Renal Failure

ISSN: 0886-022X (Print) 1525-6049 (Online) Journal homepage: informahealthcare.com/journals/irnf20

Daily Dietary Energy and Macronutrient Intake and Anthropometric Measurements of the Peritoneal Dialysis Patients

Gamze Akbulut, Nevin Şanlıer, Salih İnal, Nilüfer Acar Tek, Kürşad Öneç & Yasemin Erten

To cite this article: Gamze Akbulut, Nevin Şanlıer, Salih İnal, Nilüfer Acar Tek, Kürşad Öneç & Yasemin Erten (2013) Daily Dietary Energy and Macronutrient Intake and Anthropometric Measurements of the Peritoneal Dialysis Patients, Renal Failure, 35:1, 56-61, DOI: 10.3109/0886022X.2012.734768

To link to this article: https://doi.org/10.3109/0886022X.2012.734768

Renal Failure, 2013; 35(1): 56–61

ISSN 0886-022X print/1525-6049 online
DOI: 10.3109/0886022X.2012.734768

informa
healthcare

CLINICAL STUDY

Daily Dietary Energy and Macronutrient Intake and Anthropometric Measurements of the Peritoneal Dialysis Patients

Gamze Akbulut[1], Nevin Şanlıer[1], Salih İnal[2], Nilüfer Acar Tek[1], Kürşad Öneç[2] and Yasemin Erten[2]

[1]*Department of Nutrition and Dietetics, Faculty of Health Sciences, Gazi University, Ankara, Turkey;* [2]*Department of Nephrology, Faculty of Medicine, Gazi University, Ankara, Turkey*

Abstract

Introduction: This study was planned to investigate the relation between dietary macronutrient status and anthropometric measurements in peritoneal dialysis (PD) patients. *Materials and methods*: A total of 28 clinically stable patients were enrolled in this study. All patients were taken a dietary therapy according to the guidelines of the American Journal of Kidney Foundation for 12 weeks. The anthropometric measurements were taken by bioelectrical impedance analyzer. The daily macronutrient intakes of the patients were calculated by the food consumption records. *Results*: The mean age was 48.3 ± 13.10 years [56.3 ± 7.41 years for males ($n = 14$) and 40.3 ± 12.84 years for females ($n = 14$)]. There were significant changes in fat percentage (%), total body water (TBW; %, L), extracellular water (ECW; %, L), basal metabolic rate over body weight (BMR/BW), and body fat mass index (BMFI) in males ($p < 0.05$), but there was no change in females ($p > 0.05$). The daily dietary energy and protein intakes were under the recommended level in the study period. *Conclusion*: Patients undergoing PD frequently have low intakes of protein and energy. It is recommended that individuals undergoing PD periodically maintain 3-day dietary records followed by dietary interviews conducted by a dietitian.

Keywords: peritoneal dialysis, food consumption, dietary energy, protein intake, anthropometric measurements

INTRODUCTION

Chronic renal failure (CRF) is a growing health problem worldwide that leads to end-stage kidney failure and cardiovascular complications. CRF is defined as kidney damage and/or decreased kidney function expressed as glomerular filtration rate (GFR) for at least 3 months, regardless of the cause.[1] The prevalence of CRF stages 1–4 increased from 10.0% in 1988–1994 to 13.1% (in 1999–2004) according to the National Health and Nutrition Examination Surveys (NHANES).[2] In Turkey, the incidence and prevalence of kidney failure are rising. The data from the 1999 Renal Dialysis Registry of Turkey indicate that the incidence rate of end-stage renal disease (ESRD) in 1999 was 178 patients/year/per million populations.[3] In the decennium, according to the Turkish Society of Nephrology (TSN) 2008 data, the incidence of ESRD in Turkey has increased nearly fourfold since 2000.[4] According to the study of "Chronic Renal Disease In Turkey" (CREDIT) data, the prevalence was reached to 15.2% in Turkey.[1]

