High Prevalence of Overweight in a Stable Spanish Hemodialysis Population: A Cross Sectional Study

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Objective: In the general population, the prevalence of overweight is high and is considered a mortality risk factor. In maintenance hemodialysis (MHD) patients reports regarding overweight and its predictors are scarce. Our aim was to evaluate the prevalence and predictors of overweight in MHD patients, supplemented with additional follow-up data on mortality.

Methods: Retrospective, observational, cross-sectional study of 190 white, noncomplicated patients on MHD recruited from 5 Spanish dialysis centers. Three anthropometric indexes were scored (relative body weight, skinfold thickness, and midarm muscle circumference), and body mass index (BMI) and dietary intake during a 5-day period were recorded. Patient survival was evaluated during a mean follow-up period of 25 $\pm$ 20 months.

Results: Undernutrition (score $<$ 7) was detected in only 15% of patients, and no patient had severe malnutrition (score $<$ 4). The percentage of patients scored below 7, was similar in nondiabetics and type 2 diabetic patients, whereas it was significantly higher in type 1 diabetics ($P = .002$). Notably, 38% of patients (38% of nondiabetics, 50% of type 2 diabetics, and none of the type 1 diabetics) were overweight (BMI $\geq$ 25 kg/m^2). To evaluate the predictors of overweight, a stepwise logistic regression analysis was performed entering age, sex, time on dialysis, caloric intake normalized for ideal energy requirements, and protein intake. Overweight was independently influenced only by ageing (odds ratio [OR], 1.04; confidence interval [CI], 1.02-1.07; $P = .0007$) and female gender (OR, 2.05; CI, 1.09-3.86; $P <$ .0001). By Cox proportional multivariate analysis, survival was positively influenced by BMI (RR, 0.88, CI, 0.79-0.97; $P <$ .01). As expected, albumin also had a positive influence whereas age and diabetes had a negative influence on survival. This preliminary result suggests that a higher BMI may exert a protective role on survival.

Conclusion: Overweight represents the predominant nutritional abnormality in our MHD population, especially in the elderly, women, and type 2 diabetics.

OVERWEIGHT and obesity appear to be an increasing nutritional disorder in the United States general population, and increase with age.[1] In Europe, more than half the adults between 35 to 65 years are overweight or obese.[2]

In maintenance hemodialysis (MHD) patients, the enthusiasm to emphasize the relevance of malnutrition contrasts with the scarce information about overweight. However, considering that the dialysis population could be a reflection of the general population, overweight should not be regarded as unusual. In fact, 3 recent epidemiologic surveys have reported a high prevalence of overweight in United States dialysis populations,[3-5] but predictors of overweight were not addressed in these studies. These short-term studies ascribe to overweight a protective effect on survival.

In the present study, we evaluated the anthropometric pattern and nutrient intake in a Spanish white population on MHD to explore the prevalence of overweight and its predictors.

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Subjects and Methods

Patients

An observational, retrospective, cross-sectional study of 200 noncomplicated MHD patients (all whites) was carried out. Patients were recruited from the University Hospital (67 patients) and Tamaragua Hospital (72 patients) of the Canary Islands, and from 3 different hemodialysis facilities (61 patients) from the Navarra Region in the mainland of Spain. Only clinically stable patients without any acute illness requiring hospital admission in the 2 months before the start of the study were included. To evaluate the influence of BMI on survival the patients were followed for 25 ± 20 months (range, 1 to 104 months). Surviving patients were censored at the time of transplantation or at the end of observation period. No patients were transferred to peritoneal dialysis or lost to follow-up.

Missing values for the major anthropometric parameters or nutrient intake data accounted for the decreased sample size as follows: 7 patients had missing anthropometric data and 3 patients had missing diet chart data. The final sample size was 190 patients. One hundred and forty-three patients were nondiabetics, 38 were type 2 diabetics (20%), and 9 were type 1 diabetics (5%). The diagnosis of the type of diabetes was based on a combination of clinical manifestations and treatment requirements. Briefly, criteria for diabetes type were: age of onset, presence of ketoacidotic or hyperosmolar episodes, and insulin requirements.[6] Most type 2 diabetic patients received insulin for glycemic control while on dialysis.

