Physical Activity Is Associated with Serum Albumin in Peritoneal Dialysis Patients

The incidence of metabolic syndrome is about 50% in peritoneal dialysis (PD) patients. The positive association of metabolic syndrome with lower physical activity (PA) has been reported in the general population, but the effect of PA in PD patients has not been clarified. The purpose of the present study was to evaluate PA in PD patients and to clarify the correlations between PA and various clinical parameters in PD patients.

We assessed 38 PD patients (22 men; age: 63.9 ± 10.8 years; body mass index: 24.0 ± 3.9; 15 with diabetes) who had been treated with PD at least for 3 months. We defined PA as the average number of steps per day measured using a pedometer for 1 month. Blood biochemical findings and dialysis adequacy were measured as clinical parameters.

Of the 38 patients, only 11 (29%) reached the steps per day of healthy individuals. In addition, steps per day were significantly correlated with serum albumin ($r = 0.45$, $p = 0.01$), C-reactive protein ($r = -0.33$, $p = 0.04$), and age ($r = -0.34$, $p = 0.04$). Multiple regression analysis showed that serum albumin was the only variable that significantly correlated with steps per day ($\beta = 0.42$, $p = 0.01$).

Our study showed that PA declines significantly in PD patients, which might correlate with malnutrition–inflammation–atherosclerosis syndrome.

Key words
Physical activity, steps per day

Introduction
Patients with obesity or metabolic syndrome are increasing in number worldwide, and the number of dialysis patients complicated with metabolic syndrome has been growing in the United States (1). In addition, obesity is a risk factor for renal dysfunction (2), and metabolic syndrome is a risk factor for cardiovascular disease (3). Therefore, strict management of obesity and metabolic syndrome is essential for chronic kidney disease (CKD) patients.

Li et al. reported that the incidence of metabolic syndrome was about 50% in peritoneal dialysis (PD) patients (4). Patients on PD are at high risk of developing hyperglycemia, dyslipidemia, and obesity because of long-term exposure of the abdominal cavity to glucose in high concentrations (5). Appropriate exercise and diet therapy are important to manage obesity.

The parameters of exercise are typically expressed in terms of frequency, duration, and intensity. In recent years, it has been reported that the average number of steps per day is a useful index of exercise or physical activity (PA) (6,7). The positive association of metabolic syndrome with lower PA has been reported in the general population (8). Several studies (9,10) have shown that steps per day in hemodialysis patients were significantly less than in healthy individuals. However PA in PD patients has not been clarified.

The purpose of the present study was to evaluate PA in PD patients and to clarify the correlations between PA and various clinical parameters in PD patients.

Methods
We assessed 38 PD patients (22 men, 16 women) attending our hospital or Kawasaki Municipal Hospital. The mean age in this group was 63.9 ± 10.8 years (range: 35 – 89 years). Mean duration on PD was 21.4 ± 15.1 months (range: 3 – 60 months). The
causes of end-stage kidney disease were diabetes (15 patients), glomerulonephritis (8 patients), nephrosclerosis (3 patients), polycystic kidney disease (3 patients), purpura nephritis (2 patients), interstitial nephritis (1 patient), and unknown (6 patients).

Our analysis excluded PD patients with severe infection, cardiopulmonary dysfunction, or uncontrolled hypertension and hyperglycemia, and also those using a wheelchair or walking stick or complementary dialysis (11).

We measured PA using multi-memory pedometers with accelerometers (Lifecoder EX: Suzuken, Nagoya, Japan). The pedometer used in the present study has ability to record long-term PA (up to 200 days) and to measure exercise intensity at the same time. Patients were instructed to wear the pedometer full-time daily for 1 month, except when taking a bath or sleeping. The steps per day were calculated from the record of the pedometer. The data considered valid were those measured over 14 days. Exercise intensity was classified using metabolic equivalents (Mets) as follows: high-intensity (7 – 9 Mets), middle-intensity (4 – 6 Mets), and low-intensity (1.8 – 3 Mets). We examined the proportion of exercise intensity during a typical day.

Clinical and biochemical parameters examined at the beginning of the study included serum albumin, triglycerides, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, C-reactive protein (CRP), hemoglobin, dialysis adequacy (weekly Kt/V and weekly creatinine clearance), and residual kidney function on PD (Table I).

Statistical analysis
Data are expressed as mean ± standard deviation. For comparisons of paired data, the nonparametric Mann–Whitney U-test, Student t-test, and chi-square test were used. For correlation of continuous variables, a Spearman rank correlation test was used. Multiple regression analysis was performed to clarify the factors contributing to steps per day. A p value less than 0.05 was considered statistically significant. All statistical analyses were performed using the SPSS software application (version 17: SPSS Japan, Tokyo, Japan) for Windows 7 (Microsoft Corporation, Redmond, WA, U.S.A.).

