Original Research

Nutritional Status of Functionally Dependent and Nonfunctionally Dependent Elderly in Taiwan

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Key words: nutritional status, activities of daily living, functionally dependent, nonfunctionally dependent, elderly

Objective: The purpose of this study was to measure and compare nutritional status of the functionally dependent elderly with those nonfunctionally dependent elderly by assessing nutrient intake, anthropometric measurements, hematological and biochemical parameters, and the nutritional risk index (NRI).

Methods: Ninety-six volunteers (42 functionally dependent elderly, 54 nonfunctionally dependent elderly) participated in this study. The items of activity of daily living (ADL) were assessed to determine functional status. Demographic and health data were collected at the time of interview. Subjects completed 24-hour diet recall and food frequency questionnaires. Height, weight and skinfold thickness measurements were taken. Hematological and biochemical parameters were measured. The NRI was then calculated.

Results: Osteoporosis and hypertension were the most frequently reported chronic diseases. A small proportion of the elderly with functional dependence (9.5%) and with nonfunctional dependence (13%) had a body mass index (BMI) ($\leq$21 kg/m^2), indicating they were underweight. There were no significant differences in nutrient intake between the two groups. However, a higher percentage of the functionally dependent elderly had a nutrient intake of less than 75% of the Taiwan Recommended Daily Nutrient Allowance (RDNA). The functionally dependent group had a higher prevalence of malnutrition than the nonfunctionally dependent group (44.7% vs. 25%) based on the NRI.

Conclusions: These functionally dependent elderly people exhibited a poorer nutritional status than the nonfunctionally dependent elderly. The elderly with functional dependence were at risk for inadequate iron intake and abnormal serum triglyceride concentrations; they were also at greater risk for chronic diseases and had a greater need for medications.

INTRODUCTION

Elderly people are more likely than young adults to be at high risk of nutritional deficiency in terms of loss of efficiency within organ systems and health-care problems. Inadequate dietary intake [1,2], social conditions [3], chronic diseases (i.e., cardiovascular disease, hypertension, obesity, diabetes mellitus and cancer) [4], medication use [5] and functional disabilities [6,7] are the factors that affect the nutritional status of the elderly. Studies showed that elderly people with functional limitations receive an inadequate diet [7–9]. Chan *et al.* [8] indicated that the low energy intake of the female centenarians was probably due to their low ADL.

Studies have been done to assess nutritional status of free-living or institutionalized elderly [8,11,12]. Functional status is one of the nutritional assessment methods used to examine nutritional status in the elderly; however, the effect of functional status on nutritional status has not been conducted. The purpose of this study was to determine the nutritional status of elderly persons in Taiwan and to compare the nutritional status of elderly subjects in Taiwan who were functionally and non-functionally dependent. An additional objective was to study

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the relationship between functional status and single nutritional assessment indices in the elderly.

SUBJECTS AND METHODS

Subjects

The study protocol was approved as ethical when the research proposal was reviewed by the Chung-Shan Medical and Dental College. For the purpose of this study, "elderly" is defined as someone who is sixty-five years of age or older. Subjects were free-living and were recruited from the local community and senior citizen centers in the city of Taichung, Taiwan. All subjects were examined by a physician and ascertained to have no edema or dehydration which would affect the accuracy of anthropometric measurements.

Functional status was assessed by subjects' ability to perform ADL, including bathing, dressing, grooming, toileting, walking or moving about and feeding (appetite, ability to swallow and chew as well as mouth and teeth problems were assessed) (Table 1). The ADL was ascertained by interviewing the subjects. On the basis of self-reporting, all elderly requiring help with one or more items or unable to perform any items were assigned to the functionally dependent group. Forty-two elderly (13 men, 29 women) with functional dependence and 54 elderly (27 men, 27 women) without functional dependence were recruited for this study. Informed consent was obtained from each subject.

Experimental Protocol

Demographic and health data were collected at the time of the interview. The demographic and health questionnaires were designed to obtain information on marital status, education level, living situation, alcohol use, smoking status, chronic diseases and use of medication.

