

## Dietary protein intake is strongly and positively related with muscle strength in patients with pre-dialysis chronic kidney disease

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To the Editor

Based on our previous study [1], the physical function of patients with pre-dialysis chronic kidney disease (CKD) declines as CKD progresses. Since there is an accumulating evidence that reduced physical function is strongly associated with poor prognosis in patients with CKD [2], it is important to maintain muscle strength and mass in this population; however, low-protein diet is prescribed for patients with CKD although it is known that low protein intake causes a reduction in muscle mass [3]. Thus, the prescribed low-protein diet potentially influences physical function. Therefore, this cross-sectional study aimed to investigate the relationship between protein intake and muscle strength in patients with pre-dialysis CKD.

The participants included 70 outpatients with pre-dialysis CKD stage G3-5 who can ambulate to our nephrology clinic. The participants includes 50 men, with average age of 68.4 years and mean estimated glomerular filtration rate (eGFR) of  $32.5 \pm 15.4$  ml/min/1.73 m<sup>2</sup>. Age, body mass

index (BMI), hemoglobin (Hb), serum albumin (Alb), eGFR, and urine protein (UP) levels were obtained and reviewed from medical records. Protein intake (g/kg BW/day) was estimated using data from a 24-h urine collection test, based on the report by Maroni et al. [4].

Muscle strength, including knee extensor muscle strength (kgf), was measured and evaluated according to our previous study [1].

The relationship between muscle strength and variables was examined using Pearson product-moment correlation coefficient. Stepwise multiple regression analysis was conducted using factors showing a single correlation as independent variables and muscle strength as dependent variables.

Knee extensor muscle strength was significantly correlated with age ( $r = -0.34$ ), BMI ( $r=0.36$ ), Hb ( $r=0.53$ ), Alb ( $r=0.31$ ), eGFR ( $r=0.48$ ), and protein intake ( $r=0.51$ ) (Fig. 1). On multiple regression analysis, protein intake and Hb ( $R^2=0.41$ ,  $p<0.01$ ) were correlated to knee extensor muscle strength. Thus, our study clearly showed that muscle strength was demonstrated to have a strong and positive relationship with protein intake in patients with pre-dialysis CKD.

There are some limitations of this study. First, precision of the estimate of dietary protein intake is not guaranteed because an evaluation of daily energy intake was not feasible. Second, the causal relationship between muscle strength and protein intake is unknown because this study is a cross-sectional study. However, since the participants were able to ambulate independently, direction of the causal relationship from muscle strength to protein intake (patients with low muscle strength are too weak to eat enough) is not plausible.

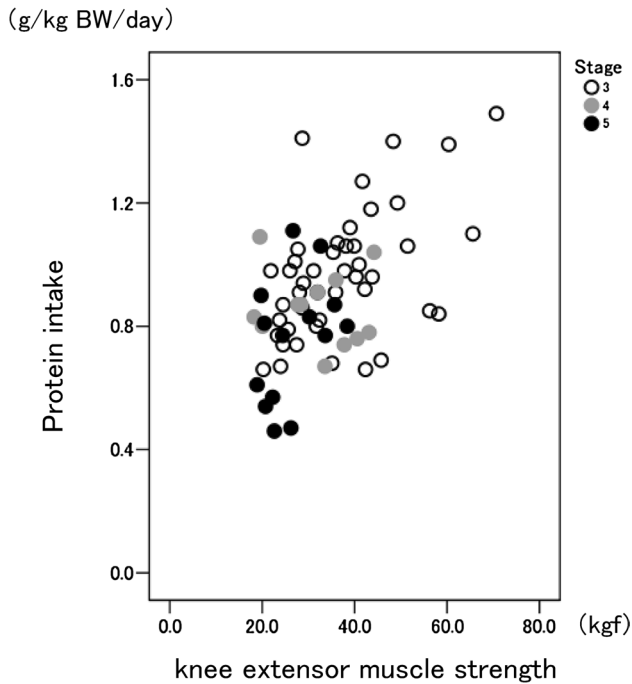
In conclusion, our study clearly showed a strong and positive relationship between dietary protein intake and

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**Fig. 1** Scattergram showing the relationship between muscle strength and protein intake

muscle strength. In particular, muscle strength tended to decrease in the thin elderly people.

#### Compliance with ethical standards

**Conflict of interest** All authors declare no conflicts of interest in relation to the work reported in this manuscript.

**Human and animal rights** This article does not contain any studies with animals performed by any of the authors. 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 and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The present study was approved by the St. Marianna University School of Medicine Institutional Committee on Human Research (Approval No. 1624).

**Informed consent** Informed consent was obtained from each patient.

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