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Effectiveness of adherence to nutritional therapy in type 2 diabetics on hemodialysis

Efectividad de la adherencia a la terapia nutricional de diabéticos tipo 2 en hemodiálisis

Patricio Salazar[1]*, Hazel Anderson[2]

[1]*Departamento de Nutrición Clínica, Hospital General Santo Domingo, Ecuador.*
[2]*Escuela de Nutrición y Dietética, Facultad de Medicina, Universidad del Zulia, Venezuela.*

**Corresponding author*

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Abstract

Type 2 diabetes is one of the leading causes of chronic kidney disease, and its treatment through hemodialysis requires strict adherence to nutritional therapy. This study evaluated anthropometric and biochemical parameters, as well as the degree of dietary adherence, in 87 patients with diabetic nephropathy undergoing hemodialysis in Ecuador. Serial measurements were conducted over a six-month period, and the DDFQ questionnaire was used to assess adherence to dietary and fluid restrictions. Significant sex-based differences were observed in waist, arm, and calf circumferences ($p<0.001$), as well as in phosphorus and potassium levels ($p\leq0.05$). A total of 48% of patients showed a moderate deviation from the diet, and 34% a severe deviation. Significant correlations were found between the degree of dietary non-adherence and levels of albumin, creatinine, phosphorus, and potassium, suggesting that these biochemical markers may reflect nutritional adherence. No significant correlations were found between fluid restriction adherence and any other variables. These findings underscore the importance of enhancing nutritional education among hemodialysis patients and support the use of the DDFQ as a valuable tool for monitoring adherence to nutritional therapy.

Keywords: nutritional status, adherence, diet, hemodialysis, type 2 diabetes.

Resumen

La diabetes tipo 2 es una de las principales causas de enfermedad renal crónica, y su tratamiento mediante hemodiálisis requiere estricta adherencia a la terapia nutricional. Este estudio evaluó los parámetros antropométricos, bioquímicos y el grado de adherencia dietética en 87 pacientes con nefropatía diabética en hemodiálisis en Ecuador. Se realizaron mediciones seriadas durante seis meses y se aplicó el cuestionario DDFQ para valorar la adherencia a la dieta y restricción hídrica. Se observaron diferencias significativas por sexo en circunferencia de cintura, brazo y pantorrilla ($p<0{,}001$), así como en niveles de fósforo y potasio ($p\leq0{,}05$). El 48% de los pacientes mostró una desviación moderada de la dieta, y el 34% una desviación severa. Se hallaron correlaciones significativas entre el grado de incumplimiento dietético y los niveles de albúmina, creatinina, fósforo y potasio, lo que sugiere que dichos marcadores bioquímicos podrían reflejar la adherencia nutricional. No se observaron correlaciones significativas con la adherencia hídrica. Estos resultados evidencian la necesidad de reforzar la educación nutricional en pacientes en hemodiálisis, y respaldan el uso del DDFQ como herramienta útil para monitorear la adherencia a la terapia nutricional.

Palabras clave: estado nutricional, adherencia, dieta, hemodiálisis, diabetes tipo 2.

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic disease of diverse origin, characterized by elevated blood glucose levels due to dysfunctions in the action or secretion of insulin (American Diabetes Association, 2021). Its prevalence has increased considerably, and it is estimated that by 2030 it will affect approximately 439 million people, a phenomenon driven by the obesity epidemic and a sedentary lifestyle (Saeedi et al., 2019). Additionally, dietary patterns characterized by high consumption of ultra-processed or "junk" foods have exacerbated metabolic imbalances in patients with chronic diseases (Gallardo, & García, 2024).

Diabetic nephropathy is a common microvascular complication in patients with diabetes and is the leading cause of chronic kidney disease (CKD) and end-stage renal disease worldwide (Gupta et al., 2023). In 2017, it was estimated that more than 9% of the world's population suffered from CKD, making it the twelfth leading cause of death. In Latin America, CKD was the fifth leading cause of death in 2017 (GBD Chronic Kidney Disease Collaboration (2020); in Ecuador in particular, it was estimated as the fourth leading cause of death (Ministry of Health of Ecuador. 2018), and a recent study reported that the number of CKD patients requiring dialysis in Ecuador by 2023 reached 21,365 (Torres et al., 2022).