Table 1. Number of Elderly Men and Women Responding as Dependent in Each Daily Living Activity

Activity	Men (n=40)	Women (n=56)
	n	
Bathing	0	0
Dressing	0	0
Grooming	0	0
Toileting	0	0
Walking or moving about	0	1
Feeding	0	0
Poor appetite	1	6
Difficulty swallowing	1	7
Difficulty chewing	2	9
Mouth problems	1	5
Tooth problems	6	10
Shopping	4	3
Food preparation	4	4
Traveling (outside the home)	0	1

Current body weight, height, triceps skinfold thickness (TSF) and mid-arm circumference (MAC) were measured. Usual body weight, defined as stable weight for six months prior to the study, was obtained from each subject. The BMI (kg/m^2), ideal body weight, mid-arm muscle circumference (MAMC) and arm muscle area (AMA) were calculated. Ideal body weight was calculated based on the formula of Huang *et al.* [13]: Men=[height (cm)−80]×0.7; women=[height (cm)−70]×0.6. This formula was used because it reflects most precisely the actual body weight of Chinese persons. Mid-arm muscle circumference (cm)=MAC (cm)−[TSF (cm)×3.14]. Arm muscle area (mm^2)=[MAC (mm)−[TSF (cm)×3.14]. Arm muscle area (mm^2)=[Mac (mm)−(TSF (mm)×3.14)]^2/4π.

Subjects were given instructions on how to complete a 24-hour diet recall and food frequency questionnaire. If subjects had trouble completing the 24-hour dietary recall and food frequency questionnaire, our trained dietitian would assist them or their designated proxies. If vitamin or mineral supplements were used, the brand name, contents, dosage and frequency were recorded so as to determine total nutrient intake. Nutrient composition was calculated using the food composition table (Department of Health, Taiwan, 1994). The results of nutrient data were compared to the RDNA (Department of Health, Taiwan, 1993).

Once the 24-hour diet recall and food frequency questionnaires had been completed, fasting venous blood samples were obtained to estimate hematological [hemoglobin, hematocrit, mean corpuscular volume (MCV), red blood cell (RBC) and white blood cell (WBC)] and biochemical (albumin, total serum cholesterol and triglycerides) parameters. Blood specimens were collected in Vacutainer tubes (Becton Dickinson, Rutherford, NJ) containing an appropriate anticoagulant (EDTA or Heparin). The hematological and biochemical parameters were determined on an Automatic Analyzer (TOSHIBA-30FR, Toshiba, Japan). The following values were considered normal for our laboratory: hemoglobin, 12–18 g/dL; hematocrit, 37%–52%; MCV, 80–100 fL; RBC, 4.2–5.6 mil/mm^3; WBC, 4.5–10.6 thous/mm^3; serum albumin, 3.5–5.0 g/dL; total cholesterol, 150–250 mg/dL; triglycerides, 40–150 mg/dL.

The NRI [14,15] was developed by Buzby *et al.* to assess malnutrition in surgical patients. Naber *et al.* [16] investigated the specificity of NRI in apparently healthy people and indicated that NRI could be used accurately to diagnose malnutrition for persons less than 70 years of age. Since most of our subjects were in this category, the NRI was calculated. The NRI=(15.9×plasma albumin, g/dL)+41.7×(present weight/usual weight). A NRI>100 indicates the subject is not malnourished, 97.5–100 mildly malnourished. 83.5–<97.5 moderately malnourished and <83.5 severely malnourished.

Statistical Analyses

Data were analyzed by using the SigmaStat statistical software (Version 1.0, Jandel Scientific, San Rafael, CA). Student's *t* test was used to determine the difference in subjects' anthropometric measurements to compare the two groups. Because some of the data were skewed rather than normally distributed, differences in subjects' hematological and biochemical parameters and nutrient intake between the two groups were determined by use of the Mann-Whitney rank test. For categorical response variables, differences between groups were assessed by Chi-square or Fisher's exact test. Multiple regression stepwise procedures were performed to assess the relationship between functional status and each nutritional status parameter. Statistical results were considered to be significant at $p \leq 0.05$. Values presented in the text are means±standard deviation (SD) with the median value in parentheses.

