in Indonesia, which also found a negative correlation between depression and hemoglobin levels in hemodialysis patients, indicating that subjects with severe depression had lower hemoglobin levels than those with mild depression ⁴¹.

These results are consistent with previous studies suggesting that psychological distress may alter hematological function through inflammatory and neuroendocrine mechanisms ⁴².

These results highlight the importance of incorporating regular psychological and nutritional assessments and targeted interventions in hemodialysis centers in order to better prevent and manage depression and dietary restrictions in this vulnerable population.

CONCLUSION

End-stage chronic renal failure is characterized by irreversible loss of kidney function requiring replacement therapy such as hemodialysis, which is considered the most commonly used treatment. Patients treated with hemodialysis encounter several nutritional, social, and psychological problems, including depression, which is considered the most recurrent psychological problem in hemodialysis patients. It is associated with several sociodemographic, nutritional, and biochemical parameters such as gender, calorie intake, phosphorus intake, and hemoglobin levels. The results of this study show the influence of sociodemographic, nutritional, and biochemical parameters on the psychological state of patients with end-stage renal disease, highlighting the importance of multidisciplinary care to ensure good survival and quality of life for these patients.

Consent for Publication

This study was approved by the research authorities of Ibn Tofail University, Morocco, under the supervision of the Laboratory of Natural Resources and Sustainable Development, Research Unit in Nutrition, Metabolism, and Physiology. Although the university does not have a formal ethics committee, the research protocol was reviewed and authorized by institutional guidelines. The study was conducted in full compliance with the ethical principles outlined in the Declaration of Helsinki. All participants gave their informed consent before inclusion, and all procedures were carried out with strict attention to privacy, confidentiality, and participant welfare.

Acknowledgments

The authors would like to thank all participants in this study for their valuable collaboration. Their commitment, availability, and trust were essential to the success of this research project.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

Declaration on the Use of AI: We declare the use of grammar correction

software: Grammarly and Quillbot.

Funding

This study received no funding.

Data Availability Statement

The anonymized data supporting the conclusions of this study are available upon request from the corresponding author, in accordance with ethical requirements and participant confidentiality.

