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Impact of type 2 diabetes mellitus on physical activity in pre-dialysis patients with chronic kidney disease

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Physical activity (PA) is related to slower decline of estimated glomerular

filtration rate (eGFR) and lower risk of progression to end-stage kidney disease in patients with chronic kidney disease (CKD) [1]. Generally, patients with diabetes mellitus (DM) tends to have lower PA than those without DM [2]. The number of patients with diabetic nephropathy is increasing, and CKD patients with DM correlate negatively with lower PA levels. However, the association between PA and CKD patients with DM is unknown.

This observational study was conducted from September 2011 to May 2015. We enrolled 99 consecutive outpatients visiting a pre-dialysis CKD clinic (median age, 69.0 years; 78.7% men; mean eGFR, 37.9 mL/min/1.73 m²). Patients with type 1 DM, severe neurological and orthopedic disease, and dementia were excluded. Patients were divided into two groups based on the presence of DM: CKD patients with DM group (n = 29) and CKD patients without DM group (n = 70).

We measured daily number of steps taken (step count) and energy expenditure (EE) on daily PA over 8 days using a Kenz Lifecorder EX uniaxial accelerometer (Suzuken Co., Ltd., Nagoya, Japan). Average daily step count over 1 week (comprising the final 7 days of continuous data from the 8-day collection period) was calculated as total step count over 7 days/7 (steps/day) and average of daily EE as (kcal) expended over 7 days/7 [3].

We reviewed the medical records of the patients to investigate baseline demographic and clinical characteristics including age, sex, body mass index (BMI), eGFR, serum albumin, hemoglobin (Hb), and glycated Hb (HbA1c).

The characteristics of the patients are shown in Table 1. We assessed the impact of type 2 DM on step counts and EE with multiple regression analysis. Step counts and EE were the independent variables, diabetes status the dependent variable, and the

covariates entered were factors affecting step counts and EE as reported in a previous study of patients with CKD.

Step counts and EE were significantly lower in the CKD patients with DM group versus CKD patients without DM group: 5360 ± 3348 vs. 6970 ± 2709 steps/day, $p = 0.01$ and 104.0 (29–385) vs. 188.5 (14–389) kcal/day, $p < 0.01$ (Fig. 1). Multiple regression analysis showed presence of CKD patients with DM to be significantly associated with step counts (β : -0.23 , 95% confidence interval: -2855.67 – -186.43 , $p = 0.03$) after adjustment for age, sex, BMI, Hb, and eGFR.

We suggest that the decrease in EE in the CKD patients with DM group is due to the lower muscle mass in this group versus that in the CKD patients without DM, and thus, EE during exercise is also lower [4]. Although step count and EE are indices of PA, because EE is an index that may be affected by individual differences in physique and muscle mass, step count is easy to use as an index for exercise guidance.

This study is limited by its cross-sectional design. Thus, the direct causal relationship between the presence or absence of diabetes and the amount of PA is unknown.

In conclusion, pre-dialysis CKD patients with DM had lower step counts and EE on PA than CKD patients without DM. This result may be helpful in guiding exercise to actively increase daily step counts and EE on PA in pre-dialysis CKD patients with DM.

Compliance with Ethical Standards

Conflict of interest The authors have declared that no conflict of interest exists.

Human and animal rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee at which the studies were conducted (IRB approval number