RESULTS

Demographic and Health Characteristics

Characteristics of subjects are shown in Table 2. Subjects' ages ranged from 65 to 80 years, with a mean age of 70.5±4.1 and 69.0±3.6 years for the functionally dependent and nonfunctionally dependent group, respectively. Only one man in the nonfunctionally dependent group was single; 11.9% of functionally dependent subjects and 5.6% of nonfunctionally dependent subjects lived alone. Of the subjects, 33.3% of

Table 2. Demographic and Health Characteristics of Functionally Dependent and Nonfunctionally Dependent Subjects

Characteristics	Functionally Dependent (n=42)	Nonfunctionally Dependent (n=54)
	n (%)[#]	
Age (years)		
65–69	17 (40.5%)	32 (60%)
70–79	24 (57.1%)	22 (40.7%)
≥80	1 (2.4%)	0
Marital status		
Single	0	1 (1.9%)
Married	27 (64.3%)	42 (77.8%)
Widowed/Divorced/Separated	15 (35.7%)	11 (20.4%)
Education		
None	14 (33.3%)	16 (29.6%)
Elementary school	12 (28.6%)	19 (35.2%)
Junior high school	7 (16.7%)	6 (11.1%)
High school	7 (16.7%)	7 (13%)
College	0	6 (11.1%)
Living situation		
Live alone	5 (11.9%)	3 (5.6%)
Live with couple only	9 (21.4%)	8 (14.8%)
Live with family	27 (64.3%)	41 (75.9%)
Other	1 (1.9%)	2 (3.7%)
Smoking status	4 (9.5%)	5 (9.3%)
≤half pack/day	3 (7.1%)	4 (7.4%)
≥1 pack/day	1 (1.9%)	1 (1.9%)
Alcoholic drinking	6 (14.3%)	13 (24.1%)
≤20 c.c./day	3 (7.1%)	3 (5.6%)
>100 c.c./day	2 (4.8%)	6 (11.1%)
Drug use		
One or more prescription or OTC drugs	25 (59.5%)	21 (38.9%)
Reported chronic diseases		
Osteoporosis	19 (45.2%)	24 (44.4%)
Hypertension	17 (40.5%)	21 (38.9%)
Heart disease	13 (31%)	7 (13%)
Stroke	1 (1.9%)	0
Diabetes Mellitus	5 (11.9%)	5 (9.3%)
Anemia	7 (16.7%)	10 (18.5%)
Lung disease	2 (4.8%)	4 (7.4%)
Renal disease	5 (11.9%)	3 (5.6%)
Two or more chronic diseases	7 (16.7%)	5 (9.3%)

[#] n, the number of subjects.

functionally dependent and 29.6% of the nonfunctionally dependent had received no education; 9.55% of functionally dependent and 9.3% of nonfunctionally dependent smoked regularly; 14.3% of functionally dependent and 24.1% of nonfunctionally dependent drank alcohol. Just fewer than half of the subjects took one or more prescription or over-the-counter (OTC) drugs. Osteoporosis and hypertension were the most frequently reported chronic diseases. Two or more chronic diseases were present in 16.7% of the functionally dependent and in 9.3% of the nonfunctionally dependent subjects.

Anthropometric Measurements

The results of anthropometric measurements are presented in Table 3. Subjects' mean current weights were significantly heavier than their mean ideal body weight. The elderly with functional dependence were 12.8% overweight, while nonfunctionally dependent subjects were 9.5% overweight. A small proportion of functionally dependent subjects (9.5%) and nonfunctionally dependent subjects (13%) had a BMI ($\leq$21 kg/m^2) indicating underweight, and 16.7% of functionally dependent and 13% of nonfunctionally dependent subjects had an index ($>$27 kg/m^2) indicative of obesity. Reference values on anthropometric indicators for Chinese adults have not been well established. Therefore, we used the data reported by Frisancho [17] as the reference value. None of our subjects in either group with TSF, MAC, MAMC and AMA values were higher than the 95th percentile. A higher percentage of functionally dependent subjects had MAC, MAMC and AMA measurements less than 10th percentile indicating undernutrition than nonfunctionally dependent subjects.

Hematological and Biochemical Parameters

The results of hematological and biochemical parameters are shown in Table 4. All mean values of hematological and biochemical parameters were within the normal range. Few elderly subjects had hematological and biochemical levels beyond the normal range. None of the nonfunctionally dependent subjects had abnormal serum albumin concentrations. The subjects in the functionally dependent group showed no significant differences in their hematological and biochemical parameters; however, their values were slightly lower than those of the nonfunctionally dependent group. Functionally dependent subjects did have significantly higher serum triglyceride values than nonfunctionally dependent subjects (p=0.0037).

