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24-hour Urinary Mineral Excretion and Its Developmental Trajectory and Longitudinal Changes in Relation to Renal Deterioration in Patients with CKD

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Objectives : The aim of this study was to investigate the trajectories and longitudinal changes of 24-hour urine mineral excretion (24-hour UME) and their association with chronic kidney disease (CKD) progression in patients with CKD stages 1-4.
Methods : The study collected clinical data from patients admitted to the PLA General Hospital between January 2014 and July 2022, who had at least two 24-hour UME measurements over a year-long interval. Latent class linear mixed models (LCLMM) were used to model and visualize the 24-hour UME trajectories over three years. Multinomial regression and joint models were employed to assess the associations of 24-hour UME trajectories and longitudinal changes with rapid kidney function decline and CKD progression, respectively.
Results : The study included 1,212 participants with a mean follow-up of 30 (IQR, 19-48) months. Of these, 317 (26.2%) exhibited CKD progression. The optimal linear trajectories of 7,896 UME values for each mineral were categorized into different groups. Specifically, 3 groups were identified for sodium, chloride, potassium and magnesium; 5 for calcium; and 4 for phosphorus. Multinomial logistic regression demonstrated that patients with steady lower levels of urinary calcium (OR: 10.000, 95% CI: 4.739-21.277, P<0.001) or a decreasing trajectory (OR: 9.901, 95% CI: 3.788-25.641, P<0.001) had a significantly higher risk of rapid kidney function decline than the reference group. In joint models, baseline and longitudinal 24-hour urinary potassium and calcium independently predicted CKD progression.
Conclusions : This study discovered unique patterns of 24-hour urine mineral excretion in non-dialysis-dependent CKD patients. Baseline and longitudinal 24-hour urine excretion of potassium and calcium were determined to be significant factors in CKD progression, while sodium did not show a significant association.

Figure 1.jpg

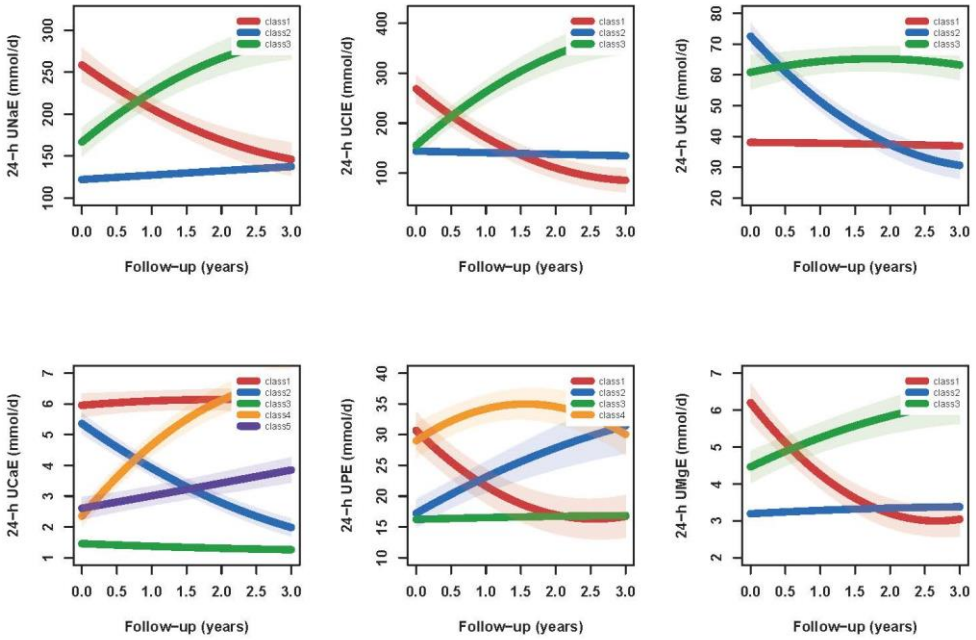

Figure 1.jpg

Table 1. The association between urine mineral excretion and CKD progression (eGFR decline ≥ 50%, dialysis or kidney transplantation)

		Model 0		Model 1		Model 2	
		HR (95% CI)	P	HR (95% CI)	P	HR (95% CI)	P
UNa (mmol/d)	Baseline UNa (per 1SD)	1.178 (1.057, 1.314)	**0.003**	1.052 (0.937, 1.181)	0.392	1.048 (0.930, 1.182)	0.441
	Longitudinal UNa (per 1SD)	0.834 (0.662 1.050)	0.122	0.945 (0.748, 1.192)	0.631	0.929 (0.728, 1.184)	0.550
UCl (mmol/d)	Baseline UCl (per 1SD)	1.059 (0.944, 1.188)	0.328	0.964 (0.852, 1.091)	0.557	0.956 (0.841, 1.087)	0.488
	Longitudinal UCl (per 1SD)	0.474 (0.371, 0.606)	<0.001	0.608 (0.470, 0.788)	<0.001	0.582 (0.445, 0.763)	**<0.001**
UK (mmol/d)	Baseline UK (per 1SD)	1.051 (0.952, 1.161)	0.325	0.925 (0.833, 1.026)	0.140	0.882 (0.789, 0.986)	**0.027**
	Longitudinal UK (per 1SD)	0.421 (0.322, 0.551)	**<0.001**	0.606 (0.460, 0.799)	**<0.001**	0.566 (0.426, 0.752)	**<0.001**
UCa (mmol/d)	Baseline UCa (per 1SD)	0.553 (0.467, 0.654)	**<0.001**	0.838 (0.706, 0.994)	**0.043**	0.809 (0.672, 0.975)	**0.026**
	Longitudinal UCa (per 1SD)	0.390 (0.298, 0.509)	**<0.001**	0.489 (0.374, 0.639)	**<0.001**	0.482 (0.368, 0.631)	**<0.001**
UP (mmol/d)	Baseline UP (per 1SD)	0.996 (0.877, 1.131)	0.950	0.997 (0.866, 1.147)	0.963	0.963 (0.833, 1.115)	0.617
	Longitudinal UP (per 1SD)	0.449 (0.367, 0.549)	**<0.001**	0.565 (0.458, 0.696)	**<0.001**	0.583 (0.470, 0.722)	**<0.001**
UMg (mmol/d)	Baseline UMg (per 1SD)	0.949 (0.845, 1.066)	0.379	0.916 (0.814, 1.032)	0.150	0.899 (0.795, 1.017)	0.089
	Longitudinal UMg (per 1SD)	0.636 (0.497, 0.814)	**<0.001**	0.729 (0.561, 0.947)	**0.018**	0.720 (0.551, 0.939)	**0.015**

Notes: HRs and 95 % CIs for the effect of a SD increase in urine mineral excretion on CKD progression, adjusted for confounders. The unit for baseline and longitudinal mineral is a SD increase in urine mineral excretion. Estimates of Model 0 were without adjustment. Estimates of model 1 were adjusted from multivariable joint model for age, sex, eGFR, and 24-hour proteinuria (Ln-transformed) at baseline. Besides the variables in model 1, model 2 was also adjusted for serum mineral (Na, K, Cl, Ca, P, Mg), hemoglobin, and albumin, 24-hour urine creatinine, hypertension, diabetes mellitus, and diuretics usage at baseline.