Medical nutritional therapy is widely recognized as an important part of the treatment for patients with CRF. Patients undergoing peritoneal dialysis (PD) are at high risk of malnutrition, which significantly impacts mortality. The prevalence of malnutrition in PD patients ranged from 18% to 56% in different studies.[5,6] Therefore, anthropometric measurements and food consumption records are of great importance in determining the nutritional status of PD patients.[7] In order to optimize quality of life (QoL), it is important that patients with ESRD on PD are given appropriate nutritional requirements. Protein requirements are a key area of importance for the dietary management of patients on dialysis.[8]

Anthropometric measurements are valid and clinically useful indicators of protein–energy nutritional status in maintenance dialysis patients. The anthropometric parameters that are generally assessed include body weight, height, percent of the body fat mass, percent of usual body weight (%UBW), percent of standard body weight (%SBW), and body mass index (BMI, kg/m^2).[9] Obesity is associated with progressive loss of kidney function as a

Address correspondence to Gamze Akbulut, Department of Nutrition and Dietetics, Faculty of Health Sciences, Gazi University, Besevler, Ankara, Turkey. Tel.: +90 312 216 26 39; Fax: +90 312 216 2636; E-mail: dytgamzea@gmail.com

Received 10 July 2012; Revised 17 September 2012; Accepted 23 September 2012

cause of glomerular hyperfiltration and increases urinary albumin loss and fecal segmental glomerulosclerosis.[2] Recent studies indicate that obesity prevalence, especially the excess body fat mass among dialysis patients most likely increases and this body fat accumulation may contribute to an inflammatory burden.[10,11] The objective of the study was to evaluate the dietary macronutrient status and anthropometric measurements for patients who were applied dietary therapy for PD.

MATERIALS AND METHODS

A total of 28 clinically stable patients were enrolled in this study. The patients were undergoing PD therapy at Gazi University Hospital who did not have peritonitis during the last 3 months. The inclusion criteria were as follows: being on PD for at least 6 months, having visited our outpatient clinic monthly, and had complete dietary treatment for three consecutive months (September–November, 2010).

Dietary Treatment

We used the American Journal of Kidney Foundation guidelines to regulate the dietary energy intake and macronutrient requirements of each patient. According to these guidelines, patients undergoing maintenance chronic PD should be prescribed a dietary energy intake of 35 kcal/kg/day for those who are <60 years of age and 30 kcal/kg for those who are ≥ 60 years of age. Maintenance chronic PD patients should be prescribed 1.2–1.3 g protein/kg/day. At least 50% of the dietary protein should be of high biological value (animal-based protein). The oral energy supply should favor lipids (30–40% of total energy intake, diet dialysate) and complex carbohydrates. Simple sugars should be restricted.[9] The detailed dietary records for three consecutive days (one for weekend) were taken from each individual. The diets were also planned according to the diagnosis of the diseases such as diabetes and/or hypertension.

Anthropometric Measurements

All measurements were taken by trained dieticians and with participants wearing light clothes and no shoes. A portable scale was used to measure body weight to the nearest half kilogram. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer.[12] Body weight, body fat, and fat-free mass and volume status of the individuals were measured by using "Quadscan 4000" (BodyStat, Douglas, UK) multifrequency bioimpedance spectrum analyzer (BIA) device throughout 12 weeks. The measurement was performed in right calf at four frequencies (5, 50, 100, and 200 kHz) at the supine position after patients emptied their dialysis solutions; extracellular water (ECW), intracellular water (ICW), and total body water (TBW) contents. ECW was normalized to patients' height in meters (N-ECW). For the BIA measurement of individuals, they have been asked not to do heavy physical activity before 24–48 hours of the test, and not to have consumed much liquid (water, tea, or coffee) and had at least 4 hours of fasting before the test.

The individuals signed a voluntary participation form and filled the questionnaires adhered to the Declaration of Helsinki (World Medical Association). The research project was approved by the Ethics Committee of the Gazi University, School of Medicine.

