Family history of chronic renal failure is associated with malnutrition in Korean hemodialysis patients[*]

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Abstract

The present study was to investigate the nutritional status and factors related to malnutrition in end-stage renal disease (ESRD) patients requiring hemodialysis (HD) in South Korea. Subjects were ESRD outpatients from general hospitals or HD centers in Seoul referred to the dialysis clinic for maintenance HD care. A total of 110 patients (46 men and 64 women; mean ages 58.6 ± 1.0 y) were eligible for this study. The family history of chronic renal failure (CRF) was considered positive if a patient reported having either a first-degree or second-degree relative with CRF. Malnutrition was defined as a triceps skinfold thickness or mid-arm muscle circumference below the fifth percentile for age and sex and forty-seven of the 110 patients were malnourished. Almost all (94%) patients had anemia (hemoglobin: <13 g/dL for men and <12 g/dL for women). Energy intake was below the recommended intake levels of energy [30-35 kcal/kg ideal body weight (IBW)] and protein (1.2 g/kg IBW) in 60% of patients. The duration of HD was longer in malnourished HD patients (P=0.0095). Malnutrition was more prevalent in women (P=0.0014), those who never smoked (P=0.0007), nondiabetic patients (P=0.0113), and patients with bone diseases (P=0.0427), adequate HD (spKt/V$\geq$1.2) (P=0.0178), and those with a family history of CRF (P=0.0255). Multiple logistic regression was used to examine the relationship between malnutrition and potential risk factors. After adjusting for age, sex, and other putative risk factors for malnutrition, the OR for malnutrition was greater in HD patients with a family history of CRF (OR, 3.290; 95% CI, 1.003-10.793). Active nutrition monitoring is needed to improve the nutritional status of HD patients. A family history of CRF may be an independent risk factor for malnutrition in Korean HD patients. A follow-up study is needed to investigate whether there is a causal relationship between a family history of CRF and malnutrition in Korean ESRD patients.

Key Words: Nutrition, ESRD patients, hemodialysis, family history, Korea

Introduction

Hemodialysis (HD) is the most widely used dialysis modality in patients with end-stage renal disease (ESRD). The number of HD patients has been increasing rapidly worldwide including Korea: the total number of HD patients has been increased 18 times from 1986 to 2006 in Korea (ESRD Registry Committee, 2006). The prognosis for ESRD patients remains poor although our understanding of the uremic state and the science and technology of HD has been improved (Caglar et al., 2002).

Malnutrition is prevalent in patients with HD and strongly associated with increased morbidity and mortality in these patients (Fleischman et al., 1999; Kopple et al., 1999; Leavey et al., 1998; Pifer et al., 2002). Factors contributing to malnutrition in HD patients may include low food intake and food intake characteristics (Aguilera et al., 2004), loss of appetite (Lopes et al., 2007), HD adequacy (Teixeira Nunes et al., 2008), comorbidity (Miskulin et al., 2004; van Manen et al., 2002),

and socioeconomic status such as income and education (Byrne et al., 1994; Perneger et al., 1995a; Perneger et al., 1995b; Young et al., 1994). Among the causes of malnutrition in HD patients, inadequate dietary intake seems to be the most frequent and important. Although it has been hypothesized that inadequate intake might be secondary to underlying illness, psychosocial conditions, aging, or chronic inflammation, definite data on the etiology of inadequate intake in HD patients are still lacking (Bergstrom, 1995). Assessment of the nutritional status in HD patients is of critical importance because poor nutritional status is associated with a poor prognosis in ESRD patients. To prevent malnutrition among HD patients, it is important to identify the patient characteristics associated with inadequate nutrition (Aguilera et al., 2004).

Several studies have shown that family history of ESRD is strongly associated with increased risk of ESRD (Ferguson et al., 1988; Freedman et al., 1993; Freedman et al., 1995; Lei et al., 1998; Spray et al., 1995; Steenland et al., 1990). An

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individual's family history of ESRD is a better predictor of the future risk for CRF than blood glucose concentration or blood pressure (Freedman *et al.*, 1997; Seaquist *et al.*, 1989), indicating genetic susceptibility increased the risk of developing the commonly reported etiologies of ESRD. One population-based study found that the familial component of ESRD plays a significantly independent role in both ESRD and non-ESRD chronic kidney disease mortality (Goldfarb-Rumyantzev *et al.*, 2006), suggesting a direct association between family history and ESRD mortality. It is possible that a family history of CRF is related to a poor prognosis for ESRD, including malnutrition.

