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Poor Nutritional Status Is Associated with Low Physical Activity in Patients Undergoing Peritoneal Dialysis

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29 dialysis patients

Chronic kidney disease (CKD) is an important risk factor for cardiovascular disease and mortality [1]. In patients undergoing dialysis, malnutrition and low physical activity (PA) are common complications that are independent predictors of hospitalization, morbidity and mortality [2-4]. However, these are modifiable risk factors that may affect the development and course of CKD. Previous studies have established the benefits of increased PA on mortality in the general population and in patients with CKD [5-7]. Pupim et al. reported that PA may facilitate the anabolic effects of nutritional interventions [8]. We previously reported that the PA of peritoneal dialysis (PD) patients was significantly lower than that of healthy people [9]. Oishi et al. also reported that serum albumin, age and C-reactive protein (CRP) are associated with a decline in the PA of PD patients [10].

To assess nutritional status in the elderly population, the Geriatric Nutritional Risk Index (GNRI) is a simple tool and a better nutrition-related risk index than albumin or body mass index (BMI) alone [11]. Some studies showed the usefulness of the GNRI as a new marker for malnutrition screening in dialysis patients [12, 13]. A few reports have also shown that in PD patients, the GNRI is associated with nutritional status and is an independent risk factor for mortality [14, 15]. Therefore, we believe that any differences in GNRI status in relation to PA in PD patients also requires elucidation. We hypothesized that a low GNRI status might be related to reduced PA in PD patients and that there is a relation between PA and nutrition. However, this remains to be studied in PD patients. Therefore, the purposes of the present study were to evaluate 1) differences in PA as related to the GNRI and 2) to determine the association between GNRI and PA in PD patients.

The present study was a cross-sectional study comprising 48 consecutive outpatients undergoing PD who could walk to Kawasaki Municipal Tama Hospital under their own power. Patients with neurological and orthopedic disease were excluded in the present study.

Patient characteristics were evaluated by review of medical records and included age, sex, BMI, primary kidney disease and history of diabetes mellitus, cardiovascular disease and peripheral arterial disease. Clinical and biochemical parameters assessed included serum albumin, hemoglobin, CRP, weekly Kt/V, weekly creatinine clearance (CCr), weekly residual kidney CCr and brain natriuretic peptide (BNP). The St. Marianna University School of Medicine Institutional Committee on Human Research approved this study (approval number: 1965), which was conducted in accordance with the Declaration of the World Medical Association. Informed consent was obtained from each patient.

The GNRI was calculated by serum albumin level and BMI as follows: $GNRI = 14.89 \times \text{albumin (g/dl)} + 41.7 \times (\text{body weight} / \text{ideal body weight})$. Body weight or ideal body weight was set to 1 when the patient's body weight exceeded the ideal body weight [11]. The patients' nutritional risk was classified on the basis of a GNRI of 91.2 number of which is based on the findings from a previous study [12]. Patients whose GNRI was <91.2 were included in the low-GNRI group and those with a $GNRI \geq 91.2$ were included in the high-GNRI group.

Averages of the daily number of steps taken and daily energy expenditure on PA for 9 days were used as the indices of PA. These indices were measured with the Kenz Lifecorder EX 1-axial accelerometer (Suzuken Co., Ltd., Nagoya, Japan). All subjects wore the accelerometer continuously for 9 days on a belt at waist level just above either leg [16]. Number of steps taken and daily energy expenditure on PA are recorded by the accelerometer on the basis of pre-entered data of age, sex, height, and weight. After the device was retrieved, the recorded data were downloaded into a computer with Microsoft Excel software. The final 7 days of continuous data recorded over the 9-day collection period were used to assess each patient's usual daily PA. The average of daily number of steps taken was calculated as total step count

over 7 days / 7 (steps/day), and the daily energy expenditure on PA was calculated as kcal expended over 7 days / 7 (kcal/day). Results are expressed as mean $\pm$ standard deviation (SD). The Mann-Whitney U test or chi-squared test were used, as appropriate, to compare patient characteristics and PA between the two groups. The relation between GNRI and PA was analyzed by Spearman's partial correlation coefficients. A p value of <0.05 was considered to indicate statistical significance. Statistical analyses were performed with IBM SPSS 17.0 J statistical software (IBM SPSS Japan, Inc., Tokyo, Japan).

Of the 48 patients, 4 patients with neurological or orthopedic disease were excluded. Thus, 44 patients were included in the present study. These 44 patients were divided into the high-GNRI group (≥ 91.2 points) (n = 33) and low-GNRI (< 91.2 points) group (n = 11). There were no significant differences in patient characteristics between the two groups (Table 1). Clinical and biochemical parameters according to nutritional risk are shown in Table 2. Except for that of serum albumin, the values of all parameters were similar between the two groups (Table 2).

Both the average daily number of steps taken and the daily energy expenditure on PA in the low-GNRI group were significantly lower than those in the high-GNRI group (Table 3).