Results
Body mass index in our PD patients was 24.0 ± 3.9 kg/m² (range: 17.5 – 30.7 kg/m²), which is higher than the average body mass index reported by the Japanese Society for Dialysis Therapy for Japanese hemodialysis patients in 2005 (21 kg/m²). The pedometer was worn by the patients for a mean of 26.9 ± 5.8 days (range: 14 – 43 days), and all patients were eligible for the analysis based on the conditions defined before the start of the study.

The average steps per day in this group were 4367 ± 2590. That result is clearly less than the steps per day reported for healthy individuals by the Japanese National Survey in 2008 (men: 7416 ± 1113; women: 6381 ± 1214). Only 11 patients (29%) reached the average steps per day of healthy individuals. Furthermore, of daily exercise, the greatest proportion (78.3% ± 15.5%) was low-intensity exercise, followed by middle-intensity exercise (20.6% ± 15.3%) and high-intensity exercise (1.2% ± 2.6%).

We also divided the patients into two groups by median steps per day (4046 steps). Compared with
the high steps-per-day group, the low steps-per-day group had significantly lower serum albumin and Kt/V (serum albumin: 3.5 g/dL vs. 3.8 g/dL; Kt/V: 1.8 vs. 2.0; both $p = 0.04$). Steps per day correlated negatively with age ($r = -0.34$, $p = 0.04$) and CRP ($r = -0.33$, $p = 0.04$) and positively with serum albumin ($r = 0.47$, $p = 0.01$; Figure 1). The multiple regression analysis for steps per day used age, serum albumin, CRP, and hemoglobin as dependent variables. The result of the analysis showed that only serum albumin was independently related to steps per day ($\beta = 0.42$, $p = 0.01$).

**Discussion**

Body mass index in the Japanese population is clearly lower than that in Western populations. However, as the number of patients with CKD caused by diabetes increases, the number of dialysis patients with obesity and metabolic syndrome will grow in the future.

The average steps per day ($4367 \pm 2590$) were significantly lower in PD patients than in healthy individuals as reported in 2008 by the Japanese National Survey. Masuda et al. (12) reported that the average steps per day in PD patients were 6336 ± 4924. However, their study cohort (mean age: 47.5 years) was younger than ours, and their patients were observed for a shorter period. The average age of the subjects in our study is similar to the average age of patients at dialysis start in Japan (mean: 67.8 years). In addition, we observed them for about 1 month. We therefore assume that the subjects of our study represent average dialysis patients in Japan better than those in the earlier study.

We believe that the low PA in PD patients is associated with renal anemia and MIA (malnutrition–inflammation–atherosclerosis) syndrome in CKD. In addition, we believe that the low PA in PD patients is partly caused by the time needed for dialysate bag exchanges and by lumbago and abdominal distension attributable to dialysate.

Gandra et al. (13) reported that treatment of anemia improves PA in pre-dialysis patients, and

![Figure 1](image-url)  
**Figure 1**  Correlation between steps per day and (A) serum albumin, (B) C-reactive protein, and (C) age in peritoneal dialysis patients.
thus they suggested that anemia was associated with low PA. However, hemoglobin levels were similar in both the low and the high steps-per-day groups in our study. Therefore, in our study, anemia was not involved in low PA.

It has been reported that PA is positively correlated with serum albumin in hemodialysis patients (9). However, the relationship between serum albumin and PA has not been clarified in PD patients. We found that serum albumin in our patients was significantly higher in the high steps-per-day group than in the low steps-per-day group. Moreover, serum albumin was significantly correlated with steps per day both by Spearman rank correlation ($p = 0.01$) and multiple regression analysis ($p = 0.01$).

Hypoalbuminemia is an important risk factor for mortality among end-stage kidney disease patients (14). Given that various factors—inflammation, loss of protein into the dialysate, and volume overload—lead to hypoalbuminemia in PD patients, serum albumin is not only the parameter of nutrition status (15). Elevation in another well-known indicator of inflammation, CRP, has been suggested to be a risk factor for mortality in PD patients (16). Given that hypoalbuminemia and high CRP both correlated with low PA, we hypothesize that PD patients with low PA were complicated with MIA syndrome.

In our assessment of the relationship between steps per day and exchanges, dwell times, and abdominal fill volumes, we found no significant correlations.

The highest proportion of the exercise in PD patients was low-intensity exercise. We suggest that it is difficult for PD patients to exercise at middle to high intensity because of the high abdominal pressure caused by dialysate.

This observational study was retrospective. More work is needed in future to clarify the effects of improvements in PA on lipid and glucose metabolism, nutrition status, and inflammation. Recently, it was reported that PA prevented progression of CKD (17). Additionally, residual kidney function is known to be associated with morbidity and mortality in PD patients (18). We suggest that exercise might improve survival in PD patients by helping to maintain residual kidney function.

Conclusions
Our study showed that PA declined significantly in PD patients, which might correlate with MIA syndrome.

Disclosures
The authors have no financial conflicts of interest to declare.

References


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