Although a few studies have reported inadequate nutritional status and its correlates in Korean HD patients (Kim *et al.*, 1990; Kim *et al.*, 2000; Kim *et al.*, 2001), to our knowledge, no study has investigated the factors related to malnutrition after controlling for other factors and the relationship between malnutrition and family history of CRF. We investigated the nutritional status and factors influencing malnutrition including a family history of CRF in ESRD patients in South Korea.

Subjects and Methods

Subjects

All subjects were ESRD outpatients from general hospitals or HD centers in Seoul who had been referred to our dialysis center in Seoul, Korea, for maintenance of HD care. To be eligible for inclusion in the study, a patient had to have been undergoing maintenance HD three times a week for more than 3 months, to have signed a consent form, and not to have advanced senility or dementia. Among the 144 patients recruited from June 2007 through March 2008, 110 (46 men and 64 women) agreed to participate and were enrolled in this study. The median age of these patients was 58.6 y (range, 28-81 y). All patients were interviewed individually to obtain information about their general characteristics and health behaviors. Patients were asked about a family history of CRF and the family history was considered positive if a patient reported having either a first-degree (parent, sibling, or child) or second-degree (grandparent, aunt, uncle, grandchild, or half sibling) relative with CRF. The primary cause of ESRD was reported and documented by the treating nephrologist. For information about comorbidity, patients were asked to report whether they had ever been diagnosed previously as having diabetes mellitus, bone diseases, hypertension, heart diseases, gastrointestinal diseases, or other diseases.

Measurements

For anthropometrics, height and postdialysis weight were measured with light clothes and without shoes using an automatic height/weight measuring instrument. Percentage of ideal body weight (%IBW) was calculated as (actual body weight /

IBW)×100, and body mass index (BMI) was calculated as kg/m^2. Triceps skinfold thickness (TSF) was measured using a Lange skinfold caliper (Cambridge Scientific Inc., Cambridge, MD, USA). Mid-arm circumference (MAC) was measured with a plastic measuring tape using standardized techniques. Mid-arm muscle circumference (MAMC) was calculated as MAC-(0.314× TSF) (Blumenkrantz *et al.*, 1980). We defined malnutrition as a TSF or MAMC less than the fifth percentile for age and sex for Korean adults (Wicks *et al.*, 1995).

Food intake was recorded using a 24-hour recall method for two consecutive days including one dialysis day and one nondialysis day. The average intake of the two days was considered the daily food intake. The portion size picture booklet was used to help the patients estimate portion size. Food intake data were analyzed using CAN-Pro 3.0 software (The Korean Nutrition Society, 2006) and compared with the Dietary Reference Intake (The Korean Nutrition Society, 2005) for Koreans. Energy and protein intake data were compared with the National Kidney Foundation Kidney Dialysis Outcome Quality Initiative (National Kidney Foundation, 2000) recommended intake for HD patients. The percentage of calories from carbohydrate, fat, and protein was also calculated. Other methods of the study have been described elsewhere (Cho *et al.*, 2008).

Statistical analysis

Data were expressed as mean and standard error (continuous variables) or number and percentage (categorical variables). Differences between diabetic and nondiabetic ESRD patients were evaluated using Student's *t* test or the chi-square test, as appropriate. Because serum ferritin and triglyceride concentrations had a skewed distribution, these variables were log-transformed before analysis. Multivariable-adjusted logistic regression analysis was conducted to examine the odds ratio (OR) for malnutrition between patients with and without a family history of ESRD. All analyses were performed using SAS 9.1 software (SAS Inc., Cary, NC, USA). Significance was defined as $P < 0.05$.

Results

Prevalence of malnutrition and characteristics of Korean HD patients

The clinical characteristics of these Korean HD patients are shown in Table 1. The mean age and duration of HD were 58.6 years and 5.8 years, respectively. Forty-seven of the 110 patients were malnourished. Diabetes mellitus was the main primary cause of ESRD. About 17% of patients had a positive family history of CRF, 85% had hypertension, 49% had diabetes, and 93% anemia, defined as a hemoglobin level <13 g/dL for men and <12 g/dL for women. As expected, the mean BMI and %IBW were greater in patients without malnutrition (both $P < 0.0001$).