Chronic kidney disease predisposes patients to malnutrition, which increases the risk of an adverse prognosis due to nutritional problems, such as cachexia and protein-energy wasting. Furthermore, these patients show a higher prevalence of cardiovascular disease and are vulnerable to malnutrition-inflammation syndrome, all of which are associated with increased mortality rates (Valente et al., 2019). For this reason, metabolic control, which can be achieved through lifestyle modifications, including medical nutritional therapy, is crucial, as it can delay the development of albuminuria and improve clinical outcomes in individuals with both diabetes and kidney disease (Sohrabi et al., 2015).

Nutritional status plays a fundamental role in the health of these patients. Its assessment can be performed through various nutritional screening tools, such as anthropometric methods that include weight, body mass index (BMI), and measurement of arm and calf circumference (Peng et al., 2021). The success of a hemodialysis program depends on adherence to four key factors: a balanced diet, appropriate medication use, fluid restriction, and regular attendance at the corresponding program. In this context, it has been noted that diet and fluid restriction can be significant factors associated with malnutrition, as they involve drastic modifications in adapting to a new diet (De las Heras-Mayoral & Martínez-Rincón, 2015). Similar nutritional assessment approaches have been applied in institutionalized older adults, revealing significant associations between nutritional indicators and health outcomes (Rodríguez & García, 2025).

Dietary and fluid restrictions in patients with CKD reduce the amount of urea, creatinine, and electrolytes that must be excreted through the renal system. Failure to comply with these restrictions is associated with a buildup of fluid and metabolic waste products in the bloodstream, leading to health problems, hospitalizations, and high mortality rates. Excessive fluid intake, for example, can lead to high blood pressure, muscle cramps, and pulmonary edema, which can lead to cardiovascular damage and death (Halle et al., 2020). Furthermore, adhering to a specific diet has multiple benefits, including preventing relapse, alleviating symptoms, and improving overall health (Efe et al., 2015).

In Ecuador, information on this topic is scarce. Therefore, the objective of this study was to evaluate the anthropometric and biochemical parameters, as well as dietary adherence, of patients with type 2 diabetes mellitus undergoing hemodialysis at the dialysis clinic of IESS Riobamba General Hospital. This information is of great interest and can be used to develop strategies to improve care and dietary adherence within the framework of nutritional therapy for these patients.

METHODOLOGY

A quasi-experimental study was conducted with patients treated at the dialysis clinic of the IESS Riobamba General Hospital, from June to December 2023. The participant subjects (87) were selected who met the following inclusion criteria:

a) Patients of both sexes diagnosed with type 2 diabetes b) With diabetic nephropathy c) aged between 40 and 70 years, d) who had been receiving dialysis treatment for a minimum of 2 months, e) who were oriented in time and space, free of cerebrovascular or psychological disease that could compromise their cognitive or thinking abilities and who had the support and backing of their family. Patients who had skipped or shortened a dialysis session in the last 2 weeks were excluded, which could bias the readings of objective markers of non-compliance, and those patients with pathologies such as HIV, cancer, or autoimmune diseases.

The research received approval from the Bioethics Committee and the Research Directorate of the IESS General Hospital in Riobamba, Ecuador, as well as from the Bioethics Committee of the Doctorate in Health Sciences at the Faculty of Medicine of the University of Zulia. The ethical guidelines stipulated in the Declaration of Helsinki were strictly followed. Additionally, informed consent was obtained from all participants involved in the study.

All patients are instructed by qualified personnel on the dietary and fluid restriction guidelines they must follow from the beginning of their hemodialysis therapy. After obtaining informed consent from the subjects selected for this study, data collection began, including the DDFQ questionnaire, which was conducted by interviewing patients during the first 90 minutes of the dialysis session. Various assessments were conducted, including clinical, anthropometric, and dietary evaluations, using specific forms. The information was compiled and recorded in each patient's medical record. Data were collected at four key points during the study: at baseline, at one month, three months, and six months.