A significant positive correlation coefficient was observed between GNRI and PA as measured by the average daily number of steps taken ($r=0.38$ $p=0.01$) and the daily energy expenditure on PA ($r=0.47$ $p=0.01$) (Fig.1). This is the first report, to our knowledge, to show that in PD patients, both the average

daily number of steps taken and daily energy expenditure on PA in patients with a low GNRI were significantly lower than those of patients with a high GNRI and that a positive correlation existed

between GNRI and PA. Because serum albumin is required for calculation of the GNRI [11], we excluded

this factor when assessing differences in PA based on the GNRI. After calculating this value, significant differences were present in PA measures in relation to GNRI, indicating that a low GNRI, an index of nutrition-related risk, might reflect reduced PA in PD patients. The level and intensity of spontaneous PA is positively related to the daily energy intake [3]. Malnutrition and decreased protein metabolism together with increased catabolism strongly influence the ability to perform daily PA [18]. Our results support the findings of these previous studies [3, 18]. Serum albumin level in PD patients may be affected by a variety of non-nutritional factors such as inflammation, fluid overload and other comorbidities [17]. In the present study, however, there were no significant differences in CRP and BNP levels between the high- and low-GNRI groups, indicating that there was little influence by inflammation or fluid overload with hemodilution. The level of PA was very low in the study patients, especially in those of the low-GNRI group. Tudor-Locke et al [19]. classified the lifestyle of healthy subjects as “sedentary” when <5000 steps were taken per day. Avesani et al [20]. also reported that 45% of hemodialysis patients had PA levels indicative of a sedentary lifestyle. Moreover, Matsuzawa et al. reported the median value of daily steps taken by hemodialysis patients to be 3925 steps/day [21]. The average number of steps taken per day in the low-GNRI group was 3422.9 ± 2457.5 steps/day, which was equivalent to that of these previous studies. We could not compare the daily energy expenditure on PA between our study and other studies because the other studies did not examine this factor in relation to PD patients. Therefore, the values of daily energy expenditure on PA reported here may be useful data in relation to nutritional status and PA in PD patients. Physical inactivity is a long-standing clinical problem among CKD patients, especially in those undergoing dialysis treatment [22]. From previous research in hemodialysis patients, physical exercise increases the anabolic effects of nutritional interventions [8]. Therefore in PD patients,

increases in PA and physical performance might improve their nutritional status. Because this is a cross-sectional study, the causal relationship between nutritional status and PA is not clear. A prospective study is needed to investigate the effects on nutrition and mortality of interventions to improve PA and physical performance. Then, we may be able to use the GNRI as simple screening tool to assess the PA of PD patients. Limitations in the present cross-sectional study include its small sample size and that measurement of PA occurred only over one 7-day period. We could not investigate many other factors related to nutritional status and PA such as muscle mass, strength, gait speed and patients with frailty. Data on timing of nutritional status and PA in relation to mortality or re-hospitalization were not assessed due to the limited amount of related data available. Physical activity by the average daily number of steps taken and energy expenditure of PA patients affected by nutrition, as indicated by GNRI, indicating that a low GNRI may be a useful predictor of poor PA.

CONFLICT OF INTEREST

All authors decline no conflicts of interest in relation to the work reported in this manuscript.

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182

183 **FIGURES REGENDS**

184 Fig.1 Relationship between GNRI and PA.

185 Scatter plots show the positive correlation between GNRI and average daily number of
186 steps taken and average daily energy expenditure in all patients.