Table 1. Clinical characteristics of Korean hemodialysis (HD) patients[1]

Variables	All (n=110)	Without malnutrition (n=63)	With malnutrition (n=47)	P
General characteristics				
Age (y)	58.6 ± 1.0	56.5 ± 1.4	58.7 ± 1.4	0.9070
Women	64 (58.2)	28 (44.4)	36 (76.6)	0.0014
Duration of HD (y)	5.8 ± 0.5	4.7 ± 0.5	7.3 ± 0.8	0.0095
Primary cause				
Chronic glomerulonephritis	39 (35.5)	21 (33.3)	18 (38.3)	0.1269
Diabetes mellitus	50 (45.5)	34 (54.0)	16 (34.4)	
Hypertension	5 (4.5)	2 (3.2)	3 (6.4)	
Other	16 (14.5)	6 (9.5)	10 (21.3)	
Family history of CRF	19 (17.3)	6 (9.5)	13 (27.7)	0.0255
Comorbidities				
Diabetes	54 (49.1)	38 (60.3)	16 (34.0)	0.0113
Hypertension	93 (84.6)	57 (90.5)	36 (76.6)	0.0844
Heart diseases	21 (19.1)	12 (19.1)	9 (19.2)	1.0000
Bone diseases	30 (27.3)	12 (19.1)	18 (38.3)	0.0427
Gastrointestinal diseases	37 (33.6)	17 (27.0)	20 (42.6)	0.1321
Liver diseases	11 (10.0)	5 (7.9)	6 (12.8)	0.6073
Neuropsychiatric diseases	3 (2.7)	1 (0.9)	2 (3.2)	0.7963
Cancer	3 (2.7)	3 (4.8)	0 (0.0)	0.3549
Cerebrovascular diseases	6 (5.5)	4 (6.4)	2 (3.2)	0.9569
Respiratory diseases	3 (2.7)	0 (0.0)	3 (6.4)	0.1492
BMI (kg/m^2)	22.1 ± 0.3	23.4 ± 0.4	20.2 ± 0.3	<0.0001
% ideal body weight	103.6 ± 1.5	109.7 ± 1.9	95.5 ± 1.7	<0.0001
Having appetite	64 (58.2)	39 (61.9)	25 (53.2)	0.4708
Drinking alcohol				
Current drinker	27 (24.6)	19 (30.2)	8 (17.0)	0.1158
Ex-drinker	34 (30.9)	21 (33.3)	13 (27.7)	
Nondrinker	49 (44.6)	23 (36.5)	26 (55.3)	
Ever smoker	37 (33.6)	30 (47.6)	7 (14.9)	0.0007
Education[2]				
≤Elementary school graduate	31 (28.7)	19 (30.2)	12 (26.7)	0.9247
Middle school graduate	18 (16.7)	10 (15.9)	8 (17.8)	
High school graduate	33 (30.6)	18 (28.6)	15 (33.3)	
≥College graduate	26 (24.1)	16 (25.4)	10 (22.2)	
Personal expense, Korean won				
<100,000	44 (40.0)	23 (36.5)	21 (44.7)	0.4232
100,000-500,000	50 (45.5)	32 (50.8)	18 (38.3)	
>500,000	16 (14.6)	8 (12.7)	8 (17.0)	
Doing regular exercise	57 (51.8)	37 (58.7)	20 (42.6)	0.1371
Nutritional supplement use	13 (11.8)	6 (9.5)	7 (14.9)	0.5724
Clinical variables				
Systolic blood pressure (mmHg)	151.6 ± 2.4	155.0 ± 2.9	147.0 ± 4.1	0.1058
Diastolic blood pressure (mmHg)	81.6 ± 1.2	83.1 ± 1.5	79.5 ± 1.9	0.1312
HD adequacy				
spKt/V <1.2	16 (14.6)	14 (22.2)	2 (4.3)	0.0178
URR <65%	20 (18.2)	18 (28.6)	2 (4.3)	0.0025
Anemia[3]				
Hemoglobin <13 g/dL men, <12 g/dL women	102 (93.6)	58 (93.6)	44 (93.6)	1.0000
Hypocholesterolemia				
Total cholesterol <150 mg/dl	51 (46.4)	27 (42.9)	24 (51.1)	0.5089
Hematological variables				
Hematocrit (%)	33.7 ± 0.3	33.1 ± 0.4	34.4 ± 0.5	0.0416
Iron (μg/dl)[4]	73.3 ± 3.0	79.1 ± 3.7	64.4 ± 4.5	0.0151
TIBC (μg /dl)[5]	249.0 ± 4.7	256.5 ± 5.5	237.5 ± 8.1	0.0471
Ferritin (ng/ml)[6,7]	262.1 ± 49.1	211.5 ± 44.3	331.8 ± 99.2	0.2709
Albumin (g/dl)	3.8 ± 0.0	3.8 ± 0.1	3.7 ± 0.1	0.4962
Total Protein (g/dl)	6.7 ± 0.0	6.7 ± 0.1	6.6 ± 0.1	0.2990
Blood urea nitrogen (mg/dl)	69.4 ± 1.7	70.9 ± 2.2	67.4 ± 2.4	0.2912
Creatinine (mg/dl)[2]	9.7 ± 0.3	10.3 ± 0.4	8.9 ± 0.4	0.0099
Uric acid (mg/dl)[8]	7.8 ± 0.2	8.1 ± 0.2	7.3 ± 0.3	0.0444
Potassium (mmol/l)	5.4 ± 0.1	5.3 ± 0.1	5.6 ± 0.1	0.1528
Sodium (mmol/l)	138.5 ± 0.3	138.7 ± 0.4	138.2 ± 0.6	0.5095
Calcium (mg/dl)	8.8 ± 0.1	8.8 ± 0.1	8.9 ± 0.1	0.6985
Phosphorus (mg/dl)[2]	5.2 ± 0.2	5.2 ± 0.2	5.2 ± 0.2	0.8951
HDL-C (mg/dl)[8]	45.0 ± 1.6	42.5 ± 1.9	49.0 ± 2.4	0.0419
Triglyceride (mg/dl)[7,8]	114.8 ± 6.4	127.3 ± 9.0	94.8 ± 7.3	0.0339
LDL-C (mg/dl)[8]	83.5 ± 3.1	85.2 ± 4.0	81.0 ± 5.1	0.5197