All patients were on thrice-weekly 3.5 to 4.5 hours of standard bicarbonate hemodialysis with a prescribed percent urea reduction equal or higher than 65%. They were managed according to a standardized protocol. Dialyzers were not reused. No patient received anabolic steroids or protein supplements. The prescribed diet was basically free, with potassium, sodium, and fluid restriction according to patient's needs. The general recommendations for protein and caloric intake were 1 to 1.2 gr/kg/d and 30 to 35 kcal/kg/d. Patients with uncontrolled serum phosphorus received additional recommendations to limit dairy products and animal protein ingestion.

Table 1. Scores for 3 Anthropometric Measurements

Scores	1	2	3
RBW (%)	$< 70\%$	70%-89%	$\geq 90\%$
TSF (percentile)	< 5	5-15	> 15
MAMC (percentile)	< 5	5-15	> 15

NOTE. The patient data was compared with their healthy counterparts obtained from the standard reference tables of each Spanish region.[12,13]

Abbreviations: RBW, relative body weight; TFS, triceps skinfold thickness; MAMC, midarm muscle circumference.

Anthropometry

Relative body weight (RBW) was recorded as the percentage of dry weight to desirable body weight. Ideal or desirable body weight was obtained from Broca formula.[7] Triceps skinfold thickness (TSF) and midarm muscle circumference (MAMC) was determined as previously reported.[8,9] Measurements were made in triplicate after a dialysis session when the patient was at dry weight and the mean was estimated. The results of these measurements were compared with healthy counterparts obtained from the standard reference tables for each Spanish region.[10,11]

Percentiles of the reference data were used to evaluate anthropometric measurements. This procedure is recommended for the study of a relatively well-nourished population, in which very few patients have indices below the extreme percentile of the reference population, and no errors are introduced even if the data have a skewed distribution.[12,13] Measurements below the fifth percentile are evidence of depletion, whereas patients whose measurements are between the fifth and fifteenth percentiles can be considered at risk of becoming depleted.[13] We applied this methodology, assuming that the standard to diagnose nutritional abnormalities in dialysis patients is that of their healthy counterparts in the general population. On this basis, 3 anthropometric indexes were scored. A value of 1, 2, or 3 was given to each of the parameters (Table 1). Addition of scores yielded a total score for each patient varying from 3 to 9. The patients were classified according to anthropometric score as normal nutritional status (score ≥ 7), suboptimal or undernutrition (score < 7), and overt malnutrition (score < 4). Body Mass Index (BMI) was computed from dry weight divided by the square

Table 2. Clinical, Biochemical Data, and Nutrient Intake of Patients

	Total	Nondiabetes	Type 2 diabetes	Type 1 diabetes	*P*-Value
N (%)	190	143 (75)	38 (20)	9 (5)	
Age (y)	58 ± 15	56 ± 16	68 ± 8	43 ± 8	*03†.001. ‡.001
Sex (% females)	44	42	58	22	0.08
Months on MHD	50 ± 65	52 ± 65	36 ± 55	70 ± 97	0.23
Albumin (g/dL)	4.1 ± 0.5	4.1 ± 0.6	4.1 ± 0.4	4.3 ± 0.3	0.26
Protein I/kg id bw	1.04 ± 0.3	1.04 ± 0.3	0.99 ± 0.4	1.14 ± 0.4	0.46
Caloric I/kg	24 ± 8	24.5 ± 8	21 ± 7	29 ± 10	†.03. ‡.023
Caloric I/kg id bw	25 ± 7	25.6 ± 7	22.7 ± 7	25.3 ± 8	0.08
Caloric I/TEE (id bw)	0.65 ± 0.2	0.65 ± 0.2	0.67 ± 0.3	0.63 ± 0.2	0.81
RBW	107.4 ± 19.6	107 ± 19.7	110.6 ± 19	89.9 ± 7.7	*.02. ‡.001
TSF	14.6 ± 7.3	14.2 ± 7.8	16.5 ± 5.8	12.01 ± 0.13	0.18
MAMC	42.9 ± 9.8	43.8 ± 9.8	40.2 ± 9	38.2 ± 10.4	0.05
Anthropometric score	8.06 ± 1.2	8.09 ± 1.2	8.16 ± 1.2	7.11 ± 1.4	0.05
% of patients scored < 7	15	13	11	56	0.002
BMI (kg/m^2)	24.3 ± 4.4	24.4 ± 4.4	24.8 ± 4.4	20.4 ± 1.9	*.02. ‡.015