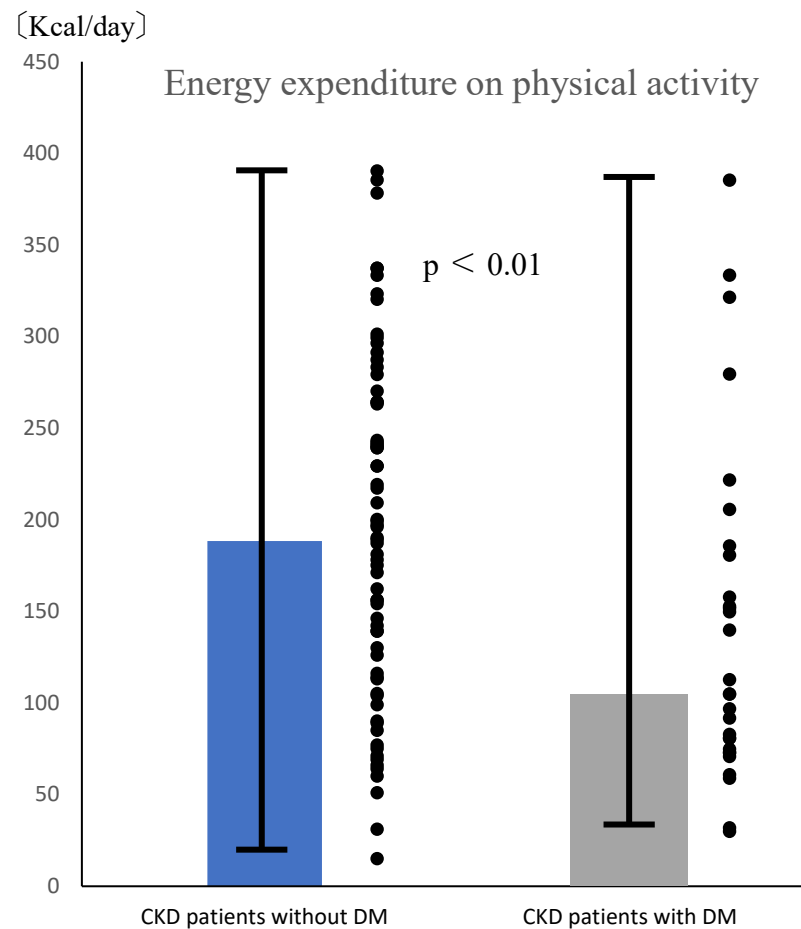
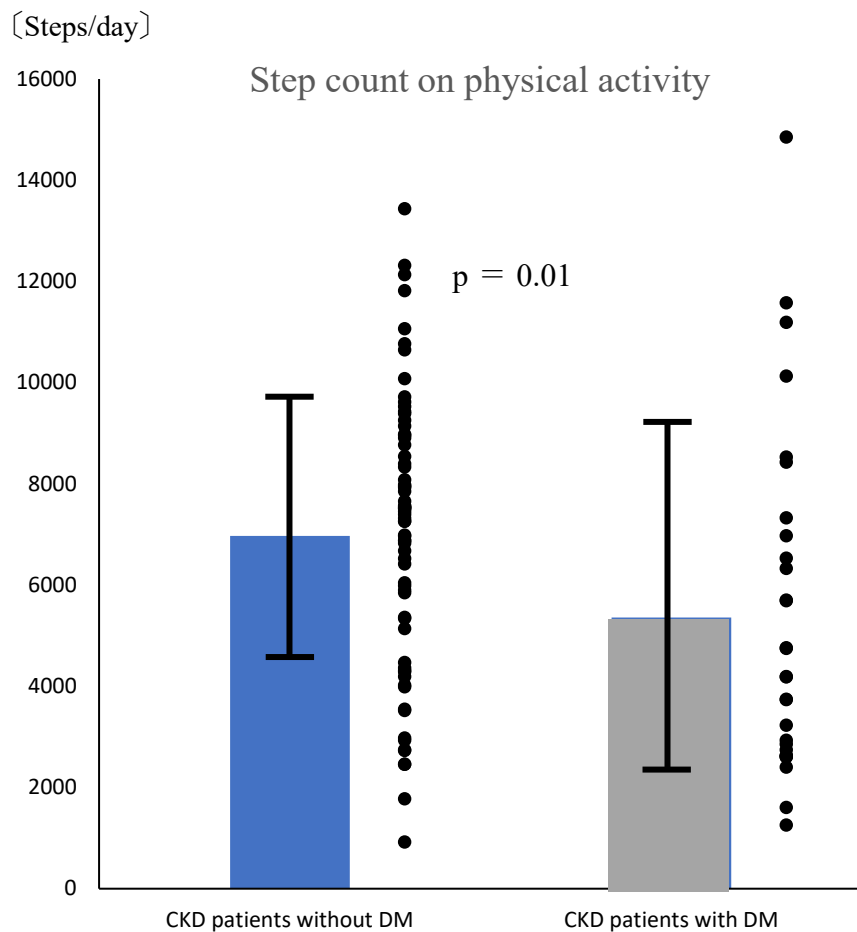
1624), and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Figure Legend

Fig. 1 Both step counts and energy expenditure on physical activity were significantly lower in the ~~DKD~~ DM versus non- ~~DKD~~ DM group of pre-dialysis CKD patients. See text for details. ~~DKD; diabetic kidney disease~~, DM; diabetes mellitus, CKD; chronic kidney disease.



Figure

Table 1

Clinical characteristics of the patients.

Characteristic	CKD patients without DM (n=70)	CKD patients with DM (n=29)	p Value
Age, years, median (IQR)	69 (36-87)	68 (40-81)	0.73
Sex, male, n (%)	52 (74.2)	26 (89.7)	<0.01
Body mass index, (kg/m ²), median (IQR)	23.7 (15.8-33.6)	24.3 (14-41.3)	0.29
Primary kidney disease			<0.01
Chronic glomerulonephritis, n (%)	23 (32.9)	3 (10.3)	
Diabetes mellitus, n (%)	0 (0)	20 (69.0)	
Nephrosclerosis, n (%)	34 (48.6)	3 (10.3)	
Others, n (%)	3 (4.3)	0 (0)	
Unknown, n (%)	10 (14.3)	3 (10.3)	
Hemoglobin, (g/dL), mean $\pm$ SD	12.6 $\pm$ 1.9	11.6 $\pm$ 2.1	0.02
Albumin, (g/dL), mean $\pm$ SD	3.9 $\pm$ 0.3	3.9 $\pm$ 0.5	0.46
eGFR, (mL/min/1.73 m ²), mean $\pm$ SD	41.5 $\pm$ 16.1	29.2 $\pm$ 16.1	<0.01
HbA1c, (%), median (IQR)	5.3 (4.2-6.3)	5.9 (4.5-8.9)	<0.01
Insulin use, n (%)	0 (0)	8 (28)	<0.01
Energy expenditure, (kcal), median (IQR)	188.5 (14-389)	104 (29-385)	<0.01
Step count, (steps/day), mean $\pm$ SD	6970 $\pm$ 2709	5360 $\pm$ 3348	0.01

Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HbA1c, glycated Hb; IQR, interquartile range; SD standard deviation.