[1] Values are means ± SE or n (%). *P* values were obtained using Student's *t* test or a chi-square test.
[2] Data for 108 patients
[3] Data for 109 patients
[4] Data for 92 patients
[5] Data for 93 patients
[6] Data for 107 patients
[7] Values were log-transformed before analysis.
[8] Data for 83 patients

Malnutrition was more prevalent in women (*P*=0.0014), nondiabetic patients (*P*=0.0113), those with an adequate HD (*P*=0.0178), patients with a family history of CRF (*P*=0.0255) or bone diseases (*P*=0.0427). Fewer patients who had ever smoked were malnourished than those who had never smoked (*P*=0.0007). For hematological variables, hematocrit was slightly higher in malnourished HD patients (*P*=0.0416), whereas serum iron concentration (*P*=0.0151) and TIBC (*P*=0.0471) were higher in HD patients without malnutrition. Serum concentrations of creatinine (*P*=0.0099) and uric acid (*P*=0.0444) were higher in HD patients without malnutrition. Serum HDL-C concentration was higher in HD patients with malnutrition (*P*=0.0419), and serum TG concentration was higher in HD patients without malnutrition (*P*=0.0339).

Inadequacy of nutrient intake of Korean HD patients

The inadequacy of daily nutrient intake of patients is shown in Table 2. More than 60% of patients consumed less than the intake of energy (30-35 kcal/kg IBW) and protein (1.2 g/kg IBW) recommended by the National Kidney Foundation Kidney Dialysis Outcome Quality Initiative. The percentages of patients consuming less than the Korean estimated average requirements

Table 2. Inadequacy of daily nutrient intake of Korean HD patients[1]

Variables	All (n=110)	Without malnutrition (n=63)	With malnutrition (n=47)	P
Energy (kcal)/IBW (kg)	27.1 ± 0.6	27.4 ± 0.8	26.6 ± 1.0	0.5579
Below NFK[2]	74 (67.3)	43 (68.3)	31 (66.0)	0.9613
Protein (g)/IBW (kg)	1.1 ± 0.0	1.1 ± 0.0	1.1 ± 0.1	0.6872
Below NFK	70 (63.6)	42 (66.7)	28 (59.6)	0.5724
Energy, below EER[3]	98 (89.1)	54 (85.7)	44 (93.6)	0.3144
Below EAR[4]				
Protein	11 (10.0)	5 (7.9)	6 (12.8)	0.6073
Calcium	90 (81.8)	50 (79.4)	40 (85.1)	0.6014
Phosphorus	23 (20.9)	11 (17.5)	12 (25.5)	0.4279
Iron	17 (15.5)	11 (17.5)	6 (12.8)	0.6839
Zinc	48 (43.6)	24 (38.1)	24 (51.1)	0.2451
Vitamin A	32 (29.1)	19 (30.2)	13 (27.7)	0.9416
Vitamin B_1	66 (60.0)	39 (61.9)	27 (57.5)	0.7830
Vitamin B_2	89 (80.9)	53 (84.1)	36 (76.6)	0.4539
Vitamin B_6	19 (17.3)	8 (12.7)	11 (23.4)	0.2246
Vitamin C	66 (60.0)	35 (55.6)	31 (66.0)	0.3655
Folate	105 (95.5)	59 (93.7)	46 (97.9)	0.5560
Energy distribution				
% Carbohydrate	59.5 ± 0.8	60.1 ± 1.0	58.8 ± 1.2	0.4014
% Protein	16.2 ± 0.3	15.9 ± 0.3	16.6 ± 0.4	0.1600
% Fat	24.7 ± 0.7	24.6 ± 0.9	24.7 ± 1.0	0.9069