REFERENCES

- Bello, A. K., Okpechi, I. G., Osman, M. A., Cho, Y., Htay, H., Jha, V., Wainstein, M., & Johnson, D. W. (2022). Epidemiology of haemodialysis outcomes. *Nature reviews. Nephrology*, 18(6), 378–395. <https://doi.org/10.1038/s41581-022-00542-7>
- Lee, D. Y., Yoo, D. K., Han, S. Y., Lee, K., Lee, Y., Teopiz, K. M., Mansur, R. B., Rosenblat, J. D., & McIntyre, R. S. (2022). Association between depressive symptoms and bone density in elderly patients with non-dialysis dependent chronic kidney disease. *Journal of affective disorders*, 319, 549–554. <https://doi.org/10.1016/j.jad.2022.09.014>
- Chang, J., Hou, W. W., Wang, Y. F., & Sun, Q. M. (2020). Main Risk Factors Related to Activities of Daily Living in Non-Dialysis Patients with Chronic Kidney Disease Stage 3-5: A Case-Control Study. *Clinical interventions in aging*, 15, 609–618. <https://doi.org/10.2147/CIA.S249137>
- Sallam, L., Alsharif, F., Abaalalaa, S., Alakeely, R., Abdullah, Z., Alkhamis, Z., Sindi, N., & Sharif, L. S. (2022). Prevalence of depression in patients with end-stage renal disease undergoing hemodialysis in Saudi Arabia: A cross-sectional study. *Belitung nursing journal*, 8(4), 296–303. <https://doi.org/10.33546/bnj.2080>
- Steel, A., & Bertfield, D. (2020). Increasing advance care planning in the secondary care setting: A quality improvement project. *Future healthcare journal*, 7(2), 137–142. <https://doi.org/10.7861/fhj.2019-0040>
- Al-Naamani, Z., Gormley, K., Noble, H., Santin, O., Al Omari, O., Al-Noumani, H., & Madkhali, N. (2024). The lived experiences of fatigue among patients receiving haemodialysis in Oman: a qualitative exploration. *BMC nephrology*, 25(1), 239. <https://doi.org/10.1186/s12882-024-03647-2>
- Sultan, B. O., Fouad, A. M., & Zaki, H. M. (2022). Adherence to hemodialysis and medical regimens among patients with end-stage renal disease during COVID-19 pandemic: a cross-sectional study. *BMC nephrology*, 23(1), 138. <https://doi.org/10.1186/s12882-022-02756-0>
- Ständer, S., Fishbane, S., Schaufler, T., Ruessmann, D., Morin, I., Menzaghi, F., Wen, W., & Kalantar-Zadeh, K. (2024). Chronic kidney disease-associated pruritus and quality of life with difelikefalin treatment: a *post hoc* analysis of phase 3 data using the Skindex-10 questionnaire. *Clinical kidney journal*, 17(10), sfac274. <https://doi.org/10.1093/ckj/sfac274>
- Kohzuki M. (2024). Renal Rehabilitation: Present and Future Perspectives. *Journal of clinical medicine*, 13(2), 552. <https://doi.org/10.3390/jcm13020552>
- Mayes, J., Young, H. M. L., Blacklock, R. M., Lightfoot, C. J., Chilcot, J., & Nixon, A. C. (2022). Targeted Non-Pharmacological Interventions for People Living with Frailty and Chronic Kidney Disease. *Kidney and Dialysis*, 2(2), 245–261. <https://doi.org/10.3390/kidneydial2020025>
- Win, K. C. M., Zhou, H., Patton, V., Steen, M., & Della, P. (2025). Factors Contributing to Non-Adherence to Treatment Among Adult Patients with Long-Term Haemodialysis: An Integrative Review. *Nursing reports (Pavia, Italy)*, 15(9), 314. <https://doi.org/10.3390/nursrep15090314>
- urtak, G., Lerch, N., Kozłowski, M., Tkacz, P., Piekara, E., Łagódka, M., Durys, D., Gutowska, I., Widecka, K., Marchelek-Myśliwiec, M., Żwierzeło, W., & Cymbaluk-Płaska, A. (2024). Assessment of IL-8, RANTES, MIG, MCP-1, IP-10, and IL-12p70 and Their Association with Anxiety and Quality of Life in Patients with Chronic Kidney Disease or After Kidney Transplantation. *International journal of molecular sciences*, 25(24), 13449. <https://doi.org/10.3390/ijms252413449>
- Al-Ali, F., Elshirbeny, M., Hamad, A., Kaddourah, A., Ghonimi, T., Ibrahim, R., & Fouda, T. (2021). Prevalence of Depression and Sleep Disorders in Patients on Dialysis: A Cross-Sectional Study in Qatar. *International journal of nephrology*, 2021, 5533416. <https://doi.org/10.1155/2021/5533416>
- Delgado-Domínguez, C. J., Sanz-Gómez, S., López-Herradón, A., Díaz Espejo, B., Lamas González, O., de Los Santos Roig, M., Berdud Godoy, I., Rincón Bello, A., & Ramos Sánchez, R. (2021). Influence of Depression and Anxiety on Hemodialysis Patients: The Value of Multidisciplinary Care. *International journal of environmental research and public health*, 18(7), 3544. <https://doi.org/10.3390/ijerph18073544>