Anthropometric assessment was performed by a clinical nutrition specialist and included measurements of weight, height, waist circumference, mid-upper arm circumference, and calf circumference. Patient height was measured with an INBODY wall-mounted stadiometer, ensuring that participants stood upright with their palms next to their legs. Weight was recorded before and after dialysis treatment using a 150-kg OMROM scale. Participants wore light clothing and no shoes, with an allowance of 0.6 kg for the weight of clothing. BMI was calculated by dividing the weight in kilograms by the height in meters squared, applying the Quetelet equation, and interpreted according to the ranges proposed by the WHO.

Blood samples were obtained from each patient after a 12-hour fast to determine biochemical and hematological parameters. A Cobas C501 (Roche Diagnostics Laboratories, USA) was used to assess total cholesterol, triglycerides (TG), HDL cholesterol, LDL cholesterol, glucose, albumin, creatinine, uric acid, sodium, phosphorus, and potassium.

Dietary and fluid intake noncompliance was defined as the degree to which patients' fluid restriction and dietary behaviors did not correspond to prescribed guidelines. The Dialysis Diet and Fluid Non-Adherence Questionnaire (DDFQ) was used to assess dietary adherence. The

DDFQ was designed to assess dietary adherence and fluid restriction behaviors in hemodialysis patients; its reliability has been confirmed for patients undergoing hemodialysis treatment (Vlaminck et al., 2001). This self-report tool measures the frequency of nutritional and fluid deprivation over the past 14 days. It consists of four sections: the first two relate to dietary nonadherence and ask about the frequency and degree of noncompliance with the specified diet; the third and fourth sections assess fluid adherence, asking about the frequency and degree of noncompliance with imposed restrictions.

1.1. How many days during the past 14 days didn't you follow your diet guidelines? ……….

1.2. To what degree did you deviate from your diet guidelines?

No deviation	Mild	Moderate	Severe	Very Severe
0	1	2	3	4

2.1. How many days during the past 14 days didn't you follow your fluid guidelines? ………

2.2. To what degree did you deviate from your fluid guidelines?

No deviation	Mild	Moderate	Severe	Very Severe
0	1	2	3	4

Figure 1. Dialysis Diet and Fluid Non-Adherence Questionnaire (Vlaminck et al., 2001).

The frequency of nonadherence to dietary and fluid guidelines is measured by the number of days of nonadherence a patient experienced in the previous 14 days. The following scale of nonadherence frequency in days was used in this study (0-2; 2-4; 4-6; 6-8 and 8-10 days) (Kugler et al., 2005). The degree of deviation in adherence to dietary guidelines and fluid intake is assessed according to a five-point Likert scale ranging from 0 to 4 (no deviation = 0; mild = 1; moderate = 2; severe = 3; very severe = 4). The higher the score, the greater the patient's nonadherence (Vlaminck et al., 2001).

The values obtained were recorded in a Microsoft Excel spreadsheet. SPSS version 22.0

was used for the analysis. Results are presented as frequencies, percentages, and/or mean ± standard deviation (SD). The Kolmogorov-Smirnov test was applied to determine the distribution of the data, resulting in a normal distribution. Analysis of variance (ANOVA) was used to determine whether there were significant differences in anthropometric and biochemical parameters across the different periods studied. Spearman's correlation coefficient was used to assess the association between the degree of deviation from dietary and fluid intake guidelines and other variables of interest. A *p-value of* less than 0.05 was considered significant.

RESULTS AND DISCUSSION

All patients selected for this study met the inclusion criteria. A total of 87 individuals participated, comprising 47 males (54%) and 40 females (46%). Table 1 presents the different anthropometric parameters examined by gender and across the various periods studied. Waist circumference, arm circumference, and calf circumference values gradually decreased, with statistically significant differences between the two genders.

Women had lower scores on specific anthropometric parameters compared to men, specifically in terms of waist, arm, and calf circumference. In this regard, it is established that there are significant differences in anthropometric characteristics between genders. Men generally have greater muscle mass than women, and this difference is more pronounced in the upper body (Brennan et al., 2024).