[1] Values are mean ± SE or n (%). P values were calculated using Student's t test or a chi-square test.
[2] Number of patients whose intake was below the recommendation of the NFK-KDOQI.
[3] Number of patients whose intake was below the estimated energy requirement (EER) for Korean adults.
[4] Number of patients whose intake was below the estimated average requirement (EER) for Korean adults.

Table 3. Adjusted OR and 95% CI for malnutrition in Korean HD patients

Variables	OR (95% CI)
Age (y)	0.998 (0.951-1.048)
Female	1.568 (0.324-7.582)
Duration of HD	1.065 (0.968-1.172)
Having diabetes	0.519 (0.197-1.370)
Having bone diseases	1.317 (0.451-3.846)
Family history of CRF	3.322 (1.011-10.916)
Never smoked	0.458 (0.080-2.623)
HD adequacy (spKt/V ≥ 1.2)	1.993 (0.342-11.619)

(EAR) was 81.8% for calcium, 60.0% for vitamin B_1, 80.9% for vitamin B_2, 60.0% for vitamin C, and 95.5% for folate. The percentage of patients consuming less than the energy/IBW and protein/IBW levels recommended by the Korean EAR did not differ significantly between HD patients with and without malnutrition.

OR and 95% confidence intervals for malnutrition

The relationships between various factors and the risk of malnutrition are shown in Table 3. After adjusting for age, sex, duration of HD, having diabetes, having bone diseases, smoking,

and HD adequacy, the OR for malnutrition was higher in HD patients with a family history of CRF (OR, 3.290; 95% confidence interval (CI), 1.003-10.793).

Discussion

Nutritional assessment and management are considered as an important therapeutic approach for HD patients for better prognosis. We found that 43% of Korean HD patients were malnourished, as defined by TSF or MAMC values below the fifth percentile for age and sex for Korean adults. Previous studies of Korean HD patients have used different indicators to assess the prevalence of malnutrition; for example, 76% of patients were classified as being mildly malnourished based on the weight and serum albumin concentration (Kim et al., 2000), and 21% were classified as underweight (Kim et al., 2001). Malnourished HD patients often have low fat mass and lean body mass (Kim & Kim, 2001; Kim et al., 2001; Oksa et al., 1991). Thus, the assessment of fat mass by TSF and lean body mass by MAMC is an important part of the nutritional assessment of HD patients. HD patients' daily nutrient intakes are also inadequate. More than 60% of our patients had dietary intakes below the levels of energy and protein recommended by the National Kidney Foundation Kidney Dialysis Outcome Quality Initiative (2000); our data are consistent with those of another study (Kim et al., 1990) showing HD patients were in protein and energy malnutrition. The percentage of patients consuming less than the EAR was 81.8% for calcium, 60.0% for vitamin B_1, 80.9% for vitamin B_2, 60.0% for vitamin C, and 95.5% for folate. In previous studies in Korea, Kim et al. (1990) reported inadequate intake of protein, energy, and vitamins A, B_1, B_2, and C in HD patients, and Chun (2001) reported insufficient intakes of vitamins A, B_1, and B_2, and niacin.

