Evaluation of Nutritional Biochemical Parameters in Haemodialysis Patients over a Ten-year Period

AIQ Alfonso, RF Castillo, FJ Gomez Jimenez, AM Nuñez Negrillo

ABSTRACT

Aim: *Protein-energy malnutrition as well as systemic inflammation and metabolic disorders are common in patients with chronic kidney failure who require renal replacement therapy (haemodialysis). Such malnutrition is a factor that significantly contributes to their morbidity and mortality. This study evaluated the nutritional status of haemodialysis patients by assessing biochemical and anthropometric parameters in order to determine whether these patients suffered disorders reflecting nutritional deterioration directly related to time on haemodialysis.*

Subjects and Method: *This research comprised 90 patients of both genders with chronic kidney failure, who regularly received haemodialysis at our unit over a period of ten years. The patients' blood was tested quarterly for plasma albumin, total cholesterol and total proteins, and tested monthly for transferrin. The patients' weight, height and body mass index (BMI) were monitored. Body mass index was calculated using the formula: weight (kg)/height (m^2) and classified in one of the following categories defined in the World Health Organization (WHO) Global Database on Body Mass Index: (i) underweight [BMI < 18.50], (ii) normal [BMI 18.50 – 24.99], (iii) overweight [BMI 25 – 29.99], (iv) obese [BMI ≥ 30].*

Results: *In the ten-year period of the study, the patients experienced a substantial decline in their biochemical parameters. Nevertheless, their BMI did not show any significant changes despite the patients' state of malnutrition.*

Conclusions: *The prevalence of malnutrition in haemodialysis patients was evident. Nevertheless, the BMI of the subjects did not correspond to the biochemical parameters measured. Consequently, the results showed that the nutritional deterioration of these patients was mainly reflected in their biochemical parameters rather than in their anthropometric measurements.*

Keywords: Anthropometry, body mass index, haemodialysis, kidney disease, nutrition

Evaluación de Parámetros Bioquímicos Nutricionales en Pacientes de Hemodiálisis durante un Período de Diez Años

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RESUMEN

Objetivo: *La desnutrición es un trastorno frecuente entre los pacientes con insuficiencia renal crónica (IRC) y tratamiento en hemodiálisis), este hecho contribuye a un aumento en la morbimortalidad de estos pacientes. El objetivo de este trabajo fue evaluar parámetros bioquímicos nutricionales y parámetros antropométricos para determinar el estado nutricional de estos pacientes.*

Sujetos y Método: *Este estudio ha valorado a 90 pacientes de ambos sexos con insuficiencia renal crónica que realizaban hemodiálisis periódicamente en el hospital durante diez años. A todos los pacientes se le realizaron mediciones trimestrales de albúmina plasmática (Alb), colesterol total (CT), proteínas totales (PT) y mensuales de transferrina (Tr), y se les efectuaron mediciones antropométricas de peso, altura e índice de masa corporal calculado mediante la formula peso/talla^2, y agrupada según la clasificación de la OMS en IMC < 18.50 infrapeso, 18.50 a 24,99 normal, 1.25 a 29,99 sobrepeso y > 30 del IMC s/OMS.*

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Resultados: *Durante 10 años de dialisis todos los pacientes presentaron un importante descenso de los parámetros bioquímicos, en cambio el IMC no presentó cambios significativos en relación a la desnutrición.*
Conclusiones: *La desnutrición de los pacientes en diálisis es un hecho patente, el IMC no se corresponde con lo parámetros bioquímicos observados, por lo que el deterioro nutricional de estos pacientes se manifiesta principalmente mediante los parámetros bioquímicos estudiados.*

Palabras clave: Indice de masa corporal, hemodiálisis, nutrición, antropometria, enfermedad renal crónica

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INTRODUCTION

Protein-energy malnutrition affects a high percentage of patients with chronic kidney failure and is associated with increased morbidity and mortality rates. Factors that directly contribute to malnutrition in these patients are mainly alterations in protein-energy metabolism, hormonal derangements, infections, and a reduction in food ingestion because of anorexia, nausea and vomiting produced by uraemic toxicity. After beginning renal replacement therapy, patients usually find that most of the evident symptoms of uraemia abate or disappear altogether. As a result, their appetite improves and they begin to feel better. However, various studies show that the prevalence of protein-energy malnutrition in haemodialysis patients still remains high. In fact, 23−76% of patients undergoing haemodialysis generally suffer from malnutrition (1−3).

In recent years, research on haemodialysis patients has pinpointed an association between signs of malnutrition, particularly a decrease in plasma albumin and an increase in morbidity and mortality (4, 5). Moreover, predictors of the low survival of these patients include atherosclerosis (aggravated by high blood pressure and smoking), oxidative stress, inflammation and malnutrition (6, 7), combined with a low body mass index (BMI), altered lipoprotein profiles and high low-density lipoprotein (LDL) levels (8−11).