Table 2 presents the results obtained for the various metabolic parameters studied by gender and across different periods. In males, significant differences were observed in hemoglobin, creatinine, albumin, phosphorus, and potassium levels. In females, statistically significant differences were observed for uric acid, phosphorus, and potassium, which suggests that these biochemical markers may reflect nutritional adherence. These biochemical changes may also be related to the dietary antioxidant capacity and its influence on redox balance, which is increasingly recognized as relevant in chronic disease management (Forbes-Hernández et al., 2020).

Regarding the different biochemical parameters studied, an ANOVA revealed statistically significant differences in the concentrations of hemoglobin, creatinine, and albumin among males. These three parameters have been associated with a state of nutritional deficiency.

Table 1. Anthropometric parameters according to gender in different periods

Parameters anthropometric	Time (Months)									
	Male (n=47, 54%)					Female (n=40, 46%)				
	Start	1	3	6	p	Start	1	3	6	p
Size (cm)	1.62 ± 0.08	1.62 ± 0.08	1.62 ± 0.08	1.62 ± 0.08	1,000	1.59 ± 0.07	1.59 ± 0.07	1.59 ± 0.07	1.59 ± 0.07	1,000
Pre-dialysis weight (kg)	62 ± 10	61.6 ± 9.9	61.4 ± 10.1	61 ± 10.3	0.415	61 ± 10.6	60.1 ± 10.5	61 ± 10.2	61.6 ± 10.2	0.678
Dry weight (kg)	58.1 ± 9.7	58.04 ± 10.1	58.7 ± 10.1	58 ± 10.2	0.510	56.3 ± 10.6	57.1 ± 11.6	58 ± 11.3	57.1 ± 10.2	0.202
BMI (kg/m^2)	21.85 ± 2.7	21.79 ± 2.2	22.1 ± 2.2	21.8 ± 2.9	0.278	22.13 ± 3.62	22 ± 4.4	22.8 ± 4.0	22.5 ± 3.6	0.292
Waist circumference (cm)	77.8 ± 9.0	77.61 ± 9.7	77 ± 8.5	73 ± 8.4	0.006*	71.3 ± 8.28	71.38 ± 8.14	70.95 ± 8.0	70.53 ± 8.0	0.000*
Circumference of calf (cm)	33.1 ± 2.9	32.9 ± 2.2	31 ± 3.0	31 ± 2.9	0.04*	31.3 ± 3.0	31 ± 3.3	30.5 ± 3.1	30 ± 3.0	0.000*
Arm circumference (cm)	33 ± 2.5	32.7 ± 2.5	32 ± 0.1	31.3 ± 2.9	0.002*	28.5 ± 1.9	28.7 ± 1.9	27.9 ± 1.8	27.5 ± 1.8	0.000*

Data were expressed as mean ± standard deviation. *$p \leq 0.05$.

Table 2. Biochemical parameters according to gender in the different periods

Biochemist parameters	Time (Months)									
	Male (n=47, 54%)					Female (n=40, 46%)				
	Start	1	3	6	p	Start	1	3	6	p
Hemoglobin (g)	13.6±1.7	13.3±1.6	13.4±1.18	12.5±1.9	<0.01*	13±1.8	13±1.7	13.4±1.58	10.5±4.59	NS
Glucose (mg/dL)	177.2±73	168.4±64	170.7±54	156.9±35	NS	163±63	161±60	162.5±44.3	150±24.2	NS
Creatinine (mg/dL)	4.5±1.45	4±1.42	3.8±0.86	3.3±0.66	<0.0001*	3.5±1.48	3.4±1.22	3.5±0.83	3.3±0.69	NS
Uric acid (mg/dL)	5.7±1.70	5.8±1.59	5.3±1.24	5.2±0.86	NS	6.1±1.46	6.0±1.32	5.1±1.12	5.0±0.60	<0.0001*
Cholesterol (mg/dL)	191±43	191.3±46	183±34	186.7±30.1	NS	184.9±40.6	182±13.9	180.3±28.9	188.4±42.2	NS
HDL-c (mg/dL)	45.2±8.05	45.1±8	46.1±6.6	45.3±6.2	NS	46.9±6.8	46.8±6.7	47.1±6.3	47.5±5.3	NS
LDL-c (mg/dL)	118.3±17.2	116.8±18.2	111.9±7.5	109.8±14.9	NS	108.4±15.9	109.5±16.5	105.6±14.9	101.8±12.6	NS
Triglycerides (mg/dL)	152.6±28.8	152±26.57	157.3±24.3	156.6±23.56	NS	152.2±23.4	152.5±22.6	149.8±24.3	147.4±21.51	NS
Albumin (g/dL)	3.4±0.62	3.1±0.52	3.1±0.52	2.9±0.44	<0.0001*	3.0±0.73	3.0±0.58	3.0±0.51	2.8±0.32	<0.0001*
Sodium (mEq/L)	133.9±7.2	130.6±7.9	124.4±8.9	131.7±8.3	NS	133.9±6.69	130.5±8.5	131.4±9.9	132.0±7.56	NS
Phosphorus (mg/dL)	4.0±1.07	4.3±0.83	4.3±0.68	4.5±0.66	0.04*	3.7±1.29	3.6±0.87	3.8±0.78	4.4±0.69	<0.01*
Potassium (mEq/L)	4.5±1.0	4.4±0.97	4.5±0.86	5.0±0.76	0.003*	4.5±0.78	4.1±0.82	4.4±0.76	4.9±0.79	<0.0001*