187

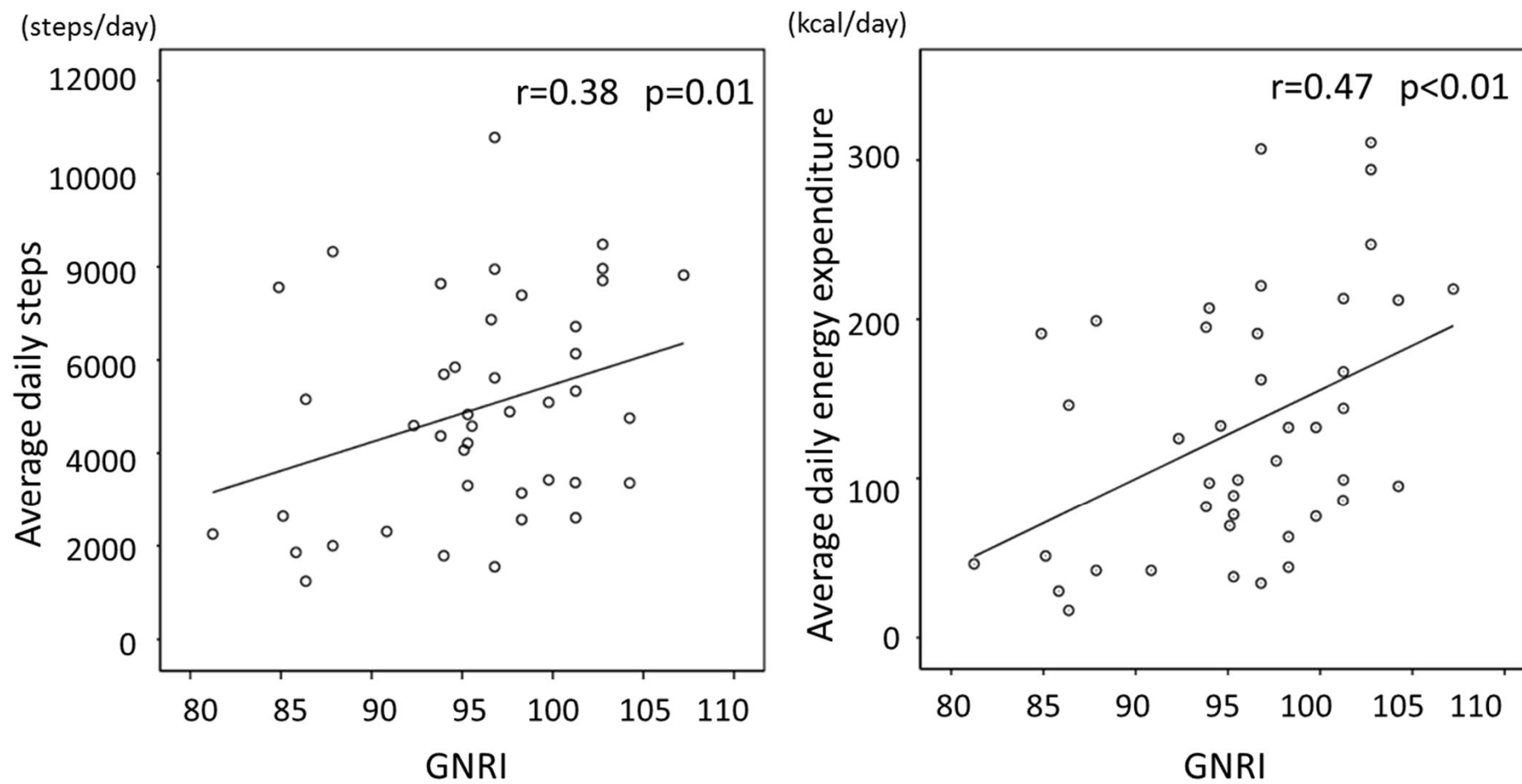


Figure 1.

Table 1. Patient characteristics of the low-GNRI and high-GNRI groups

	Low-GNRI group n=11	High-GNRI group n=33	Z & χ^2 value	P value
Age (yrs)	69.9±13.0	62.0±11.6	-1.36	0.18
Sex (Male/Female)	7/4	21/12	0.00*	0.64
BMI (kg/m ²)	23.7±2.6	24.3±3.7	-0.57	0.57
Primary kidney disease				
CGN	1	3	2.68*	0.75
DMN	5	11		
Hypertension	2	4		
Other	3	15		
DM	5	11	0.91*	0.28
CVD	3	9	0.00*	0.64
PAD	1	2	0.12*	0.59

Values are mean ± standard deviation or number.

GNRI, Geriatric Nutritional Risk Index; BMI, body mass index; CGN, chronic glomerulonephritis; DMN, diabetic nephropathy; DM, diabetes mellitus; CVA, cerebrovascular accident; PAD, peripheral arterial disease.

* χ^2 value.

Table 2. Clinical and biochemical parameters of the low-GNRI and high-GNRI groups

	Low-GNRI group n=11	High-GNRI group n=33	Z value	P value
Serum albumin (g/dl)	3.1±0.1	3.8±0.2	-4.95	<0.01
Hemoglobin (g/dl)	9.9±1.2	10.8±1.0	-1.70	0.09
CRP (mg/dl)	0.3±0.4	0.2±0.4	-1.02	0.33
Weekly Kt/V	1.8±0.3	1.9±0.3	-0.98	0.34
Weekly CCr (L/week/1.73 m ²)	79.8±24.7	64.5±17.9	-1.53	0.13
Residual kidney CCr (L/week/1.73 m ²)	54.8±30.5	39.7±20.7	-1.29	0.21
BNP (pg/ml)	271.0±245.9	166.6±248.0	-1.64	0.10

Values are mean ± standard deviation.

GNRI, Geriatric Nutritional Risk Index; CRP, C-reactive protein; PD, peritoneal dialysis; CCr, creatinine clearance; BNP, brain natriuretic peptide.

Table 3. Physical activity of the low-GNRI and high-GNRI groups

	Low-GNRI group n=11	High-GNRI group n=33	Z value	P value
Average daily step count (steps/day)	3422.9±2457.5	5285.3±2152.4	-2.43	0.01
Average daily energy expenditure (kcal/day)	77.6±66.9	144.6±77.8	-2.71	0.01

Values are mean ± standard deviation.

GNRI, Geriatric Nutritional Risk Index.