The objective of this research study was to assess the nutritional state of the patients at a haemodialysis unit by evaluating biochemical parameters (total proteins, albumin, cholesterol and plasma transferrin) and anthropometric parameters of weight, height and BMI. The patients were monitored over a period of ten years in order to determine whether they suffered disorders that could be caused by a state of malnutrition directly related to the length of the haemodialysis treatment.

SUBJECTS AND METHODS

The sample comprised 90 patients of both genders with chronic kidney failure who regularly received haemodialysis at the haemodialysis unit at the Virgen de las Nieves University Hospital in Granada (Spain). The subjects were not randomly selected and their participation in the study was determined by the fact that they were being treated at the unit from January 2002 until January 2013, the time period in which the research study was carried out. The patients (47 males and 43 females) ranged in age from 32 to 83 years. The average time that they received haemodialysis was 10.5 ± 5.2 years. Table 1 shows the aetiology of the kidney disease of the subjects.

Table 1: Causes of chronic kidney disease in the study population

Causes	%
Unknown	17.8
Diabetes	17.8
Interstitial	15.1
Glomerular	20.5
Vascular	15.1
Polycystic	9.6
Nephroangioesclerosis	2.7
Lupus	1.4

Every three months, the patients' blood was tested for levels of plasma albumin (Alb), total cholesterol (TC) and total proteins (TP), and monthly for transferrin (Tr). Blood samples were obtained directly from the vascular access for haemodialysis before beginning the actual treatment and before administering heparin. Also measured were the patients' weight and height with a scale/stadiometer (Perperson 113481). Weight was measured in kilograms and height in centimetres. Body mass index was calculated with the weight (kg)/height (m^2) formula and classified in one of the following categories defined in the World Health Organization (WHO) Global Database on Body Mass Index: (i) underweight [BMI < 18.50], (ii) normal [BMI 18.50 − 24.99], (iii) overweight [BMI 25 – 29.99], (iv) obese [BMI ≥ 30].

Statistical analysis

The SPSS 15.0.1 software package was used for the statistical analysis. The evaluation of significant differences between BMI, biochemical parameters and years was performed with an analysis of variance (ANOVA). All data are expressed as a mean value ± standard deviation (X ± SD), based on a statistical significance of $p < 0.05$.

RESULTS

The mean levels of total proteins progressively declined from the first to the fourth year of the study. However, over the ten-year period, levels were generally erratic, with an overall tendency to decrease (Fig. 1).

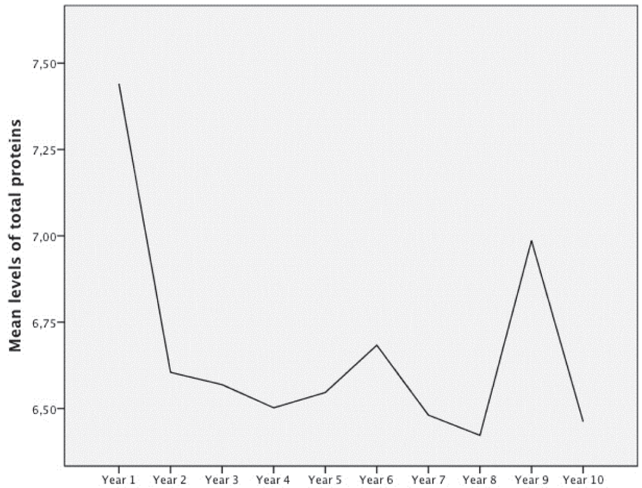

Fig. 1: Evolution of total proteins in the sample population over a period of ten years.

As established by our laboratory, reference values of the total plasma protein levels ranged from a minimum of 6 g/dL, to a maximum of 8.3 g/dL. In the first year of the study, there were no values lower than 6 g/dL. However, in the second year, 19.4% corresponded to values lower than 6 g/dL and in the third year, 12.9%. This percentage continued to decrease until the fifth year. It then began to progressively rise until the tenth year when it reached 11%. This is significant since none of the patients in the study had plasma protein levels higher than the laboratory reference values.

As shown in Fig. 2, mean levels of serum albumin also declined substantially during the ten-year period of the study. In the first year, there were no values lower than normal (3.4−5.4 g/dL). However, from the second to the tenth year, the percentage of values lower than the minimum reference value increased to 20%. None of the patients showed levels of serum albumin higher than the laboratory reference values.