Statistical Analysis

The data analysis was carried out using SPSS version 15.0 software (SPSS Inc., Chicago, IL, USA). Results were expressed as means ($\bar{x}$) and standard deviation (SD) for the data. Wilcoxon signed-rank test was used to assess the comparison of nonnormally distributed values between the two groups. Significance is defined as a p-value less than 0.05.

RESULTS

This study was conducted on 28 (14 males, 14 females) PD patients between the ages of 22–70 years. The mean age was 48.3 ± 13.10 years (56.3 ± 7.41 years for males, and 40.3 ± 12.84 years for females). All of the males and 57.1% of the females were married and the 42.9% were single or divorced. The 57.2% of the males and 28.5% of the females were graduated from high school and/or had bachelor's degree. When the individuals were evaluated to their professions, 64.3% of the males were retired and the 78.6% of the women were housewives.

In total, 75% of the patients (21 of 28 patients) had diagnosis of hypertension and 17.9% (5 of 28 patients) of them were diabetics. The mean systolic blood pressure (SBP) was measured 130.0 ± 21.20 for males and 139.3 ± 20.17 for females ($p < 0.05$), and the mean diastolic blood pressure (DBP) was 81.1 ± 11.46 for males and 86.1 ± 12.43 for females in the beginning of the study ($p < 0.05$). After 12 weeks, the mean SBP was 126.8 ± 21.71 for males and 128.6 ± 19.84 for females. The mean DBP was 77.8 ± 10.69 for males and 78.6 ± 10.63 for females ($p < 0.05$). The decrease in BP was statistically significant at the end of the study.

When we analyzed the patients' activity status, it was found that just 21.4% of the men and 28.6% of the women were doing regular physical activity. It was also found that only 28.6% of the males and 50% of the women told that they perform their diets before the study. According to the results of the subjective global assessment (SGA), the 78.6% of males and 71.4% of the females were well nourished (category A) and 14.3% of the males and 28.6% of the females were moderately malnourished (category B). The 85.7% of the males and 64.3% of the females had three main meals regularly and also 50.0% of the males and 71.4% of the females have skipped meals when evaluated according to the snacks and main meal consumption status.

The anthropometric measurements of the study group measured by BIA are shown in Table 1. There were

Table 1. The anthropometric measurements of the individuals according to gender.