15. Alaoui, A. C., Omari, M., Quarmich, N., Kouiri, O., Chouhani, B. A., Berraho, M., Tachfouti, N., Houssaini, T. S., & El Fakir, S. (2024). Prevalence and determinant factors of depression and anxiety in people with chronic kidney disease: a Moroccan cross-sectional study. *The Pan African medical journal*, 48, 15. <https://doi.org/10.11604/pamj.2024.48.15.42881>
16. Chaanoun, K., Azria, S., Ben Cheikh, S., Zamd, M., Mtioui, N., El Khayat, S., Medkouri, G. et Benghanem-Gharbi, M. (2022). La dialyse aggrave-t-elle les troubles anxiodépressifs chez l'insuffisant rénal chronique ? *Néphrologie & Thérapeutique*, 18 (5), 446. <https://doi.org/10.1016/j.nephro.2022.07.122>
17. World Health Organization. (2003). *Obesity: Preventing and managing the global epidemic* (WHO Technical Report Series No. 894). WHO.
18. Chen, Z. Q., Luo, L., Chen, X. X., Zhang, X. Y., Yin, S. Q., Xiao, G. H., Xu, N., Liu, Q., & Su, C. Y. (2024). Dietary nutrient intake and nutritional status in maintenance hemodialysis patients: a multicenter cross-sectional survey. *Renal failure*, 46(2), 2363589. <https://doi.org/10.1080/0886022X.2024.2363589>
19. Sin, D., Harasemiw, O., Curtis, S., Iman, Y., Buenafe, J., DaCosta, J., Mollard, R. C., Tangri, N., Protudjer, J. L. P., & Mackay, D. (2022). Dietary Patterns and Perceptions in Older Adults With Chronic Kidney Disease in the Canadian Frailty Observation and Interventions Trial (CanFIT): A Mixed-Methods Study. *Canadian journal of kidney health and disease*, 9, 20543581221140633. <https://doi.org/10.1177/20543581221140633>
20. G. Dufourny, K. Elmoumni, and E. Maimouni, "Aliments et préparations typiques de la population Marocaine, outil pour estimer la consommation alimentaire," Centre d'Information et de Recherche sur les Intol'érances et l'Hygiène Alimentaires (CIRIHA), p. 158, 2008
21. SU.VI.MAX. (2002). *Food portions: Photo manual for estimating quantities*. Polytechnica.
22. Hamilton, M. (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery, and Psychiatry*, 23(1), 56–62.
23. Pehlivan, M., Karateke, E., & Çalışkan, E. (2025). The relationship between phase angle, nutritional status and blood biochemical parameters in hemodialysis patients: an example study in Edirne city center. *Anatolian Current Medical Journal*, 7(2), 210-217.
24. Kumar, A., Jain, A., & Rikhari, P. (2023). Biochemical and sociodemographic correlates of major depressive disorder in patients with chronic kidney disease receiving hemodialysis. *Cureus*, 15(8).
25. Cohen, S., & Kimmel, P. (2007). Nutritional status, psychological issues and survival in hemodialysis patients. *Contributions to Nephrology*, 155(R), 1.
26. Mazharulhaq, M., Rafique, K., Ahmad, Z., Khan, A. U., Arshad, A., & Ilyas, K. (2023). Prevalence of depression in patients on hemodialysis. *International Journal of Health Sciences*, 7(S1), 41-48.
27. Khadka, S., Adhikari, R., et Paudel, T. (2020). Dépression chez les patients atteints de maladies rénales chroniques sous hémodialyse. *Journal of Karnali Academy of Health Sciences*, 3 (2), 73-79.
28. Megahed, F. A., Elbahnasawi, M. M., Tobar, S., Magdy, H., El Bahnasawy, H. A. M. S., & Sayed Ahmed, N. (2023). Frequency and correlates of depression in hemodialysis patients versus apparently healthy population in Egypt. *Annals of Advanced Biomedical Sciences*, 6(1), 000205. <https://doi.org/10.23880/aabsc-16000205>
29. Albuhayri, A. H., Alshaman, A., Alanazi, M., Aljuaid, R., Albalawi, R., Albalawi, S., Alsharif, M. A., Alharthi, N. M., & Prabakar, K. (2022). Cross-sectional study on assessment of depression in hemodialysis patients. *Journal of Advanced Pharmaceutical Technology & Research*, 13(4), 266–270. https://doi.org/10.4103/japtr.japtr_322_22
30. Yıldırım, S., Albayrak, HC, Helvacı, Ö., Erten, Y., Derici, U., Ayli, D., ... & Guz, G. (2023). # 6075 DISPARITÉS DE GENRE CHEZ LES PATIENTS HÉMODIALYSÉS : VIE PROFESSIONNELLE, ÉTAT MENTAL ET CAPACITÉ PHYSIQUE. *Nephrology Dialysis Transplantation*, 38 (Supplément_1), gfad063c_6075.
31. Alkubati, S. A., Al-Sayaghi, K. M., Salameh, B., Halboup, A. M., Ahmed, W. A., J. Alkuwaisi, M., & Zoromba, M. A. (2024). Prevalence of depression and its associated factors among hemodialysis patients in Hodeida City, Yemen. *Journal of multidisciplinary healthcare*, 689-699.
32. da Silva, F. A., Silva Martins, M. T., Gutiérrez-Peredo, G. B., Kraychete, A. C., Penalva, C. C., Lopes, M. B., ... & Lopes, A. A. (2023). Mortality, health-related quality of life, and depression symptoms in younger and older men and women undergoing hemodialysis. *The International Journal of Artificial Organs*, 46(8-9), 492-497.
33. Nafay, A., & Mahmud, S. N. (2025). Evaluation of the incidence and severity of depression in patients of a single-center dialysis unit, Shifa International Hospital, Islamabad. *Journal of Public Health and Social Sciences*, 3(3), 79–83. <https://doi.org/10.63163/jpehss.v3i3.550>
34. Hoffmire, C. A., Block, R. C., Thevenet-Morrison, K., & van Wijngaarden, E. (2012). Associations between omega-3 polyunsaturated fatty acids from fish consumption and severity of depressive symptoms: an analysis of the 2005–2008 National Health and Nutrition Examination Survey. *Prostaglandins*,