NOTE. Data represent mean ± SD. Score: see text.

Abbreviations: BMI, body mass index; protein I, protein intake; caloric I, caloric intake; TEE, total energy expenditure; RBW, relative body weight; TFS, triceps skinfold thickness; MAMC, midarm muscle circumference.

*: Non-diabetics vs type 1 diabetics. †: Non-diabetics vs type 2 diabetics. ‡: type 1 diabetics vs type 2 diabetics.

of height in meters (kg/m^2). Overweight was defined as a BMI ≥ 25 kg/m^2.[14]

Assessment of Nutrient Intake and Energy Expenditure

The dietary intake was prospectively recorded during a 5-day period, which included 2 dialysis days and the weekend. Dietary records were validated by dietary recall carried out by the same nutritionist. Dietary intake was calculated with a computer program based on standard food composition tables.[15] The estimated energy requirements for adult patients of average size were derived from the following formula: Total energy expenditure (TEE) = BEE * AF Basal energy expenditure (BEE) was obtained from the Harris-Benedict equation,[16] and Activity Factor (AF) (sedentary, 1.3; light activity, 1.5, moderate activity, 1.75 to 2; heavy activity, 2 to 3).[17] TEE was employed to calculate the ratio caloric intake/TEE. Although the Harris Benedict formula may not be the gold standard to evaluate energy requirements, we considered it a useful tool to optimize the estimation of actual energy needs, and much better than the dry weight alone.

Biochemistry

All blood samples in hemodialysis were collected immediately before midweek dialysis session. Serum parameters of biochemical indicators were analyzed by routine methods.

Statistical Analysis

All the data are expressed as mean ± SD. Characteristics of the groups for continuous variables were compared by 2-tailed unpaired *t*-test or 1-way analysis of variance when appropiate. Post hoc analysis was performed using Tukey test. Differences between categoric variables were tested with the χ-square test. We applied a quadratic regression model to best evaluate the relationship between age and BMI. Stepwise logistic regression analysis was performed with BMI as the dependent variable. The Cox proportional hazard analysis (regression) was used to evaluate the relationship between BMI and mortality. Significant differences were defined as $P < .05$. Statistical analysis was performed with the SPSS 10.0 for Windows (SPSS Inc, Chicago, IL).

Results

Demographic characteristics (age and sex) of our patients were comparable with the Spanish MHD population.[18] Patient characteristics, nutrient intakes, serum albumin, and anthropometric indicators are shown in Table 2 subgrouped in nondiabetes, type 2 diabetes and type 1 diabetes. For all groups, mean caloric intake adjusted for body weight was 20% to 35% below the recommended 30 to 35 kcal/kg/d.[19] Mean protein intake was acceptable around 1 g/kg of ideal body weight and dry weight. Type 1 diabetics ingested more calories and proteins adjusted for body weight than nondiabetics and type 2 diabetics. When nutrient intake was adjusted to desirable body weight or ideal requirements (total energy expenditure), differences between groups disappeared.

Anthropometric differences among groups were especially marked between type 1 diabetics and the other 2 groups. Type 1 diabetics had lower anthropometric parameters than the other 2 groups. Anthropometric score also showed that undernutrition (score < 7) was detected in just 15% of patients, and especially in type 1 diabetics (56%), but no patient had severe malnutrition (score < 4).

