

DIETARY NET ENDOGENOUS ACID PRODUCTION AND CHRONIC KIDNEY DISEASE IN ELDERLY ADULTS

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Background

Dietary net endogenous acid production (NEAP), which represents total dietary load of nonvolatile acid, may affect kidney function. A few studies are available assessing the association between NEAP and chronic kidney disease (CKD), and its relation to dietary protein and potassium intake in the elderly.

Methods

A total 1369 community-dwelling elderly Koreans in the Kangbuk Samsung Cohort Study (KSCS) were evaluated using a food frequency questionnaire (FFQ) and comprehensive health examination. We evaluated the association between NEAP and the CKD. We also examined their relation to protein and potassium intake.

Results

NEAP was correlated with potassium intake ($r=-0.410$, $P < 0.001$), but not correlated with protein intake ($r=-0.004$, $P = 0.879$) (Fig 1). In a full multivariate adjustment for sociodemographic factors, dietary factors, and comorbidities, the participants with higher NEAP quartiles (Q2, Q3, Q4) had higher odds of CKD compared to the lowest NEAP quartile (Q1); OR (95% CI) were 1.47 (0.78-2.72), 1.66 (0.85-3.23), and 2.30 (1.16-4.60) respectively (P for trend = 0.019) (Table 3). The odds of CKD decreased for participants with higher potassium intake quartiles (Q2, Q3, Q4) compared to the lowest potassium intake quartile (Q1); OR (95% CI) were 0.52 (0.28-0.95), 0.50 (0.26-0.96), and 0.50 (0.21-0.99) respectively (P for trend = 0.050) (Table 3). Protein intake was not associated with CKD. The association between NEAP and CKD was similar in subgroups analysis (Fig 2).

Table 3. Association of CKD with dietary NEAP, protein intake, and potassium intake quartiles

	Odds ratio (95% confidence interval)				P for trend
	Quartile 1	Quartile 2	Quartile 3	Quartile 4	
NEAP quartile increase					
Crude	1.00 (reference)	1.02 (0.68-1.56)	0.85 (0.55-1.30)	1.47 (1.00-2.19)	0.102
Model 1	1.00 (reference)	1.07 (0.69-1.66)	0.88 (0.55-1.42)	1.45 (0.90-2.34)	0.189
Model 2	1.00 (reference)	1.47 (0.78-2.76)	1.66 (0.85-3.23)	2.30 (1.16-4.60)	0.019
Protein intake quartile increase					
Crude	1.00 (reference)	0.64 (0.42-0.96)	0.85 (0.58-1.26)	0.64 (0.42-0.97)	0.104
Model 1	1.00 (reference)	0.61 (0.38-1.01)	0.77 (0.45-1.34)	0.55 (0.27-1.16)	0.260
Model 2	1.00 (reference)	0.53 (0.27-1.02)	0.68 (0.32-1.46)	0.56 (0.21-1.47)	0.444
Potassium intake quartile increase					
Crude	1.00 (reference)	0.69 (0.46-1.03)	0.73 (0.49-1.08)	0.64 (0.43-0.97)	0.046
Model 1	1.00 (reference)	0.68 (0.44-1.05)	0.71 (0.44-1.17)	0.65 (0.34-1.22)	0.196
Model 2	1.00 (reference)	0.52 (0.28-0.95)	0.50 (0.26-0.96)	0.50 (0.21-0.99)	0.050

Model 1: Adjusted for age, sex, total caloric intake, dietary sodium intake; Model 2: model 1 + body mass index, smoking, education state, health-enhancing physical activity; hypertension, diabetes, hyperlipidemia, cardiovascular disease.

CKD, chronic kidney disease; NEAP, net endogenous acid production.

Table 1. Clinical characteristics of 1,369 elderly adults by dietary NEAP quartiles.