Dietary Intakes

Nutrient intake from the 24-hour dietary recall kept by the subjects was calculated (Table 5). There were no significant

Table 3. Anthropometric Measurements of Functionally Dependent and Nonfunctionally Dependent Subjects

Anthropometry	Functionally Dependent (n=42)	Nonfunctionally Dependent (n=54)
Height (cm)	155.4±8.1 (155.3)[#]	158.4±6.8 (157.3)
Weight		
Current weight (kg)	59.6±9.0 (58.5)	60.0±8.8 (59.0)
Ideal body weight	52.0±5.6[†] (50.6)	54.3±5.3[†] (53.5)
Weight change exceeding±4 kg within the past six months	4	1
BMI (kg/m^2)	24.7±3.2 (24.4)	23.9±2.9 (23.8)
≤21 kg/m^2	4 (9.5%)	7 (13%)
>27 kg/m^2	7 (16.7%)	7 (13%)
Triceps skinfold (mm)	17.4±6.2 (15.5)	15.5±6.9 (15.5)
≤10th percentile*	7 (16.7%)	10 (18.5%)
>95th percentile*	0	0
Mid-arm circumference (cm)	27.9±2.6 (28.0)	28.2±2.9 (28.5)
≤10th percentile**	8 (19.0%)	8 (6.8%)
>95th percentile**	0	0
Mid-arm muscle circumference (cm)	22.4±2.0 (22.4)	23.5±3.1 (23.2)
≤10th percentile***	12 (28.6%)	12 (22.2%)
>95th percentile***	0	0
Arm muscle area (cm^2)	40.4±7.3 (40.1)	43.9±10.0 (43.0)
≤10th percentile****	12 (28.6%)	12 (22.2%)
>95th percentile****	0	0

[#] Data are expressed as mean±SD with the median value in the parentheses.

* 10th percentile: men, 6 mm; women, 14 mm; 95th percentile: men, 22 mm; women, 36 mm.

** 10th percentile: men, 26.3 cm; women, 25.2 cm; 95th percentile: men, 35.5 cm, women, 37.3 cm.

*** 10th percentile: men, 23.5 cm; women, 19.5 cm; 95th percentile: men, 30.6 cm, women, 27.9 cm.

**** 10th percentile: men, 44.11 cm^2; women, 30.18 cm^2; 95th percentile: men, 74.53 cm^2, women, 62.14 cm^2.

[†] The value is significantly different than current body weight within group; $p<0.05$.

Table 4. Biochemical Measurements of Functionally Dependent and Nonfunctionally Dependent Subjects

Biochemical Parameters	Functionally Dependent (n=42)	Number of Subjects and Percentage Beyond the Normal Range	Nonfunctionally Dependent (n=54)	Number of Subjects and Percentage Beyond the Normal Range
Hemoglobin (g/dL)				
[12–18 g/dL]*	13.5±3.3 (13.3)#	5 (11.9%)	13.6±1.4 (13.7)	4 (7.4%)
Hematocrit (%)				
[37–52%]	40.1±6.1 (41.4)	5 (11.9%)	42.3±3.7 (42.2)	4 (7.4%)
Mean Corpuscular Volume (fL)				
[80–100 fL]	90.6±6.6 (92.0)	3 (7.1%)	91.5±7.6 (93.0)	5 (9.3%)
Red Blood Cells (mil/mm^3)				
[4.2–5.6 mil/mm^3]	4.5±0.7 (4.4)	8 (19%)	4.6±0.5 (4.7)	8 (14.8%)
White Blood Cells (thous/mm^3)				
[4.5–10.6 thous/mm^3]	6.3±1.7 (6.3)	4 (9.5%)	6.4±1.7 (6.4)	6 (11.1%)
Albumin (g/dL)				
[3.5–5.0 g/dL]	4.0±0.2 (4.1)	2 (4.8%)	4.1±0.2 (4.1)	0
Total cholesterol (mg/dL)				
[150–250 mg/dL]	197.4±38.0 (199.5)	5 (11.9%)	199.9±38.1 (199.5)	6 (11.1%)
Triglycerides (mg/dL)				
[40–150 mg/dL]	148.8±88.9† (134.0)	18 (42.9%)	105.6±58.6 (91.0)	6 (11.1%)

Data are expressed as mean±SD with the median value in the parentheses.
* Figure in the brackets indicates normal range.
† The value is significantly different than that for nonfunctionally dependent elderly, $p=0.0037$.