With respect to overweight, BMI was used to evaluate its prevalence and predictors. Table 3 shows that overweight (BMI $\geq$ 25 kg/m^2) appeared in 38% of this population, and was more frequent in older patients and females. However, there were no differences regarding nutrient intake between overweight and nonoverweight patients. The prevalence of overweight was slightly higher in type 2 diabetics than nondiabetic patients, and no type 1 diabetics showed overweight (Fig. 1). In spite of this, the mean BMI of our MHD population was lower than the general population for all age groups and both genders (Fig. 2).[20] To analyze the predictors of overweight (dependent variable), a stepwise logistic regression analysis was performed, entering age, gender, time on dialysis, caloric intake/TEE (ideal body weight) and protein intake (g/kg ideal body weight) as independent variables (Table 4). Overweight was independently influenced by age and sex. That is, for each year of increasing age, the likelihood of being overweight increased 4%, and the probability of being overweight was twice as high in females than in males. Protein and caloric intake, and time on dialysis did not predict this anthropometric abnormality. When diabetes was entered in the analysis as an independent variable, this disease was not a predictor of overweight, because type 1 and type 2 diabetes represent the 2 extremes of BMI, regardless of nutrient intake.

Table 3. Patients Characteristics According to BMI Higher or Lower than 25kg/m^2. By Definition, BMI was Different Between Groups. Overweight Group was Significantly Older and Female Sex Predominated

	BMI $<$ 25	BMI $\geq$ 25	*P*-Value
% patients	62	38	—
BMI (kg/m^2)	21.6 $\pm$ 2.1	28.7 $\pm$ 3.5	$<$ .001
Age (y)	54.5 $\pm$ 17	63.3 $\pm$ 10	$<$ .001
Sex (% females)	36	58	.003
Months on dialysis	54.4 $\pm$ 65	42.8 $\pm$ 64	.23
Pro I/kg id bw	1.05 $\pm$ 0.3	1.02 $\pm$ 0.4	.61
Cal I/kg id bw	24.9 $\pm$ 7	25.2 $\pm$ 7	.85
Cal I/TEE (id bw)	0.65 $\pm$ 0.2	0.66 $\pm$ 0.2	.78
Serum albumin (g/L)	4.1 $\pm$ 0.5	4.3 $\pm$ 0.5	.67

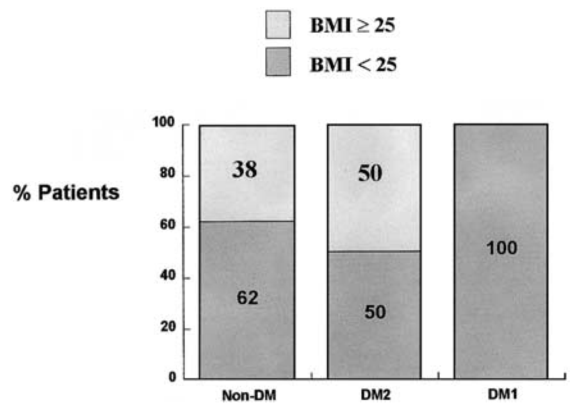

Figure 1. Of nondiabetics (Non-DM), 38% and 50% of type 2 diabetics (DM2) presented overweight. On the other hand, no type 1 diabetic (DM1) patients presented overweight (χ^2 = 7.79; $P < .02$).

During a mean follow-up period of 25 $\pm$ 20 (range, 1 to 104) months, 21% of patients died. The effect of baseline measurements on mortality risk was evaluated by Cox proportional univariate and multivariate analysis. By univariate analysis survival was positively influenced by BMI and albumin. Age and diabetes had a negative influence on survival. By Cox multivariate analysis, survival was independently and positively influenced by BMI (Table 5). Each unit of BMI increase was associated with a 14% reduction in mortality ($P < .01$). As expected, albumin retained significant influence on survival whereas diabetes had a negative influence. Gender and time on dialysis had no significant influence.