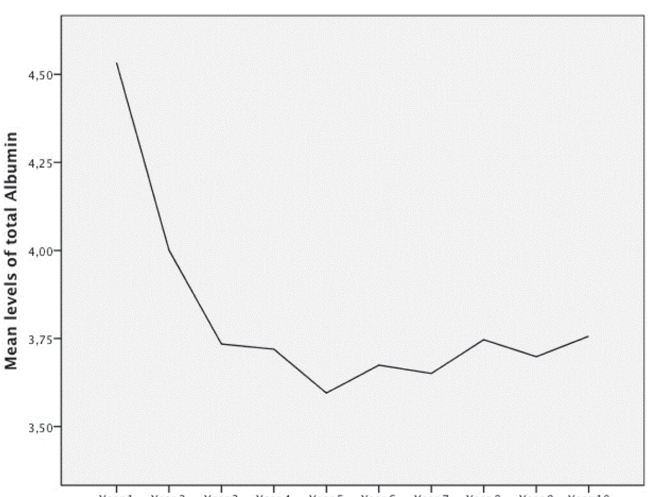

Fig. 2: Evolution of albumin in the sample population over a period of ten years.

There was also a decline in the levels of total cholesterol from the first to the tenth year of the study (Fig. 3). More specifically, in the first year, 29.8% had lower than the minimum reference value (150 mg/dL). In subsequent years, this percentage gradually increased until it reached 71% at the end of the study. The values obtained ranged from 79 mg/dL to 305 mg/dL. In this regard, there were no total cholesterol levels higher than the laboratory reference values (200−240 mg/dL).

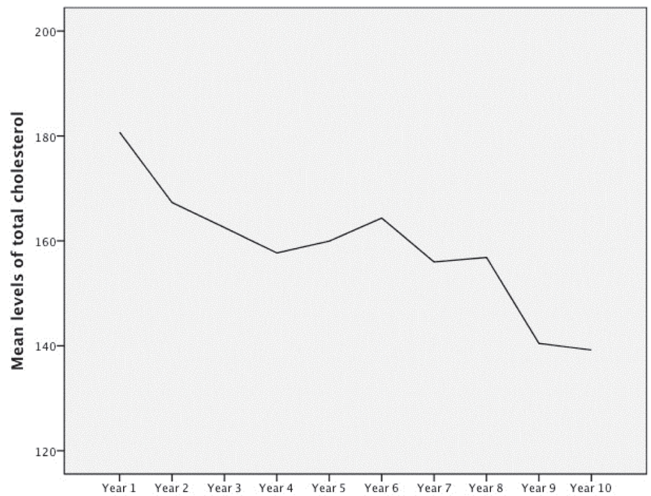

Fig. 3: Evolution of total cholesterol in the sample population over a period of ten years.

As part of the study, a total of 1950 measurements of plasma transferrin were performed (normal reference values: 200−405 mg/dL). The results showed a decline in the transferrin value throughout the ten-year period (Fig. 4).

In the first year, there were no plasma transferrin values lower than the minimum reference value. In the second year, the percentage was 3.3%. Subsequently, the percentage began to steadily increase to 88.8% in the seventh year, after which it decreased to 71.7% at the end of the study.

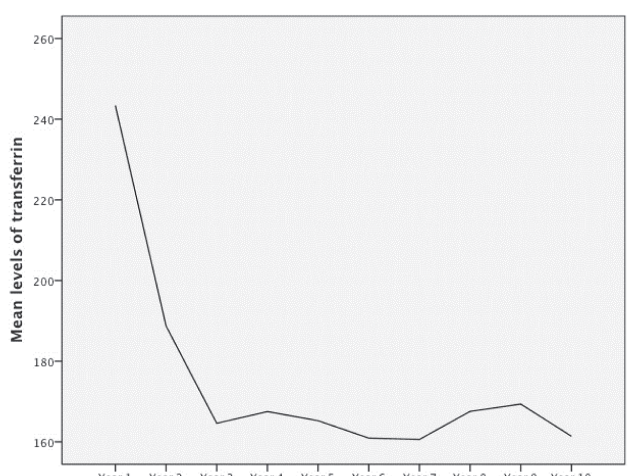

Fig. 4: Evolution of transferrin in the sample population over a period of ten years.

When the mean BMI values for the ten years of the study were compared, they showed no statistically significant differences ($p < 0.605$). Nonetheless, as can be observed, at the beginning of the study, all of the patients were moderately overweight (Table 2).

Table 2: Evolution of the mean annual values of the body mass index in the sample population

Year	Mean	Std deviation	Minimum	Maximum
1º	25.60	3.82	18.2	31.6
2º	25.01	3.62	17.2	31.4
3º	25.37	3.46	18.2	37.8
4º	25.04	3.94	16.3	37.6
5º	25.16	4.04	16.1	37.2
6º	25.37	4.29	17.9	35.6
7º	25.05	4.48	16.1	35.6
8º	24.51	4.73	17.2	39.3
9º	24.49	4.86	16.5	40.6
10º	25.31	5.16	18.2	40.8

As reflected in the mean BMI values classified according to the WHO criteria, each year the percentage of overweight patients became lower. This produced a progressive increase in the percentage of normal weight subjects and to a lesser degree, an increase in the percentage of obese subjects (Table 3).