Data are expressed as mean ± standard deviation. *p ≤ 0.05. NS: not significant.

The hemoglobin concentration in individuals with chronic kidney disease tends to fluctuate frequently above or below recommended levels in short periods. In this study, a decrease in hemoglobin concentration was observed in both sexes by the sixth month, which could be associated with a decline in kidney function, a finding corroborated in previous studies (Qian et al., 2022; Cui et al., 2024).

Serum albumin, on the other hand, is a valuable indicator for assessing visceral protein storage and is often used to determine the risk of malnutrition in patients (Zheng et al., 2019). Although statistically significant differences were observed only in men, a decrease in this parameter was also observed in women towards the sixth month. Although it is not the most sensitive marker for detecting malnutrition, it remains widely used in clinical settings to assess nutritional status (Li et al., 2023).

Serum creatine concentrations also exhibited the same behavior. Previous studies have confirmed that serum creatinine levels are a strong indicator of nutritional status and an important predictor of malnutrition. When renal function in hemodialysis patients is poor or nonexistent, creatinine concentration can serve as an adequate biochemical indicator of muscle mass (Bakkal et al., 2020; Yoshida et al., 2022).

Regarding uric acid, significant differences were observed in females. Uric acid is the end product of purine metabolism, and renal excretion accounts for approximately 70% of its elimination in healthy individuals. Therefore, serum uric acid concentration tends to rise with the progression of chronic kidney disease (Park et al., 2017).

Furthermore, the use of serum phosphorus and potassium concentrations as key biochemical criteria for assessing non-adherence to diet and fluids has been documented (Iborra et al., 2012; St.-Jules et al., 2018; Bakkal et al., 2020). The concentrations of these two analytes progressively increased, showing statistically significant differences in both sexes.

Tables 3 and 4 present the results of adherence to the diet and fluid guidelines, respectively, as determined by the application of the DDFQ questionnaire. Regarding the dietary guidelines, 4.31% of the subjects reported noncompliance for 0 to 2 days; 37.65% reported an average of 2 to 4 days of noncompliance, while 44.82% indicated noncompliance for 4 to 6 days, and 13.2% reported noncompliance for 6 to 8 days.

Table 3. Days and degree of non-compliance with the diet according to the DDFQ questionnaire

Days of non-compliance during the last two weeks	Time (Months)				Average (%)
	Start N (%)	1 N (%)	3 N (%)	6 N (%)	
0-2	1 (1.15)	9 (10,34)	4 (4.60)	1 (1.15)	4.31
2-4	37 (42.53)	33 (37.94)	28 (32,18)	33 (37.93)	37.65
4-6	39 (44.83)	36 (41,38)	44 (50.57)	37 (42.53)	44.82
6-8	10 (11.49)	9 (10,34)	11 (12.64)	16 (18.39)	13.2
Degree of dietary deviation					
No deviation	0	0	0	0	0
Mild	7(8.05)	15(17,24)	19(21,84)	10(11.50)	14.66
Moderate	45(51,72)	40(45.98)	44(50,57)	38(43,68)	47.99
Severe	29(33,33)	28(32,18)	23(26,44)	38(43,68)	33.91
Very severe	6(6,90)	3(3,45)	1(1,15)	1(1,15)	3.16