	Men ($n = 14$)			Women ($n = 14$)			Total ($n = 28$)		
	Initial	12th week		Initial	12th week		Initial	12th week	
Anthropometric measurements	$\bar{x} \pm SD$	$\bar{x} \pm SD$	p-Value	$\bar{x} \pm SD$	$\bar{x} \pm SD$	p-Value	$\bar{x} \pm SD$	$\bar{x} \pm SD$	p-Value
BW (kg)	81.2 ± 15.35	81.3 ± 14.85	0.615	67.2 ± 15.10	66.8 ± 16.34	0.308	74.2 ± 16.54	74.4 ± 16.97	0.732
Fat mass (kg)	20.5 ± 5.32	21.6 ± 5.64	0.074	22.9 ± 8.3	23.0 ± 9.35	0.875	21.7 ± 6.97	22.3 ± 7.61	0.249
Fat percentage (%)	25.0 ± 4.84	26.4 ± 4.12	0.006*	33.8 ± 7.83	33.7 ± 7.83	0.999	29.4 ± 7.80	30.1 ± 7.18	0.068
Fat-free mass (kg)	60.8 ± 12.29	59.8 ± 10.88	0.096	44.3 ± 11.21	43.8 ± 9.83	0.509	52.6 ± 14.30	51.8 ± 13.04	0.113
Dry lean weight (kg)	14.3 ± 3.71	14.6 ± 3.90	0.182	10.9 ± 4.33	10.9 ± 4.35	0.859	12.6 ± 4.34	12.8 ± 4.45	0.264
TBW (%)	57.4 ± 4.58	55.9 ± 3.91	0.021*	50.2 ± 6.02	49.9 ± 6.71	0.660	53.8 ± 6.42	52.9 ± 6.17	0.050*
TBW (L)	46.7 ± 9.16	45.4 ± 7.47	0.019*	33.4 ± 7.38	32.8 ± 6.08	0.345	40.1 ± 10.6	39.1 ± 9.26	0.025*
ECW (%)	26.2 ± 6.07	25.5 ± 6.29	0.028*	23.5 ± 2.69	23.4 ± 2.98	0.730	24.9 ± 4.80	24.5 ± 4.94	0.060
ECW (L)	19.9 ± 3.85	19.2 ± 3.11	0.011*	15.7 ± 2.99	15.4 ± 2.39	0.135	17.8 ± 4.00	17.3 ± 2.36	0.012*
ICW (%)	31.3 ± 4.02	30.7 ± 3.54	0.132	26.3 ± 2.09	26.3 ± 2.30	0.972	28.8 ± 4.05	28.5 ± 3.68	0.252
ICW (L)	25.6 ± 4.45	25.4 ± 3.99	0.325	17.6 ± 4.32	17.5 ± 4.08	0.700	21.6 ± 5.94	21.5 ± 5.65	0.332
Body cell mass	36.4 ± 6.25	36.2 ± 5.61	0.441	25.2 ± 6.17	25.0 ± 5.84	0.552	30.8 ± 8.36	30.6 ± 8.00	0.340
Third space water	1.2 ± 1.14	0.7 ± 0.62	0.014	0.1 ± 1.08	−0.0 ± 1.18	0.944	0.6 ± 1.23	0.3 ± 1.00	0.050*
Nutrition index	0.4 ± 0.00	0.4 ± 0.00	0.084	0.4 ± 0.01	0.4 ± 0.01	0.166	0.4 ± 0.02	0.4 ± 0.02	0.027*
Illness marker	0.8 ± 0.01	0.8 ± 0.26	0.187	0.8 ± 0.03	0.8 ± 0.03	0.294	0.8 ± 0.03	0.8 ± 0.19	0.064
BMR	1791.3 ± 310.76	1763.9 ± 275.0	0.102	1468.8 ± 280.46	1455.9 ± 243.26	0.433	1630.1 ± 333.67	1609.9 ± 299.17	0.096
BMR/BW	22.7 ± 1.42	21.8 ± 1.34	0.007*	22.2 ± 3.01	22.3 ± 3.11	0.929	22.2 ± 2.31	22.0 ± 2.36	0.094
Est. Av. Rate	2508.0 ± 434.97	2469.4 ± 385.09	0.096	2056.3 ± 392.83	2038.4 ± 340.50	0.432	2282.1 ± 467.22	2253.9 ± 418.79	0.096
BMI (kg/m^2)	28.4 ± 4.31	28.5 ± 4.29	0.362	27.1 ± 4.17	26.9 ± 4.27	0.506	27.7 ± 4.21	27.7 ± 4.28	0.923
BMFI	7.1 ± 2.00	7.6 ± 1.97	0.013*	9.3 ± 3.24	9.3 ± 3.45	0.929	8.2 ± 2.87	8.4 ± 2.89	0.108
FFMI	21.2 ± 3.17	20.9 ± 2.86	0.093	17.7 ± 2.46	17.6 ± 2.07	0.598	19.5 ± 3.31	19.2 ± 2.97	0.169
WHR	0.99 ± 0.06	0.99 ± 0.06	0.569	0.88 ± 0.08	0.88 ± 0.06	0.964	0.94 ± 0.09	0.93 ± 0.08	0.685
Impedance	504.6 ± 114.92	493.9 ± 168.39	0.064	615.8 ± 120.37	629.3 ± 125.34	0.245	560.1 ± 128.62	561.6 ± 161.13	0.038*

Notes: BW, body weight; TBW, total body water; ECW, extracellular water; ICW, intracellular water; BMR, basal metabolic rate; BMI, body mass index; Est. Av. Rate, mean energy requirement; BMFI, body fat mass index; FFMI, body fat free mass index; WHR, waist hip ratio.