Table 5. Mean Dietary Intakes of Functionally Dependent and Nonfunctionally Dependent Subjects

Nutrients	Functionally Dependent (n=42)	Nonfunctionally Dependent (n=54)
Energy (kcal)	1589.7 ± 525.4#,* (1463.2)	1700.2 ± 427.0* (1650.5)
Carbohydrate (g)	214.4 ± 87.6 (191.8)	231.8 ± 24.8 (220.8)
% total energy	53.9 ± 10.6 (53.6)	59.6 ± 11.3 (55.5)
Fat (g)	55.7 ± 22.7 (53.3)	45.1 ± 35.8 (51.0)
% total energy	31.5 ± 9.1 (31.9)	26.1 ± 11.1 (29.8)
Protein (g)	57.7 ± 23.8 (51.3)	61.1 ± 20.3 (58.8)
% total energy	14.5 ± 1.8 (14.4)	14.3 ± 2.6 (14.4)
Vitamin A (IU)	7782.1 ± 6853.6 (5400)	8071.6 ± 6505.7 (6284.5)
Vitamin C (mg)	108.6 ± 102.4 (68.1)	112.1 ± 90.9 (86.1)
Thiamin (mg)	1.0 ± 1.1 (0.7)	0.9 ± 0.5 (0.9)
Riboflavin (mg)	1.1 ± 0.8 (0.8)	0.9 ± 0.4 (0.9)
Niacin (mg)	9.9 ± 11.9* (6.9)	9.4 ± 4.1* (9.2)
Calcium (mg)	715.0 ± 461.2 (711.8)	652.0 ± 313.3 (629.4)
Iron (mg)	20.0 ± 16.8 (15.6)	17.3 ± 8.3 (16.2)
Sodium (g)	3.4 ± 2.5 (2.4)	3.2 ± 2.1 (2.7)
Dietary fiber (g)	4.1 ± 2.0 (3.5)	4.8 ± 3.1 (4.3)

Data are expressed as mean±SD with the median value in the parentheses.
* Value is significantly below the Taiwan RDNA.

differences in nutrient consumption between the two groups; however, the functionally dependent group had slightly lower carbohydrate, vitamin A, vitamin C and dietary fiber values than the nonfunctionally dependent group. When intake of the energy-providing nutrients was expressed as a percentage of total caloric consumption, the percentage of energy from macronutrients was close to the recommended amounts (55% to 60% carbohydrate, 25% to 30% fat, 15% to 20% protein; Department of Health, Taiwan, 1993). Functionally dependent subjects consumed a slightly higher mean percentage of fat than nonfunctionally dependent subjects (31.5% *vs.* 26.1%). The elderly had a mean energy intake lower than the Taiwan RDNA of 1800 kcal/day for men and 1600 kcal/day for women (Department of Health, Taiwan, 1993). Subjects had a mean intake of vitamin A, C, thiamin, riboflavin, calcium and iron equal to or higher than the Taiwan RDNA.

Although many elderly have a nutrient intake above the Taiwan RDNA, individual variation was also considered. Fig. 1 shows percentages of subjects with dietary consumption of less than 75% of the RDNA. A majority of functionally (61.9%) and nonfunctionally (42.6%) dependent subjects had a niacin intake below 75% of the RDNA. Although no significant differences were found in nutrient assumption between the two groups, higher percentages of functionally dependent subjects consumed energy, protein, vitamin A, vitamin C, riboflavin, niacin, calcium and iron in amounts less than 75% of the RDNA than was the case for the nonfunctionally dependent subjects.

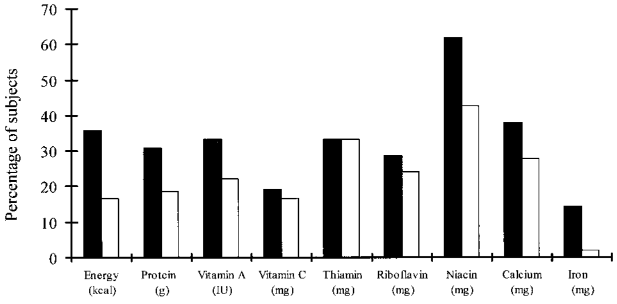

Fig. 1. The percentage of functionally dependent (n=42) and nonfunctionally dependent (n=54) subjects with dietary intakes of less than 75% of Taiwan RDNA. ■=functionally dependent, □=nonfunctionally dependent.

