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Overweight Rather Than Malnutrition Is Widely Prevalent in Peritoneal Dialysis Patients

Ana P. Bernardo,[1] Isabel Fonseca,[2] Anabela Rodrigues,[2] Maria J. Carvalho,[2] António Cabrita[2]

Peritoneal dialysis (PD) patients seem to maintain a better nutrition status than do hemodialysis patients, and some develop overweight. The clinical relevance of overweight in PD is uncertain. We assessed nutrition status and evaluated the prevalence of overweight in PD patients, and we explored the association of overweight with demographic, clinical, and dialysis factors.

The study group included 57 patients (31.5% men; 12.3% with diabetes; mean age: 49.5 ± 14.9 years) on PD for 2.9 ± 2.7 years. Nutrition status was assessed by subjective global assessment (SGA), body mass index (BMI), and a nutrition status score (NSS) based on biochemical and anthropometric measurements.

*By SGA, 70.2% of patients were classified as having a normal nutrition status; none had severe malnutrition. Based on the NSS, only 4 patients were identified as mildly-to-moderately malnourished. By BMI, 50.9% of the patients were overweight (BMI ≥ 25 kg/m^2). No relationship was found for BMI or NSS with dialysis time, Kt/V, residual renal function, or peritoneal transport. Similar results were obtained considering only overweight patients. Overweight patients had higher levels of serum albumin (*p *= 0.014), homocysteine (*p *= 0.003), and total–to–high-density lipoprotein cholesterol ratio (*p *= 0.048).*

Instead of malnutrition, overweight was highly prevalent in our PD patients. Overweight was not associated with demographic- or modality-related factors, nor with fast transport or markers of systemic inflammation.

Key words
Nutrition status, overweight

From: [1]Nephrology Department, Hospital Amato Lusitano, Castelo Branco, and [2]Nephrology Department, Centro Hospitalar do Porto, Porto, Portugal.

Introduction

Malnutrition is common among patients with end-stage renal disease (ESRD), and it undoubtedly contributes to morbidity and mortality. An assessment of nutrition status should be part of routine care in dialysis patients, but may be particularly challenging in this population. Standard parameters of nutrition assessment are often invalid in ESRD, which leads to difficulty in identifying and assessing nutrition status (1).

In ESRD, the nutrition profile is quite different by dialysis modality. In fact, although malnutrition is common in hemodialysis patients, recent studies have demonstrated that some peritoneal dialysis (PD) patients maintain good nutrition status, and some develop overweight or obesity, depending on the assessment method used (1).

Many methods have been used to assess nutrition status in patients on dialysis. No single marker of nutrition has been judged the best to evaluate these patients. Several parameters should therefore be evaluated together, including assessment of body composition, history of weight loss, estimation of dietary protein intake, and some evaluation of protein stores. Subjective global assessment (SGA) is a useful instrument that gives a global score of protein–energy nutrition status. Anthropometry quantifies subcutaneous fat mass and muscle mass, providing reliable information about nutrition status. Finally, several biochemical markers (serum albumin, prealbumin, and transferrin) have been used to evaluate visceral protein stores and nutrition status. Of these biochemical markers, serum albumin has so far been the one most commonly used to assess malnutrition, and hypoalbuminemia has sometimes been used—often erroneously, because confounding non nutrition factors influence its serum levels—to diagnose malnutrition (1,2).

Body mass index (BMI) is used both as a measure of obesity and of malnutrition. Low BMI is well known to be strongly associated with worse outcome in hemodialysis patients, because it reflects a poor nutrition status, which in turn is one of the major determinants of survival in that population (3). By contrast, patients who are obese seem to have a survival advantage (4). Most, but not all, studies show a similar survival benefit for patients on PD (4,5). Although this research places obesity in the dialysis population in a new light, it might be that for the individual patient on PD, obesity may still be considered a clinical menace because of cardiovascular morbidity and mortality. In the general population, dyslipidemia associated with obesity is one of the central features contributing to the increased cardiovascular risk in obese patients. There are no reports about the relevance of lipid profile in overweight and obese PD patients.

In the present study, we evaluated nutrition status and prevalence of overweight in PD patients. We also explored the relationship between overweight and demographic, clinical, and dialysis modality factors.

Patients and methods

All stable patients who were being treated in our PD unit and who had been on PD for a minimum of 3 months were eligible for inclusion in this cross-sectional study. We enrolled 57 PD patients.

Nutrition assessment

Nutrition status was assessed by SGA and BMI, and by a nutrition status score (NSS) based on biochemical and anthropometric measurements.