Discussion

In this study the prevalence of anthropometric recognizable abnormalities was evaluated in a sample of MHD patients. The most remarkable observation is that overweight was the predominant nutritional abnormality, especially in the elderly, females, and type 2 diabetic patients.

Over the last 2 decades, protein-caloric mal-

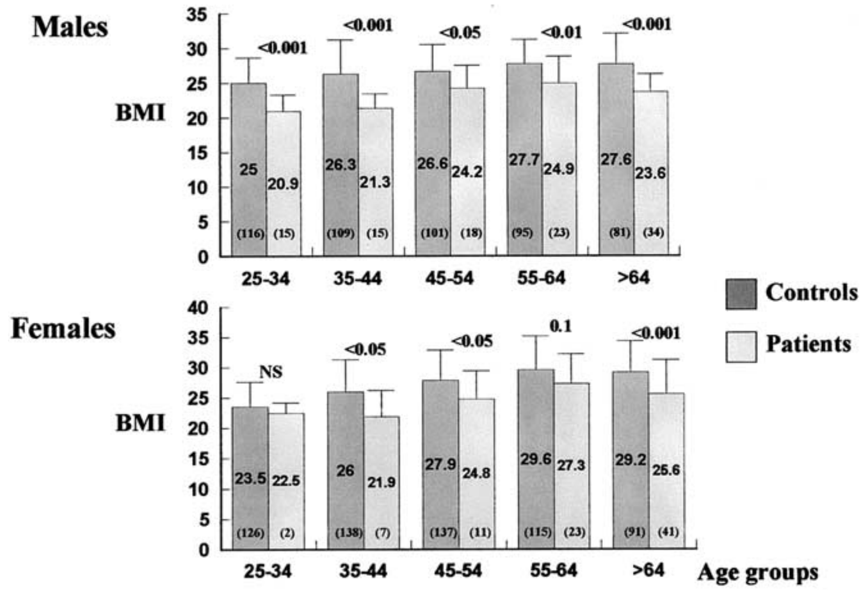

Figure 2. Distribution of BMI arrayed by age groups for normal subjects and MHD patients. Data is categorized according to gender. Number of subjects and patients in each group is shown in brackets at the bottom of each bar. The *P*-values indicate the significance of differences between matched groups.

nutrition has been regarded as the main nutritional disorder in dialyzed patients, with a reported prevalence of 25% to 75%.[8,9,21-23] Even recent studies still report a considerable prevalence of undernutrition in this population.[24,25] In contrast, a suboptimal anthropometric score was detected in only 15% of our study population, and none of them was severely malnourished. Some methodologic issues like different diagnostic criteria and a higher proportion of type 2 diabetics may partially account for these differences. Nevertheless, we think that the term malnutrition should be used with caution, because this concept implies that the functional status of the organism is affected. We prefer to use the term *store deficiency* rather than malnutrition when interpreting suboptimal anthropometric data. Thus, we only found overt malnutrition in patients affected by an intercurrent catabolic process, but it was not found in noncomplicated MHD population, provided they were receiving a balanced diet and a reasonable dose of dialysis.

The prevalence of overweight has recently been addressed by several authors. Leavey et al[3] studying a large sample obtained from USRDS, described a mean BMI of 24.4 ± 5.3 with an overweight prevalence of 25%. Fleischmann et al[4] showed that 38% of a sample of MHD population from Mississippi were overweight (defined as a BMI > 27.5 kg/m^2). Also, in a recent publication, Kopple et al[5] reported a high prevalence of overweight in MHD patients. In a series of Spanish patients, Marcen et al[24] reported a mean BMI of 23.4 for males and 24.9 for females, data very close to the upper limit of normality.