On the other hand, the majority of the subjects studied (47.99%) reported a moderate degree of deviation, followed by 33.91% who reported a severe degree of deviation. Regarding the fluid restriction guidelines, 9.49% of subjects reported noncompliance between 0 and 2 days, while 44.25% reported an average of 2 to 4 days of noncompliance. 38.22% reported noncompliance between 4 and 6 days, and 8.05% reported noncompliance between 6 and 8 days. Concerning the degree of deviation, the majority of the subjects studied (43.97%) reported a moderate degree of deviation, followed by 31.32% who reported a severe degree of deviation (Table 4).

Table 4. Days and degree of non-compliance with the fluid regimen according to the DDFQ questionnaire

Days of non-compliance with the fluid regimen	Time (Months)				Average (%)
	Start N (%)	1 N (%)	3 N (%)	6 N (%)	
0-2	0	5 (5.75)	5 (5.75)	23 (26.44)	9.49
2-4	41 (47.12)	34 (39.08)	27 (31.03)	52 (59.77)	44.25
4-6	33 (37.94)	40 (45.98)	48 (55.17)	12 (13.79)	38.22
6-8	13 (14.94)	8 (9,20)	7 (8.05)	0	8.05
Degree of deviation from the fluid pattern					
No deviation	0	0	0	0	0
Mild	4 (4.60)	3 (3.45)	17 (19.54)	47 (54.02)	20.40
Moderate	52 (59.77)	35 (40.23)	34 (39.08)	32 (36.78)	43.97
Severe	30 (34.48)	37 (42.53)	34 (39.08)	8 (9,20)	31,32
Very severe	1 (1.15)	12 (13.79)	2 (2.30)	0	4.31

Dietary adherence and fluid restriction are important and vital factors for dialysis patients, essential for their survival and well-being. In the present study, the highest percentage of patients (44.82%) reported a frequency of dietary noncompliance ranging from 4 to 6 days per week. Meanwhile, 44.25% of the subjects reported noncompliance with fluid intake restrictions for between 2 and 4 days. Other researchers have reported a mean frequency of noncompliance of 5.24 days for diet and fluid intake (De las Heras-Mayoral & Martínez-Rincón, 2015; Jampour et al., 2018).

The application of the DDFQ questionnaire showed that more than half of the patients presented difficulties in following (frequency) their diet and fluid guidelines. Previous systematic reviews have emphasized the strong interrelation between nutritional status and quality of life in older adults, underscoring the need for individualized nutritional interventions (Angulo et al., 2024). At the same time, approximately 50% reported a moderate degree of deviation and approximately 30% a severe degree of deviation in compliance with the dietary and fluid restriction guidelines. These findings differ from those reported by Iborra et al. (2012), who found 73% adherence to fluid restriction in a sample of 146 patients undergoing hemodialysis. They are also closer to other studies that report noncompliance rates of 81.4% with the diet and 74.6% with fluid restriction (García Valderrama et al., 2002; Beerendrakumar et al., 2018).

Tables 5 and 6 present the results obtained by correlating the biochemical parameters that showed statistically significant differences: BMI and the degree of deviation from the dietary and fluid guidelines, respectively. A significant positive correlation was observed between creatinine, potassium, phosphorus, and albumin concentrations and the degree of dietary noncompliance at the study's initiation. Likewise, a significant positive correlation was observed between phosphorus concentration and the degree of deviation one month after the study began (Table 5).

On the other hand, Table 6 presents the results of the correlations between biochemical parameters, BMI, and degree of deviation from the fluid pattern, showing that no statistically significant associations were found. In this study, correlation analyses were performed to investigate the relationship between nutritional status and various biochemical parameters, as well as the degree of deviation from dietary and fluid guidelines. Significant correlations were observed between albumin, creatinine, phosphorus, and potassium concentrations and the degree of dietary deviation in the total subjects studied at baseline. Patients with the highest degree of dietary deviation had higher concentrations of phosphorus and potassium. These results align with those reported in other studies (Vlaminck et al., 2001; Kugler et al., 2005; De las Heras-Mayoral & Martínez-Rincón, 2015).