The SGA was performed by a single trained observer who was blinded for the biochemical results of the patients. In brief, SGA is based on a history of weight change, appetite, and gastrointestinal symptoms, and a physical examination of body fat and muscles. The four-item 7-point system was used (6,7). An SGA score of 6 – 7 indicates a well-nourished individual (“A”); 3 – 5, a mildly-to-moderately malnourished individual (“B”); and 1 – 2, a severely malnourished individual (“C”).

Height was measured, body dry weight was determined, and BMI (kilograms per square meter) was calculated. Underweight was defined as a BMI below 18.5 kg/m^2, overweight was defined as a BMI in the range 25 – 30 kg/m^2, and obesity was defined as a BMI above 30 kg/m^2.

Anthropometric measurements were made on biceps, triceps, and subscapular skinfold thickness by a single observer, immediately after peritoneal dialysate drainage, using a conventional Harpenden skinfold caliper. Each measurement was repeated three times, and the average result was registered. Mid-arm circumference (MAC) was also measured, and mid-arm muscle circumference (MAMC) was calculated using the formula

$$\text{MAMC (mm)} = \text{MAC (mm)} - 3.14 \times \text{Triceps Skinfold (mm)}. \quad [1]$$

Body density was calculated based on the sum of skinfold thickness values, using the equations of Durnin and Womersley (8). Fat mass and lean body mass were obtained from calculated body density and body weight.

Nutrition status was also assessed by a NSS that consisted of eight components: BMI, percentage of ideal body weight (calculated according to Butheau and Metropolitan Life Insurance Company formulas), triceps and subscapular skinfold thickness, MAMC, serum albumin, total lymphocyte count, and subjective physical examination. Skinfold measurements and MAMC were compared with the 50th percentile for the appropriate age and sex and are expressed as a percentage (9). Each component of the NSS has a score from 3 (normal) to 6 (very severe). Thus, a score of 28 or lower denotes a normal nutrition status; higher scores are indicators of malnutrition (mild, moderate, or severe) as described in Table I.

Laboratory investigations

A fasting venous blood sample was taken before the morning exchange. Laboratory blood investigations included hemoglobin; serum albumin and prealbumin; transferrin; total, high-density lipoprotein (HDL), and low-density lipoprotein cholesterol; triglycerides; homocysteine; and C-reactive protein (CRP). All biochemical tests were performed in our hospital laboratory.

Dialysis adequacy, urea kinetics, and estimation of dietary protein intake

Adequacy of dialysis was calculated from a 24-hour urine and dialysate collection. Weekly Kt/V and creatinine clearance (CCr) were determined using standard methods (10). Residual glomerular filtration rate was calculated as the average of 24-hour

TABLE I Nutrition status score, based on biochemical and anthropometric measurements

Measure	Normal nutrition	Malnutrition Mild	Moderate	Severe
Body mass index (kg/m^2)	≥18.5	17.5–18.4	16.5–17.4	<16.5
Percentage of ideal body weight	≥90	80–89	60–79	<60
Triceps skinfold thickness (%)[a]	≥90	80–89	60–79	<60
Subscapular skinfold thickness (%)[a]	≥90	80–89	60–79	<60
Mid-arm muscle circumference (%)[a]	≥90	80–89	60–79	<60
Serum albumin (g/dL)	≥3.5	3.0–3.4	2.5–2.9	<2.5
Total lymphocyte count (*n*/μL)	≥1500	1200–1499	900–1199	<900
Physical exam (subjective)	Normal	Mild depletion	Moderate depletion	Severe depletion
Score	3	4	5	6
Overall score	≤28	29–32	33–35	>35

[a] Measurements of triceps and subscapular skinfold thicknesses and of MAMC were compared with percentile 50 for the same age and sex (9). The result was then expressed as a percentage.

urinary urea and CCr, as described elsewhere (11). Peritoneal membrane transport was calculated from a 4-hour peritoneal equilibration test (12).

Dietary protein intake was estimated from the protein equivalent of nitrogen appearance (PNA), using the PD Adequest software (Baxter Healthcare Corporation, Deerfield, IL, U.S.A.). This PNA was normalized for actual body weight to obtain the nPNA (grams per kilogram of body weight in 24 hours).

Statistical analysis

Data are expressed as mean ± standard deviation for continuous variables (or as otherwise stated) and as proportions for categorical variables. Normality of data was assessed using the Kolmogorov–Smirnov test. The independent Student *t*-test was used to ascertain differences between groups, and because CRP is not a normally-distributed variable, it was analyzed based on log-transformed CRP values. For categorical variables, differences were determined using the chi-square test. Correlations between variables were established using Pearson correlation coefficient or the Spearman rank test for small groups. A 0.05 level of significance was used in all statistical analyses, which were conducted using SPSS, version 15.0 (SPSS, Chicago, IL, U.S.A.).