Table 4. Predictors of Overweight (Logistic Regression Analysis)

	B	OR	95% CI	*P*-Value
Age	0.04	1.04	1.02-1.07	< .001
Sex (female)	0.71	2.05	1.09-3.86	< .001

Abbreviations: B, coefficient B; OR, odds ratio; CI, confidence interval.

Table 5. Factors Found to Significantly Influence the Patient's Survival in the Cox Proportional Multivariate Analysis

	B	RR	95% CI	*P*-Value
BMI	−0.13	1.14	1.03-1.27	.01
Age	0.03	0.97	0.94-0.99	.01
Albumin	−0.94	2.56	1.37-4.76	.03
Diabetes condition	0.89	0.40	0.20-0.83	.01

NOTE. The positive influence of BMI and albumin, and the negative influence of diabetes and age is observed.

Abbreviations: B, coefficient B; RR, relative risk; CI, confidence interval.

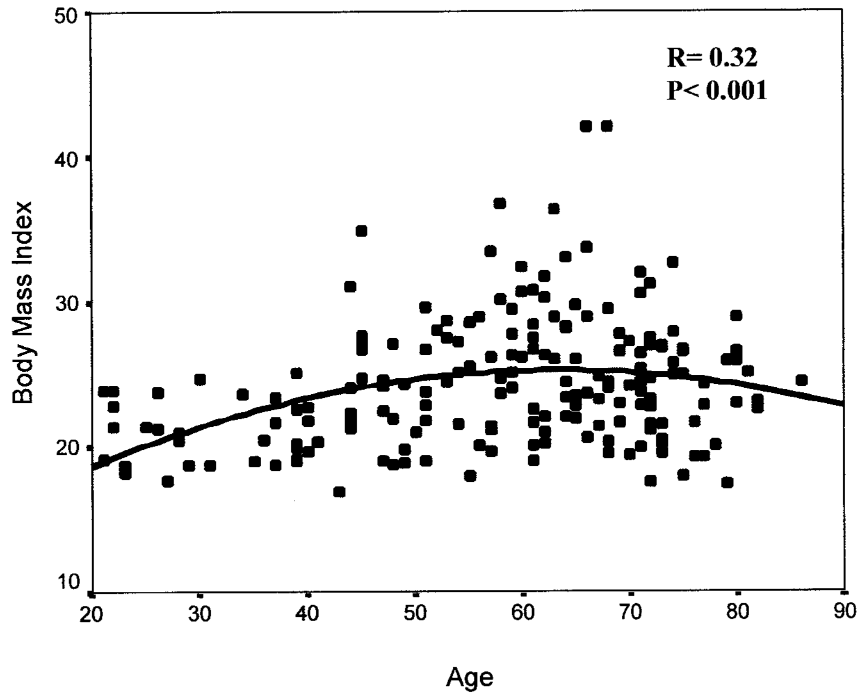

Figure 3. Quadratic regression model between age and BMI. BMI increased with age up to 65 to 70 years, declining thereafter.

Despite demographic differences, mean BMI, and overweight prevalence in these studies appeared in a similar proportion to our study. In addition, the best fit of our regression model was a quadratic relationship, where BMI distribution showed a profile similar to that of the general population[2] with BMI increasing with age up to 65 to 70 years, and declining thereafter (Fig. 3).

In addition to the evaluation of overweight prevalence, in the present study we analyzed the baseline diet records and other clinical variables as predictors of overweight. Despite apparently suboptimal nutrient intakes, the observed anthropometric values were not really deficient in our patients, especially in the elderly. Previous studies have reported lower calorie intakes normalized for body weight in elderly MHD population.[26,27] In the present study, caloric intake was adjusted for total energy expenditure, and the result of this procedure was that older patients (cutoff value of 65 years) ingested equal or even more calories for their needs, than younger patients (0.69 ± 0.2 versus 0.62 ± 0.2, vs 0.62 = .036). Furthermore, logistic regression analysis showed that the predictors of overweight were older age and female gender. These observations challenge the classic nutritional recomendations (1 g/kg/d of proteins and 35 kcal/kg/d) for MHD patients,[19,28] which do not consider the gradual decrease in nutrient intake that occurrs with increasing age, nor adjust for energy expenditure and physical activity.