In regards to the evaluation of the different biochemical parameters used to assess the nutritional status of the patients in the study, it was found that total protein levels were significantly related to the risk of death (21). In addition, there was a correlation between the levels of total plasma proteins and serum albumin. This signifies that both parameters can be used in the assessment of the patients' nutritional status since they are indicators of the visceral protein mass (22, 23).

The results of this study showed that the patients experienced a progressive decline in the mean yearly values of total proteins and serum albumin. During the ten-year period, these values significantly decreased, though the reduction in protein levels was less accentuated than the albumin levels. Serum albumin is an important nutritional marker that is used to identify malnutrition in patients with chronic kidney disease. Accordingly, various studies affirm that serum albumin levels lower than 3.5 g/dL are an important predictor for the mortality and hospitalization rate of haemodialysis patients, mainly because of cardiovascular problems (24).

In the ten-year period of this study, the mean cholesterol values also declined significantly. As specified in the European and American guidelines and the HEMO study (25), total cholesterol levels lower than 150 mg/dL were regarded as an indicator of malnutrition. Since haemodialysis patents tend to be hypocholesterolaemic, it was not surprising that the results of our study reflected low levels of total cholesterol, which is in consonance with the results of previous research (26, 27). This signifies that the patients' lipid level was indicative of nutritional deterioration.

Table 3: Evolution of the mean annual values of the body mass index (BMI) categories in the sample population

BMI	Year 1º	2º	3º	4º	5º	6º	7º	8º	9º	10º
< 18.5 Underweight	14.3%	14.6%	5.5%	9.2%	10.5%	8.7%	14.8%	12.3%	19.4%	12.9%
18.5 < 25 Normal	26.2%	37.1%	50.5%	46.8%	44.7%	46.4%	40%	58%	43.8%	48.4%
≥ 25–30 Overweight	54.8%	47.2%	34.9%	35.5%	31.6%	24.6%	27.8%	18.5%	25%	25.8%
≥ 30 Obese	4.8%	5.6%	9.2%	8.5%	13.2%	20.3%	17.4%	11.1%	11.8%	12.9%

DISCUSSION

The nutritional status of haemodialysis patents has always been difficult to evaluate because of the lack of criteria that can be used to identify a state of protein-energy malnutrition (12, 13). This type of malnutrition, which is common in haemodialysis patients, is characterized by a decrease in proteins and fats in the body. It has numerous causes since haemodialysis produces a loss of nutrients through the haemodialysis liquid as well as a decrease in protein synthesis during the treatment (14−16). However, it is also true that haemodialysis substantially improves these parameters at the beginning of the treatment when there is a rise in serum albumin, pre-albumin, acute phase reactants and serum creatinine levels (17, 18). This initially enhances the patients' appetite and improves their nutritional status. However, when patients continue to undergo haemodialysis over a longer period of time, there is an increased risk of malnutrition because of the loss of appetite stemming from uraemia and the haemodialysis technique (19, 20).

In this sense, patients with chronic kidney disease suffer from acute lipoprotein disorders from the earliest stages of the disease. The most common of these disorders is the association of hypertriglyceridaemia and low high-density lipoprotein [HDL] (28). The lipid profile in haemodialysis patients is very complex because of the fact that malnutrition and inflammation in this group can be determining factors in low total cholesterol and LDL values.

During the ten years of the study, there was also a significant decline in the patients' transferrin levels, which were considerably lower than those of healthy people. Serum transferrin levels are affected by nutritional factors (in the same way as serum albumin levels during a stress response) and also by iron metabolism (29). The shorter half-life of transferrin gives it a theoretical advantage over albumin as a nutrition marker, though both serum transferrin and albumin levels correlate with the risk of morbidity and mortality in haemodialysis patients (30).

CONCLUSIONS

This study showed that haemodialysis patients experienced a significant reduction in their nutritional biochemical parameters, namely, total proteins, albumin, total cholesterol and transferrin. This reflects the nutritional deterioration of these patients and highlights the need to seriously address and monitor their nutrition from the very beginning of the haemodialysis programme as an integral part of the therapy. Also striking was the prevalence of low values for biochemical markers. Cholesterol and transferrin levels reflected the most dramatic alterations year after year since they were found to be most sensitive to the nutritional changes suffered by the patients in our study.

As can be observed, the BMI of the subjects did not correspond to the biochemical parameters observed. Consequently, the results showed that the nutritional deterioration of haemodialysis patients was mainly reflected in their biochemical parameters rather than in their anthropometric measurements.

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