*$p < 0.05$

significant changes in fat percentage (%), TBW (%, L), ECW (%, L), basal metabolic rate over body weight (BMR/BW), and body fat mass index (BMFI) in males ($p < 0.05$), but there was no change in females ($p > 0.05$).

In Table 2, the dietary energy and macronutrient intake of the patients were indicated. According to this, the daily energy and protein intake of the patients has decreased throughout the 12 weeks. Daily protein intake was decreased from 66.4 ± 22.23 g (≈0.83 g/kg) to 62.6 ± 16.62 g (≈0.78) in men, and 56.2 ± 13.88 g (≈0.87 g/kg) to 52.1 ± 22.12 g (≈0.80 g/kg) in women. But none of the changes were statistically significant ($p > 0.05$).

DISCUSSION

Determination of body hydration and nutritional status are significant problems in dialysis patients. Bioimpedance analysis is a readily available method for the assessment of the hydration status in dialysis patients.[13] It is a method of estimating body fluid volumes by measuring the resistance to a high-frequency, low-amplitude alternating electric current (50 kHz at 500–800 mA). The amount of resistance measured is inversely proportional to the volume of electrolytic fluid in the body and, to a lesser extent, on the proportions of this volume.[14]

The clinical use of BIA is currently focused on two major fields; first, the management of ECW (dry weight) and, second, the assessment of nutritional status.[13] Different approaches (whole body or segmental BIA) are used to measure extracellular volume (ECV), intracellular volume (ICV), and TBW in dialysis patients. These studies aimed to measure hydration status and estimate dry weight by employing ratios of ECV to ICV, ECV to TBW, or ECV to body weight (BW).[15–17]

According to the results of European Body Composition Monitoring study (EuroBCM study), which was designed to measure hydration status in PD patients, mean TBW, ECW, and ICW values were 35.8, 17.2, and 18.5 L, respectively.[18] In this study, we found higher values (in both terms) than this large sample sized study's results. ECW reduced significantly by 0.5 L and TBW reduced by 1.0 L, thus with a little decrease in ICW of 0.1 L. In addition, the assessment of hydration in PD patients is important in determining "dry weight" to allow adjustment of dialysis prescription to optimize fluid balance.[19] There was determined 0.2 kg increase after the study period although it was not significant. This insignificant change of anthropometric parameters was mostly due to the patients' insufficient consumption of dietary protein and energy.

A clinical method for evaluating nutritional status, termed subjective global assessment (SGA), encompasses historical, symptomatic, and physical parameters. This approach defines malnourished patients

Table 2. The dietary energy and macronutrients intake of the individuals according to gender.