Results

The study enrolled and evaluated 57 PD patients (20 men, 37 women; mean age: 49.5 ± 14.9 years). These patients had been on PD for 2.9 ± 2.7 years (range: 0.2 – 17.4 years), with 28 of the patients (49.1%) being treated with continuous ambulatory PD (CAPD) and 29 (50.9%) being treated with automated PD (APD) using a cycler. Of these patients, only 7 (12.3%) had diabetes.

The mean BMI in these patients was 24.9 ± 4.1 kg/m^2, with 26 (45.6%) being of normal weight, 25 (43.9%) being overweight, 4 (7%) being obese, and only 2 (3.5%) being underweight. Anthropometry results, classified according to sex and age, ranged across all percentiles. Table II summarizes the results. Analyzing the SGA, 40 patients (70.2%) scored an overall "A," indicating that they were well nourished. The remaining 17 patients (29.8%) scored an overall "B," indicating that they were mildly-to-moderately malnourished. No patient fell into the severely malnourished "C" category. According to the NSS, only 4 patients were identified as mildly-to-moderately malnourished.

No correlation was found for either the NSS or the BMI with time on dialysis, Kt/V, residual renal function, or peritoneal transport. Similar results were obtained considering only patients with a BMI of 25 kg/m^2 or more.

Considering BMI classification, and after excluding the 2 underweight patients, we divided the 55 remaining subjects into a "normal weight" group (n = 26) and an "overweight" group (patients with a BMI of 25 kg/m^2 or more, n = 29). No significant differences were found between the two groups in relation to age, PD duration, or PD modality. Table III shows the comparisons between the groups.

Overweight patients had higher levels of serum albumin (4.0 ± 0.4 g/dL vs. 3.7 ± 0.4 g/dL, p = 0.014), and were more frequently scored "A" than

TABLE II Skinfold thickness measurements

	Percentile[a]											
	<5		5–15		16–25		26–50		50–75		>75	
	(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*
Triceps skinfold thickness	6	10.5	7	12.3	7	12.3	19	33.3	9	15.8	9	15.8
Mid-arm muscle circumference	7	12.3	4	7.3	6	10.5	14	24.6	13	22.8	13	22.8

[a] According to Frisancho (9).

TABLE III Comparison of demographic, biochemical, and dialysis parameters between normal weight and overweight peritoneal dialysis patients

Variable	*Normal weight (n=26)*	*Overweight (n=29)*	p *Value*[a]
Automated peritoneal dialysis (%)	53.8	48.3	0.89
Subjective global assessment score "A" (%)	53.8	89.7	0.007[b]
Age (years)	49.2±14.9	51.5±14.1	0.56
Time on peritoneal dialysis (years)	2.5±1.7	3.2±3.4	0.31
D/P creatinine (by 3.86% PET)	0.76±0.13	0.75±0.18	0.76
Kt/V	2.2±0.96	2.3±0.5	0.65
Residual renal function (mL/min/1.73 m^3)	2.3±3.4	3.8±3.6	0.10
Serum albumin (g/dL)	3.7±0.4	4.0±0.4	0.014[b]
Daily nPCR (g/kg)	1.23±0.39	1.16±0.0.29	0.46
Serum homocysteine (μmol/L)	15.5±6.0	20.7±6.2	0.003[b]
C-Reactive protein (mg/L)[c]	0.23±0.78	0.33±1.72	0.352
Serum LDL cholesterol (mg/dL)	108.8±29.6	114.7±40.2	0.67
Serum HDL cholesterol (mg/dL)	52.5±15.5	45.6±14.4	0.09
Serum triglycerides (mg/dL)	140.8±71.0	192.1±109.4	0.047[b]
Serum lipoprotein(a) (mg/dL)	75.0±74.4	80.2±78.6	0.80
LDL/HDL cholesterol	2.26±0.89	2.70±1.09	0.11
Total/HDL cholesterol	3.85±1.14	4.54±1.38	0.048[b]

[a] Percentages compared by chi-square test; means compared by independent Student *t*-test.
[b] Significant.
[c] Expressed as a geometric mean.
D/P = dialysate-to-protein; nPCR = normalized protein catabolic rate; LDL = low-density lipoprotein; HDL = high-density lipoprotein.

were normal-weight patients (89.7% vs. 53.8%, $p = 0.007$). Serum homocysteine values were more elevated in overweight patients (20.7 ± 6.2 μmol/L vs. 15.5 ± 6.0 μmol/L, $p = 0.003$), and we also found a higher total cholesterol/HDL cholesterol ratio (4.54 ± 1.38 vs. 3.85 ± 1.14, $p = 0.048$) and enhanced serum triglyceride levels (140.8 ± 71.0 mg/dL vs. 192.1 ± 109.4 mg/dL, $p = 0.047$) in that group. No significant differences were found in CRP between the normal-weight and overweight patients.