Functional Status

All subjects in the functionally dependent group were completely independent for bathing, dressing, grooming, toileting and feeding (Table 1). Elderly women tended to have more problems with a lack of appetite, with swallowing or chewing and with their mouths and teeth than did men. However, men had more difficulties with shopping and food preparation.

In comparing the differences between dietary intake and functional status of the elderly, we found that subjects who reported eating less than 75% of the recommended iron were more likely to be functionally dependent ($p=0.0409$). Functionally dependent subjects tended to use more medication ($p=0.0421$) and have higher serum triglyceride concentrations ($p=0.0093$) than the nonfunctionally dependent subjects. No associations were found between anthropometric measurements and functional status. Smoking and drinking also did not correlate with functional status. However, functional status was significantly negatively related to chronic diseases ($r=-0.244$, $p=0.016$).

Nutritional Risk Index

The result of nutritional status assessed by calculating NRI is presented in Fig. 2. The mean score of NRI was 100.6±3.7 for the functionally dependent group and 101.7±2.6 for the nonfunctionally dependent group. Subjects had mean NRI scores greater than 100 indicating they were not malnourished. The mean NRI scores were not significantly different between the two groups. However, the functionally dependent group had a higher prevalence of malnutrition than the nonfunctionally dependent group (44.7% of functionally dependent *vs.* 25.0% of nonfunctionally dependent). On the basis of the individual NRI scores, we found 13 functionally dependent subjects showed signs of mild malnourishment and four were moderately malnourished. There were nine nonfunctionally dependent subjects in the mildly malnourished stage and four in the moderately malnourished stage.

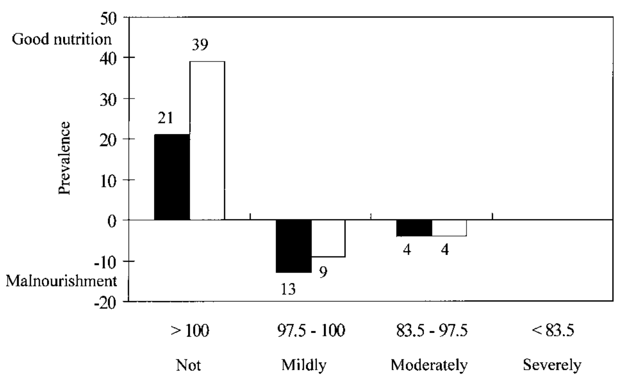

Fig. 2. Prevalence of malnutrition by calculating the Nutritional Risk Index (NRI) in functionally dependent (n=38) and nonfunctionally dependent (n=52) elderly subjects. The NRI=(15.9×plasma albumin, g/dL)+41.7×(present weight/usual weight). The NRI >100 indicates the subject is not malnourished; 97.5 to 100, mildly malnourished; 83.5 to <97.5, moderately malnourished; <83.5, severely malnourished. ■=functionally dependent, □=nonfunctionally dependent.

Fisher exact tests showed that there were no differences between NRI and smoking, drinking, medication use and reported chronic diseases. We did not find any relationships between the NRI and any anthropometric parameters, although the NRI was calculated in part by body weight. Regression analyses showed that no relationship was found between the NRI and hematological parameters with the exception of the hematocrit level ($r=0.22$, $p=0.034$). The NRI did not correlate with functional status.

DISCUSSION

Only three (7.1%) functionally dependent subjects and 14 (25.9%) nonfunctionally dependent subjects were free from any kinds of chronic diseases in our study. Other studies [7,11] have reported that more than half of their elderly subjects had at least one chronic condition. Our results showed that subjects suffering from one or more chronic diseases were more likely to have dependent functional status. Chronic disease remains one of the nutrition-related risk factors which compromise health status among older people. Elderly diagnosed with one or more chronic disease might benefit from nutrition screening.