- leukotrienes and essential fatty acids*, 86(4-5), 155-160.
35. Kader, M. (2013). Association of Fish Consumption with Prevalence of Depression among Men and Women-A Literature Review. *International Journal of Medical Research*, 1(03), 10-13.
36. Açık, M., Gümüş, A. B., Ekici, A., Yilmaz, F. Ç., & Küçüksu, M. (2025). Mediterranean-DASH diet intervention for neurodegenerative delay diet and psychological problems in maintenance hemodialysis patients by the structural equation modeling analysis of malnutrition and inflammation markers approach. *Journal of Renal Nutrition*, 35(2), 271-280.
37. Jackson, H. (2022). Food and mood: healthy eating for mental health with chronic kidney disease. *Journal of Kidney Care*, 7(4), 172-177.
38. Zhang, S., Liu, S. X., Wu, Q. J., Wang, Z. H., Liu, H., Xiao, P., ... & Meng, Q. M. (2024). Association between dietary fatty acids and depressive symptoms in Chinese haemodialysis patients: a cross-sectional study. *British Journal of Nutrition*, 132(7), 935-945.
39. Gebrie, M. H., & Ford, J. (2019). Depressive symptoms and dietary non-adherence among end stage renal disease patients undergoing hemodialysis therapy: systematic review. *BMC nephrology*, 20(1), 429.
40. Huang, L., Zhang, Y., Wang, J., & Zhou, J. (2025). Investigating the association of bioelectrical impedance analysis-derived phase angle and depressive symptoms in patients receiving maintenance hemodialysis: a cross-sectional study. *Frontiers in Nutrition*, 12, 1662484.
41. Simbolon, D., Sitorus, E., Simanjuntak, E. K., & Rantung, G. (2025). Depression and Hemoglobin levels in patients undergoing maintenance hemodialysis. *Malahayati International Journal of Nursing and Health Science*, 8(5), 664-671.
42. Qawaqzeh, D. T. A., Masa'deh, R., Hamaideh, S. H., Alkhalwaldeh, A., & ALBashtawy, M. (2023). Factors affecting the levels of anxiety and depression among patients with end-stage renal disease undergoing hemodialysis. *International Urology and Nephrology*, 55(11), 2887-2896.