Discussion

Overweight was widely prevalent in our PD population, and the incidence of malnutrition was very small according to the subjective and objective methods used in this study.

It is widely accepted that many PD patients are malnourished. This acceptance results from the belief that low serum albumin concentrations reflect poor nutrition status. However a number of non nutrition factors—such as increased protein loss in dialysate, chronic or repeated infections, inflammation, hypervolemia, acidemia, and suboptimal clearance of uremic toxins—may contribute to low serum albumin (13,14). Hypoalbuminemia does not therefore necessarily indicate malnutrition as commonly assumed, which could eventually overestimate the prevalence of malnutrition in PD patients.

The most accepted methods of assessment of nutrition status in non renal patients are anthropometric measurements. Triceps skinfold and MAMC measurements are used to estimate fat mass and lean body mass respectively. Measurements below the 15th percentile are thought to indicate poor nutrition status and reduced muscle mass. Most of our patients (77.2%) had a triceps skinfold higher than the 15th percentile, and a similar result was obtained in MAMC (80.7%). These anthropometric results corroborate the good nutrition status found in our patients by SGA.

Because of co-morbidity in chronic renal patients, the combination of objective and subjective parameters has been established as the best approach in nutrition assessment (1). In the present study, we used also a NSS based on biochemical and anthropometric parameters to assess nutrition status in our PD patients. This method produced a similar finding of well-nourished patients.

Obesity has become a national epidemic, with more than 65% of Americans currently above ideal body weight. A recent study in Portugal (15) describes a comparable finding: 53.6% of the population is overweight (BMI $\geq$ 25 kg/m^2). Modern lifestyles encourage overconsumption of energy and discourage expenditure of energy. Minor gaps (fewer than 100 kcal daily) in the balance of energy consumption and expenditure lead to a gradual but steady weight gain (16).

Conventionally, obesity is defined as body fat in excess of 25% in adult men and 35% in adult women. In Caucasians, these body fat percentages correspond to a BMI of 30 kg/m^2; a BMI of 25 kg/m^2 corresponds to body fat percentages of 20% in men and 30% in women. Accordingly, a BMI range of 25 – 29.9 kg/m^2 is defined for overweight, and 30 kg/m^2 or more indicates obesity. Considering these cutoffs, overweight was widely prevalent in our sample. As in the general population, and as reported in several other studies (17,18), the prevalence of obesity in PD patients has risen dramatically since the mid-1980s.

We found no association for overweight with demographic- or modality-related factors, nor with fast transport status. This slightly surprising result should turn our attention to the lifestyle of PD patients. In our population, the rate of peritoneal glucose absorption appears to play no role in determining obesity, suggesting that trends in the rate of obesity are related more to a reduction in energy expenditure than to an increase in caloric intake. However, we did not differentiate between overweight and normal-weight patients concerning the use of glucose-sparing solutions, which can be a limitation of our study. Nevertheless, overweight patients exhibited better indices of nutrition than did normal-weight patients with similar small-solute clearances. A particularly curious finding is that the protein catabolic rate (PCR), normalized to actual weight, although higher in the overweight group, did not reach a statistically significantly value. A possible explanation is that normalization to actual weight in obese patients creates inappropriately low values for nutrition indices, such as PCR, that are derived from urea nitrogen. We suggest that normalization of those indices by ideal weight would be preferable.

Several authors have reported an association between BMI and markers of inflammation and have concluded that obesity is a proinflammatory state in PD patients (19). We measured only CRP as an inflammatory marker, and we found no association between CRP and overweight. However, there are other inflammatory markers more related to obesity (because they are released by the adipose tissue) that were not measured in our study.

Finally, we documented a potential atherogenic lipid profile in the overweight group, which can be a risk factor for cardiovascular disease. We might be concerned about our overweight patients, given that they have an average total/HDL cholesterol ratio that is significantly higher than that in normal-weight patients, although the effects of dyslipidemia in uremic patients does not match the gloomy outcome of such a metabolic profile in a nonuremic population.

Conclusions

We can conclude that the nutrition assessment data obtained in this study underline the prevalence of overweight in the PD population. This profile is different from that of hemodialysis patients if one considers the high prevalence of reported malnutrition in that group. Whether overweight is a protective condition, associated with lower comorbidity and a lower metabolic rate, or whether it instead represents a clinical menace deserves further investigation.

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Corresponding author:
Ana Bernardo, MD, Av Pedro Álvares Cabral, Castelo Branco 6000-085 Portugal.
E-mail:
anabernardo@portugalmail.pt