It is worth noting that the mean current weight of the functionally dependent group was 12.8% over its mean ideal body weight, thereby indicating overweight. The elderly with functional dependence probably lacked the physical activity necessary to maintaining their ideal weight. However, the mean BMI value was in the normal range, and we did not find an association between the BMI and functional status. In contrast with our results, Launer *et al.* [18] indicated the effect of low, normal and high BMI on functional status. Galanos *et al.* [19] also indicated that subjects with a low BMI or a high BMI had a greater risk for functional dependence. The BMI was probably not the independent factor affecting functional status in the elderly. We expected racial differences in anthropometric measurements. The BMI, TSF and AMA of our elderly subjects were lower than those of Caucasian elderly in France [20]. Burr and Phillips [21] indicated that the BMI in Chinese elderly was lower than in Caucasian elderly of the UK.

Corti *et al.* [22] indicated that low serum albumin concentration related to functional dependence. In contrast, we observed no correlation between serum albumin concentration and functional status. Our elderly subjects had normal serum albumin, with only two functionally dependent elderly with a serum albumin value less than 3.5 g/dL. Serum albumin concentration might not have been low enough to correlate with functional status in our study. In addition, the mean albumin concentration of our elderly subjects was slightly higher than those of institutionalized elderly [20] and slightly lower than those of the free-living healthy elderly [8,23].

It has been recognized that high total serum cholesterol and/or triglycerides levels are associated with coronary heart disease. In our study, the mean serum triglyceride value of functionally dependent subjects was significantly higher than that of nonfunctionally dependent subjects although their mean value was within the normal range. Our elderly subjects with functional dependence did have a higher prevalence of hypertension and heart disease than did the nonfunctionally dependent elderly subjects.

Various dietary assessment methods have been used in the elderly; 24-hour diet recall is used the most because it is easier than the weighing method for older people. However, 24-hour diet recall would likely underestimate the intake reported by the elderly, mainly due to the lack of memory. Although the methodology of the seven-day dietary record has been proved to elicit dietary data in an elderly population [24], we preferred the 24-hour diet recall because most of our subjects were illiterate and had problems with recording (33% had no formal education). A food frequency questionnaire was also used to provide a more accurate estimation of dietary intake.

There were approximately 36% of functionally dependent subjects who consumed energy less than 75% of the Taiwan RDNA in our study. The elderly with functional dependence might have more difficulties in accessing food. However, we could not find an association between energy intake and functional status. This might be due to large variations of energy intake among individuals ranging from 573.9 to 3191.9 kcal/day.

Consistent with Payette and Gray-Donald [24], the elderly had sufficient mean protein intake, but these authors' association between protein intake and serum albumin concentration was not found. Morgan *et al.* [6], however, indicated a positive relationship between protein intake and serum albumin concentrations. It is worth noting that the association was valid only up to protein intake of 55 g/day. Since our subjects had a varied protein intake ranging from 23 g/day to 122 g/day and half of the subjects had a protein intake >55 g/day, the dietary protein intake might no longer have an effect on serum albumin concentration. Another possibility was that chronic conditions play a determinant role in affecting the albumin concentration.

Although many elderly subjects have a calcium intake above the recommended level of 600 mg (Taiwan RDNA), almost half of the subjects suffered from osteoporosis in our study. Thirty-nine percent of the functionally dependent and 28% of nonfunctionally dependent subjects had a calcium consumption of less than the 75% Taiwan RDNA. Kim *et al.* [25] reported that Asian-American elderly women they studied consumed an inadequate amount of dietary calcium (567 mg). Japanese elderly women consumed even lower calcium (325 mg) [8]. Calcium deficiency seems to be a worldwide problem.

The multi-parameter indices of nutritional status (i.e., NRI [14,15]) were mostly developed to identify nutritional status for hospitalized patients. Since the specificity of NRI has been documented in the healthy elderly less than 70 years of age [16], we tried to calculate NRI to distinguish malnutrition in this study. We observed a higher percentage (~45%) of the elderly with functional dependence in the malnourished stage. The elderly with good functional status had a lower prevalence (25%) of malnutrition; however, no association between functional status and the NRI was found. The multi-parameter indices of nutritional status should be further studied to determine the predictability, specificity and sensitivity for application to the elderly.

CONCLUSION

Although in our study population subjects with functional dependence exhibited poorer nutritional status on the basis of our assessing anthropometric measurements, hematological and biochemical parameters, nutrient intake and the multiparameter nutritional index than did nonfunctionally dependent subjects, our results showed that not all categories were different between the two groups. The elderly with functional dependence were at risk for inadequate iron intake and abnormal serum triglyceride concentrations; they were also at greater risk for chronic diseases and had a greater need for medications.

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