Table 5. Correlation analysis between the degree of deviation from the guidelines and the BMI and biochemical parameters in different periods

Parameters	Time (Months)							
	Start		1		3		6	
	Spearman (r)	*p*	Spearman (r)	*p*	Spearman (r)	*p*	Spearman (r)	*p*
Degree of dietary deviation *versus*								
Hemoglobin	0.098	NS	0.057	NS	-0.064	NS	-0.135	NS
Creatinine	0.336	*0.0007	-0.025	NS	0.000	NS	-0.023	NS
Albumin	0.218	*0.03	0.068	NS	0.019	NS	0.034	NS
Phosphorus	0.726	*<0.0001	0.318	*0.007	0.029	NS	0.019	NS
Potassium	0.428	*0.0001	-0.029	NS	0.648	NS	0.098	NS
BMI	0.163	NS	0.038	NS	-0.017	NS	0.089	NS

Spearman correlation test. *p ≤ 0.05; NS: not significant; BMI: body mass index.

Table 6. Correlation analysis between the degree of deviation from fluid guidelines versus BMI and biochemical parameters in different periods

Parameters	Time (Months)							
	Start		1		3		6	
	Spearman (r)	*p*	Spearman (r)	*p*	Spearman (r)	*P*	Spearman (r)	*p*
Degree of deviation from the fluid pattern *versus*								
Hemoglobin	-0.023	NS	0.020	NS	-0.021	NS	0.119	NS
Creatinine	-0.041	NS	0.114	NS	-0.038	NS	-0.221	NS
Albumin	-0.068	NS	-0.132	NS	0.069	NS	0.025	NS
Phosphorus	0.002	NS	0.021	NS	0.114	NS	0.039	NS
Potassium	0.065	NS	-0.176	NS	0.018	NS	0.012	NS
BMI	0.018	NS	-0.024	NS	0.029	NS	0.020	NS

Spearman correlation test. *p ≤ 0.05; NS: not significant; BMI: body mass index.

However, they differ from those reported by other researchers, who have found a lack of relationship between dietary adherence and objective measures of non-adherence, such as potassium and phosphate levels (Contreras et al., 2008). No significant associations were found between the degree of deviation from fluid restrictions and nutritional status, as well as biochemical parameters.

The level of knowledge that patients must have regarding dietary guidelines and fluid restrictions is crucial. In this context, the application of repetitive and planned training programs to hemodialysis patients has been shown to increase their adherence to dietary and fluid restrictions. Previous studies have evaluated the effect of a three-session training session delivered by specialized nurses to hemodialysis patients on their therapeutic regimen, showing that patient adherence to dietary regimens increased after the training (Nadri et al., 2020).

Conclusions

This study yielded two important conclusions: (1) the lack of adherence to dietary restrictions and fluids in the majority of Ecuadorian patients with type 2 diabetes receiving hemodialysis evaluated in this study; (2) the existence of a significant correlation between the degree of deviation from dietary guidelines measured by the application of the DDFQ questionnaire and objective biochemical markers such as phosphorus, potassium and albumin, suggests that the DDFQ can be used as a self-reported measure and allows to assume a close relationship between the recommended treatment and the desired results. Considering that hemodialysis is performed over a long period, it is essential to review patient education regarding the prescribed guidelines for their diet and fluid intake, which guide their needs. In this regard, it is crucial to highlight the importance of training and supporting nursing professionals and nutritionists in the field of nephrology. This can be achieved through the use of simple tools that allow them to identify potential noncompliance and take action to provide more effective dietary education to these patients.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Author contributions

Conceptualization: Patricio Salazar and Hazel Anderson. **Data curation:** Patricio Salazar and Hazel Anderson. **Formal analysis:** Patricio Salazar and Hazel Anderson. **Investigation:** Patricio Salazar and Hazel Anderson. **Methodology:** Patricio Salazar and Hazel Anderson. **Writing – original draft:** Patricio Salazar and Hazel Anderson. **Writing – review & editing:** Patricio Salazar and Hazel Anderson.

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