We defined the cutoff for overweight as 25 kg/m^2 in agreement with the World Health Organization (WHO) Expert Committee[14] taking into account that our study population was basically European white. However, in the United States, NHANES III[29] defined overweight as a BMI over 27.5 kg/m^2. When we applied 27.5 kg/m^2 as the cutoff, the prevalence of overweight was 23%, and performing a stepwise logistic regression analysis, female sex was the only predictor of overweight, whereas age was excluded from the equation. In addition, patients with mild overweight (BMI 25 to 27 kg/m^2) were older that patient with overt overweight (BMI > 27), but the proportion of females was significantly higher in this last group. Thus, we observed a similar trend to that in the general population, where the sex influence on obesity prevails over age.[2]

Of greater concern regarding nutritional status is the diabetes condition. Anthropometric data from the HEMO Study[30] showed that diabetic patients had significantly larger means for weight, skinfolds and BMI than nondiabetic patients. These results are broadly consistent with our results regarding the predominance of a higher BMI in type 2 diabetics. In contrast to these studies, Qureshi AR et al[25] reported a higher incidence of malnutrition in diabetics. However, the 23 diabetic patients included in that study were analyzed as a whole, without considering diabetes type, although body composition of type 1 and 2 diabetes is known to be different. In our study we differentiate the anthropometric status regarding type of diabetes. By doing so, no relevant differences were found between type 2 diabetics and nondiabetic population, but half of type 1 diabetics scored below 7, despite ingesting more protein and calories than the other 2 groups.

The measure of BMI as a marker of overweight has several limitations. Other indices of obesity may differ among men and women with the same BMI. In our patient population, in addition to a higher BMI, the triceps skinfold thickness and relative body weight were significantly higher in women than men, supporting the notion that female obesity predominated. On the other hand, BMI may be a less useful indicator of adiposity among the elderly, who tend to have a shift of fat from peripheral to central sites with a concomitant increase in waist to hip ratio but no increase in BMI. Admitting these limitations, BMI is highly correlated with more direct measures of body fat in most populations, and is accepted as a reliable marker for overweight screening.[31]

Now, the question is why a considerable proportion of dialyzed patients present overweight. Recently, Kopple J et al[5] showed that patients on MHD are, on average, less fat than their counterparts in the general population. Similar results were observed in our series (Fig. 2). A plausible explanation for this observation could be that overweight comes from the predialysis state where a trend in body weight distribution similar to the general population is observed. We do not have verifiable data about the BMI of this population before dialysis was instituted; however, more than 50% of chronic renal failure patients from our predialysis clinic (40% of them are type 2 diabetics) were overweight.[32] This trend appears to carry over into the dialysis population.

Overweight is associated with increased mortality in the normal population.[33,34] By contrast, recent reports in large series (3 to 5) suggest that overweight in MHD patients may be a predictor of longer survival. In the present study we have similar data supporting the association of high BMI with decreased mortality. However, this study analyzed global mortality, without considering comorbid conditions. Thus, although our study was not designed to investigate the mechanism for protected mortality in overweight MHD population, it seems that a significant caloric reserve may prevent patients from the high catabolic impact of the dialysis therapy.

In summary, 2 primary questions are answered in the present study: First, although dialysis patients are less fat than their counterparts in the general population, overweight represents a significant nutritional abnormality in this population, especially in older patients, females, and type 2 diabetics. This profile is very similar to that observed in the general population. Second, although dietary intake is of critical importance in establishing adequate nutrient stores in noncomplicated patients, the relationship between diet and anthropometric indices may be blunted by many confounding factors, including metabolic (insulin resistance, physical activity) and demographic conditions (age and sex). Further long term controlled studies are warranted to confirm that greater energy reserves may offer an independent protective effect on morbidity and mortality in MHD patients.

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