Dietary	Men ($n = 14$) Initial	Men 12th week		Women ($n = 14$) Initial	Women 12th week		Total ($n = 28$) Initial	Total 12th week	
	$\bar{x} \pm$ SD	$\bar{x} \pm$ SD	p-Value	$\bar{x} \pm$ SD	$\bar{x} \pm$ SD	p-Value	$\bar{x} \pm$ SD	$\bar{x} \pm$ SD	p-Value
Energy (kcal/day)	1806.2 ± 435.36	1659.9 ± 556.86	0.331	1510.2 ± 330.54	1446.4 ± 392.96	0.925	1658.2 ± 408.15	1553.1 ± 485.26	0.327
CHO (g/day)	224.5 ± 50.66	213.5 ± 84.56	0.363	171.3 ± 32.52	174.7 ± 54.29	0.875	197.9 ± 49.77	194.1 ± 72.41	0.569
CHO (%)	51.5 ± 7.41	50.6 ± 6.98	0.975	47.3 ± 7.93	48.3 ± 6.88	0.363	49.4 ± 7.83	49.5 ± 6.89	0.569
Protein (g/day)	66.4 ± 22.23	62.6 ± 16.62	0.551	56.2 ± 13.88	52.1 ± 22.12	0.433	61.3 ± 18.88	57.3 ± 19.91	0.412
Protein (g/kg/day)	0.83 ± 0.29	0.78 ± 0.21	0.470	0.87 ± 0.27	0.80 ± 0.35	0.551	0.85 ± 0.27	0.79 ± 0.28	0.439
Protein (%)	14.9 ± 3.60	16.0 ± 5.02	0.272	15.1 ± 2.36	14.1 ± 3.48	0.363	15.0 ± 2.99	15.1 ± 4.35	0.485
Fat (g/day)	69.8 ± 25.09	59.8 ± 22.7	0.363	65.3 ± 24.18	58.3 ± 15.75	0.300	67.6 ± 24.29	59.1 ± 19.2	0.158
Fat (%)	33.6 ± 6.57	32.3 ± 5.32	0.470	37.5 ± 7.07	36.6 ± 4.98	0.638	35.6 ± 6.99	34.5 ± 5.51	0.374
Fiber (g/day)	22.5 ± 8.05	18.2 ± 7.03	0.221	16.2 ± 8.56	17.4 ± 8.04	0.245	19.3 ± 8.76	17.8 ± 7.42	0.991

Note: CHO, carbohydrate.

as those who are at increased risk of medical complications and who will presumably benefit from nutritional therapy. The findings of the history and physical examination are used to categorize patients as being well nourished (category A), having moderate or suspected malnutrition (category B), or having severe malnutrition (category C).[14] In this study, it was found that 75% of the individuals were well nourished, while 21.4% was moderately malnourished.

Valuable clinical parameters for routine assessment of nutritional status are history of weight loss, percentage of standard weight, BMI, clinical evaluation of muscle and subcutaneous fat mass, and assessment of comorbid conditions. Protein intake should be at least 1.2 g/kg standard BW, to be on the safe side for almost all patients. Energy intake should be 35 kcal/kg standard BW in patients <60 years of age and 30 kcal/kg standards BW in patients >60 years of age.[20] The amount of daily energy intake is important as well as the composition of it. As the prevalence of hyperlipidemia is high in PD patients and the absorption of glucose from the dialysate, daily fat intake, and carbohydrate consumption should be checked carefully among the patients.[21,22] Nutritional status relates strongly to morbidity and mortality in dialysis patients. Whereas predialysis nutritional requirements are not different from those of healthy adults and allow for moderate protein intakes of 0.7–0.8 g/kg/day; in maintenance PD, these intakes are not enough to maintain good nutritional status and are associated with signs of malnutrition.[23] In general, both protein and energy requirements are greater in dialysis patients than in healthy persons.[24] The Dialysis Outcome Quality Initiative (DOQI) guidelines in nutrition have proposed that, based on nitrogen studies in HD and PD patients, a minimum of 1.2 g of protein/kg BW in HD and 1.3 g of protein/kg BW in PD represent the minimum daily intake to ensure a neutral protein balance.[25] Half of this intake should be made by proteins of high biological value from animal origin, for example, meat, fish, or dairy products. In this study, although most of the patients were well nourished according to SGA, their daily protein intakes were under the recommended levels in the study period. First, this was mostly due to that the patients did not obey the rules of the dietary recommendations. Food intake may vary considerably, depending on the dialysis schedule. Second, changes in lifestyle may have psychological effects and patients may not want to change their whole behavior, including food habits. This is especially important since any delay in providing adequate intake will induce a loss of energy stores and protein mass, which are not easily regained afterwards.