Unexpectedly, the means of energy/IBW and protein/IBW did not differ significantly between HD patients with and without malnutrition. The proportions of people consuming less than the Korean EAR also did not differ significantly between the two groups. That is, in our patients, the inadequacy of dietary intake did not differ significantly between the two groups. After adjusting for other variables related to malnutrition, only a family history of CRF remained significant. After adjusting for age, sex, duration of HD, having diabetes, having bone diseases, smoking, and HD adequacy, the OR for malnutrition was 3.3 times greater in HD patients with a family history of CRF (OR, 3.290; 95% CI, 1.003-10.793), indicating that a family history of CRF may be an independent risk factor for malnutrition in HD Korean patients. In HD patients, malnutrition is known to be related to case mix and comorbid conditions (Qureshi et al., 1998), which may be associated with a family history of CRF. Our results showed that nutritional intake of HD patients was inadequate but no difference in inadequacy existed between patients with and without malnutrition. Thus, malnutrition may not be mainly due to inadequate nutritional intake but be due to secondary

effects such as chronic inflammation from comorbid conditions and a poor prognosis related to familiar history of CRF in our study subjects, although we were not able to determine the causality of relation due to the nature of cross-sectional study. Family history of ESRD is strongly associated with an increased risk of ESRD (Ferguson *et al.,* 1988; Freedman *et al.,* 1993; Freedman *et al.,* 1995; Lei *et al.,* 1998; Spray *et al.,* 1995; Steenland *et al.,* 1990). A population-based study showed that a familial component of ESRD plays a significantly independent role in both ESRD and non-ESRD chronic kidney disease mortality (Goldfarb-Rumyantzev *et al.,* 2006). This suggests a direct association between family history and ESRD mortality, and it is possible that a family history of CRF is related to a poor prognosis for ESRD including malnutrition.

Family history shares both environmental and genetic factors including underlying diseases among family members. Environmental risk factors for ESRD can be shared among family members. For example, families of low socioeconomic status might not be able to afford treatment for diabetes, hypertension, or early symptoms of kidney damage because of limited access to health care (Byrne *et al.,* 1994; Perneger *et al.,* 1995a; Perneger *et al.,* 1995b; Young *et al*., 1994). To account for differences in socioeconomic status, we compared income and education levels between patients with and without malnutrition but found no significant differences. To study the role of underlying diseases, Lei *et al.* (1998) showed that familial clustering of ESRD is independent of diabetes and hypertension. We also controlled for comorbidities, but family history of CRF remained significant. It has been suggested that patients with CRF relating to a genetic predisposition might have more rapid progression of disease and reach ESRD earlier (Goldfarb-Rumyantzev *et al.,* 2006). It is possible that HD patients with a family history of CRF are more likely to be malnourished because of the rapid progression to ESRD and prolonged duration of ESRD.

Malnutrition is prevalent and is strongly associated with increased morbidity and mortality in patients on HD (Fleischman *et al.,* 1999; Kopple *et al.,* 1999; Leavey *et al.,* 1998; Pifer *et al.,* 2002). Our findings suggest that HD patients with a family history of CRF should be monitored and targeted to prevent malnutrition. Given that a family history of CRF is a strong risk factor for malnutrition, individuals with a family history should be targeted for periodic routine nutritional intervention. Adequate dietary intake seems to be one of the top priorities for them. To prevent malnutrition among HD patients, it is also important to identify patient characteristics (Aguilera *et al.,* 2004) such as socioeconomic status that would predispose them to inadequate dietary intake.

Our study had several limitations that should be addressed in future studies. We observed an association in a cross-sectional setting, but we were unable to compare the relative impact of a family history of CRF and malnutrition on morbidity and mortality in HD patients. The information about a family history of CRF relies on the ability of patients to identify correctly a positive family history. One study of African-Americans found that 88% of those who reported a positive family history of ESRD correctly identified their family history (Freedman *et al.,* 1997). Although we have no comparable data for Koreans and some of our study subjects aged over 65 years, the effect of any potential recall error is likely to be small. Our study also has several advantages. It is the first study to test whether there is a direct association between a family history of CRF and malnutrition in HD patients in Korea. We included in our analyses most of the putative risk factors for malnutrition, such as socioeconomic factors, behavioral factors, appetite, comorbidity, dietary intake, and HD adequacy. We also employed a combination of anthropometric and biochemical indicators to assess nutritional status rather than a single measure.

In conclusion, our study showed that the nutritional status of Korean HD patients is inadequate. Active nutrition monitoring is needed to improve the nutritional status of HD patients in Korea. Individuals on HD with a family history of CRF should be targeted for dietary intervention to prevent malnutrition. Our results also suggest that a family history of CRF is an independent risk factor for malnutrition in Korean HD patients. A follow-up study is needed to investigate whether there is a causal relation between a family history of CRF and malnutrition, and the underlying mechanism in Korean ESRD patients.

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