A number of studies have reported energy intakes to be as low as 22–25 kcal/kg BW/day in patients on routine dialysis treatment as it was paralleled in this study result.[8,26,27] There is no metabolic or pathological reason for not giving a standard energy intake to stable adult maintenance dialysis patients. Indeed, their metabolic needs, based on resting energy expenditure, are similar to those of normal adults, that is, 35 kcal/kg BW/day. Energy balance studies, mainly in PD patients, confirmed that a positive nitrogen balance could only be attained with energy intakes >30 kcal/kg/day. Likewise, many clinicians agree that their patients have energy intakes less than 30 kcal/kg/day but do not show weight loss in the long term. Thus, some patients would be fine with 28 kcal/kg/day, whereas others will need 35 kcal/kg/day to avoid compromising his/her protein–energy balance. It should be recalled that energy deficiency could induce a negative nitrogen balance if protein intakes are at the lower limit of requirements, whereas this protein balance could be positive with sufficient energy intakes.[26]

Evidence indicates that for patients ingesting low protein or energy intakes, increasing dietary protein or energy intake improves nutritional status. In this study, dietary intakes of energy and protein did not change during diet therapy. This may due to the reason that patients did not consume enough dietary protein sources at recommended levels. It is important, therefore, to monitor the dietary protein and energy intake of PD patients. It is recommended, therefore, that individuals undergoing PD periodically should maintain dietary training for changing wrong eating habits, and proposals should be developed to facilitate compliance with the dietary advice and 3-day dietary records periodically followed by dietary interviews via calculating nutrient intake from the diaries and interviews, for example, a registered dietitian, preferably with experience in renal disease.[8,28,29]

In conclusion, patients not meeting their dietary prescription did not adjust their intake to match the recommended advice they had been given from a dietitian. According to the food consumption results, subjects consumed less than the recommended intakes for energy and protein. This inability to change suggests that subjects may be eating to the limit of their appetite.

LIMITATIONS

There are some limitations in this study. First, the sample size was small. Second, we did not assess dietary protein intake by measuring urinary urea, thus we just had the results by the daily food consumption status.

ACKNOWLEDGMENTS

We thank all the participants who devoted their time participating in this study. Their helpful and wholehearted cooperation is warmly acknowledged.

***Declaration of interest*:** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

REFERENCES

[1] Süleymanlar G, Utaş C, Arinsoy T, et al. A population-based survey of chronic renal disease in Turkey—the CREDIT study. *Nephrol Dial Transplant*. 2011;26(6):1862–1871.

[2] Coresh J, Selvin E, Stevens LA, et al. Prevalence of chronic kidney disease in the United States. *JAMA*. 2007;298(17):2038–2047.

[3] Serdengeçti K, Süleymanlar G, Altiparmak M, Seyahi N, eds. *Registry of the Nephrology Dialysis and Transplantation in Turkey, 1999*. Istanbul: Tayt ofset; 2000.

[4] Serdengeçti K, Süleymanlar G, Altiparmak M, et al. *Registry of the Nephrology Dialysis and Transplantation in Turkey (Registry-2008)*. Istanbul: Turkish Society of Nephrology; 2009.

[5] Boxall MC, Goodship THJ. Nutritional requirements in hemodialysis. In: Mitch WE, Klahr S, eds. *Handbook of Nutrition and the Kidney*. 4th ed., Philadelphia, PA: Lippincott Williams & Wilkins; 2005:218–227.

[6] Dombros NV, Digenis GE, Oreopoulos DG. Nutritional markers as predictors of survival in patients on CAPD. *Perit Dial Int*. 1995;15:10–19.

[7] Wiesen K, Mindel G. Dialysis, in nutrition and health. *Nutr Kidney Dis*. 2008;3:231–262.

[8] Ash S, Campbell KL, MacLaughlin H, McCoy E. Evidence based practice guidelines for the nutritional management of chronic kidney disease. *Nutr Diet*. 2006;63(Suppl. 2):33–45.

[9] Clinical practice guidelines for nutrition in chronic renal failure. K/DOQI, National Kidney Foundation. *Am J Kidney Dis*. 2000;356(2):1–3.

[10] Kramer HJ, Saranathan A, Luke A, et al. Increasing body mass index and obesity in the incident ESRD population. *J Am Soc Nephrol*. 2006;17(5):1453–1459.

[11] Axelsson J, Rashid Qureshi A, Suliman ME, et al. Truncal fat mass as a contributor to inflammation in end-stage renal disease. *Am J Clin Nutr*. 2004;80(5):1222–1229.

[12] Lohman TG, Roche AF, Martorell R, eds. *Anthropometric Standardization Reference Manual*. Champaign, IL: Kinetics Books; 1988.

[13] Kotanko P, Levin NW, Zhu F. Current state of bioimpedance technologies in dialysis. *Nephrol Dial Transplant*. 2008;23:808–812.

[14] Jeejeebhoy KN. Nutritional assessment. *Nutrition*. 2000;16(7–8):585–590.

[15] Fisch BJ, Spiegel DM. Assessment of excess fluid distribution in chronic hemodialysis patients using bioimpedance spectroscopy. *Kidney Int*. 1996;49:1105–1109.

[16] Zhu F, Schneditz D, Levin NW. Sum of segmental bioimpedance analysis during ultrafiltration and hemodialysis reduces sensitivity to changes in body position. *Kidney Int*. 1999;56:692–699.

[17] Dumler F. Best method for estimating urea volume of distribution: comparison of single pool variable volume kinetic modeling measurements with bioimpedance and anthropometric methods. *Asaio J*. 2004;50:237–241.

[18] Van Biesen W, Williams JD, Covic AC, et al. EuroBCM Study Group. Fluid status in peritoneal dialysis patients: The European Body Composition Monitoring (EuroBCM) study cohort. *PLoS One*. 2011;6:17148.

[19] Woodrow G, Devine Y, Cullen M, Lindley E. Application of bioelectrical impedance to clinical assessment of body composition in peritoneal dialysis. *Perit Dial Int*. 2007;27(5):496–502.

[20] Locatelli F, Fouque D, Heimburger O, et al. Nutritional status in dialysis patients: a European consensus. *Nephrol Dial Transplant*. 2002;17(4):563–572.

[21] Liu J, Rosner MH. Lipid abnormalities associated with end-stage renal disease. *Semin Dial*. 2006;19(1):32–40.

[22] Holmes CJ, Shockley TR. Strategies to reduce glucose exposure in peritoneal dialysis patients. *Perit Dial Int*. 2000;20(Suppl. 2):37–41.

[23] Fouque D, Guebre-Egziabher F. An update on nutrition in chronic kidney disease. *Int Urol Nephrol*. 2007;39:239–246.

[24] Altay M, Turgut F, Akay H, et al. Dyspepsia in Turkish patients on continuous ambulatory peritoneal dialysis. *Int Urol Nephrol*. 2008;40(1):211–217.

[25] Patel TV, Singh AK. Kidney Disease Outcomes Quality Initiative (K/DOQI Guidelines) for bone and mineral metabolism: Emerging questions. *Semin Nephrol*. 2009;29(2):105–112.

[26] Mehrotra R, Bross R, Wang H, Appell M, Tso L, Kopple JD. Effect of high-normal compared with low-normal arterial pH on protein balances in automated peritoneal dialysis patients. *Am J Clin Nutr*. 2009;90(6):1532–1540.

[27] Dong J, Li Y, Yang Z, Luo J. Low dietary sodium intake increases the death risk in peritoneal dialysis. *Clin J Am Soc Nephrol*. 2010;5(2):240–247.

[28] Peterson S, Sigman-Grant M, Eissenstat B, Kris-Etherton P. Impact of adopting lower-fat food choices on energy and nutrient intake in American adults. *J Am Diet Assoc*. 1999;99:177–183.

[29] Blumenkrantz MJ, Kopple JD, Moran JK, Coburn JW. Metabolic balance studies and dietary protein requirements in patients undergoing continuous ambulatory peritoneal dialysis. *Kidney Int*. 1982;21:849–861.