Variable	All (n=1,369)	Quartile 1 (n=343)	Quartile 2 (n=342)	Quartile 3 (n=342)	Quartile 4 (n=342)	P
NEAP, mEq/day		1.1 to 33.3	33.3 to 45.5	45.5 to 60.5	60.5 to 219.1	
Age, y	69.0±3.7	68.9±4.1	68.8±3.2	68.8±3.5	69.2±3.9	0.440
Male sex, %	55.2	44.0	53.5	57.6	65.5	<0.001
Hypertension, %	45.7	44.6	49.7	40.6	48.0	0.086
Diabetes, %	19.9	19.8	20.2	17.0	22.5	0.342
Hyperlipidemia, %	25.4	27.7	24.3	24.6	25.2	0.724
CVD, %	11.0	10.5	13.9	9.8	11.2	0.769
Current smoker, %	10.3	7.7	10.9	8.2	14.4	0.051
Low educated, %	63.2	62.8	65.5	64.2	60.1	0.573
HEPA, %	29.1	27.9	32.7	27.3	28.8	0.413
BMI, kg/m ²	23.8±2.9	23.6±2.7	23.8±2.9	23.8±3.0	23.9±3.1	0.591
Systolic BP, mmHg	119±14	120±15	119±14	119±15	119±14	0.826
Diastolic BP, mmHg	72±9	72±9	72±9	72±9	72±9	0.809
CRP, mg/L	0.6	0.5	0.6	0.6	0.6	0.739
	[0.2 1.0]	[0.2 1.0]	[0.2 1.0]	[0.2 1.1]	[0.2 1.1]	
Total cholesterol, mg/dL	195±38	196±39	196±38	198±37	191±39	0.118
Triglyceride, mg/dL	114±58	111±52	116±57	111±57	116±64	0.495
Fasting glucose, mg/dL	103±19	104±19	104±21	102±20	103±17	0.578
eGFR, mL/min/1.73m ²	79.4±13.0	79.3±13.5	80.5±12.0	80.0±12.2	77.7±13.9	0.028
eGFR < 60 mL/min/1.73m ² , %	7.0	6.1	5.8	6.4	9.7	0.175
Urinary ACR, mg/g	7.6	7.8	8.5	6.9	7.4	0.271
	[4.4 15.0]	[4.3 15.8]	[4.7 15.1]	[4.2 13.9]	[4.1 15.4]	
Urinary ACR ≥ 30 mg/g, %	11.1	11.1	10.8	8.5	14.0	0.115
CKD, %	15.9	14.9	15.2	12.9	20.5	0.044

Values for categorical variables are given as percent; for continuous variables, as mean ± standard deviation; for CRP and urinary ACR, as median [interquartile range].

NEAP, net endogenous acid production; CVD, cardiovascular disease; HEPA, health-enhancing physical activity; BMI, body mass index, BP, blood pressure, CRP, C-reactive protein, eGFR, estimated glomerular filtration rate; ACR, albumin creatinine ratio; CKD, chronic kidney disease.

Table 2. Dietary characteristics by dietary NEAP quartiles.

Dietary parameter	All (n=1,369)	Quartile 1 (n=343)	Quartile 2 (n=342)	Quartile 3 (n=342)	Quartile 4 (n=342)	P for trend
NEAP, mEq	50.4±26.5	25.5±7.0	39.9±3.5	52.2±4.0	84.1±29.3	<0.001
Protein intake, g/day	44.4±25.3	35.3±19.3	48.6±23.4	49.7±22.5	44.0±31.8	<0.001
Protein intake, g/Kg/day	0.73±0.45	0.60±0.34	0.80±0.41	0.81±0.37	0.72±0.60	0.001
Potassium intake, mg/day	1733±990	2067±1048	2059±973	1700±776	1105±814	<0.001
Protein:Potassium ratio	1112±486	656±128	919±65	1145±74	1731±538	<0.001
Sodium intake, mg/day	1956±1420	2353±1608	2395±1442	1910±1101	1165±1107	<0.001
Calorie intake, Cal/day	1283±678	954±619	1378±642	1464±632	1335±701	<0.001

NEAP, net endogenous acid production

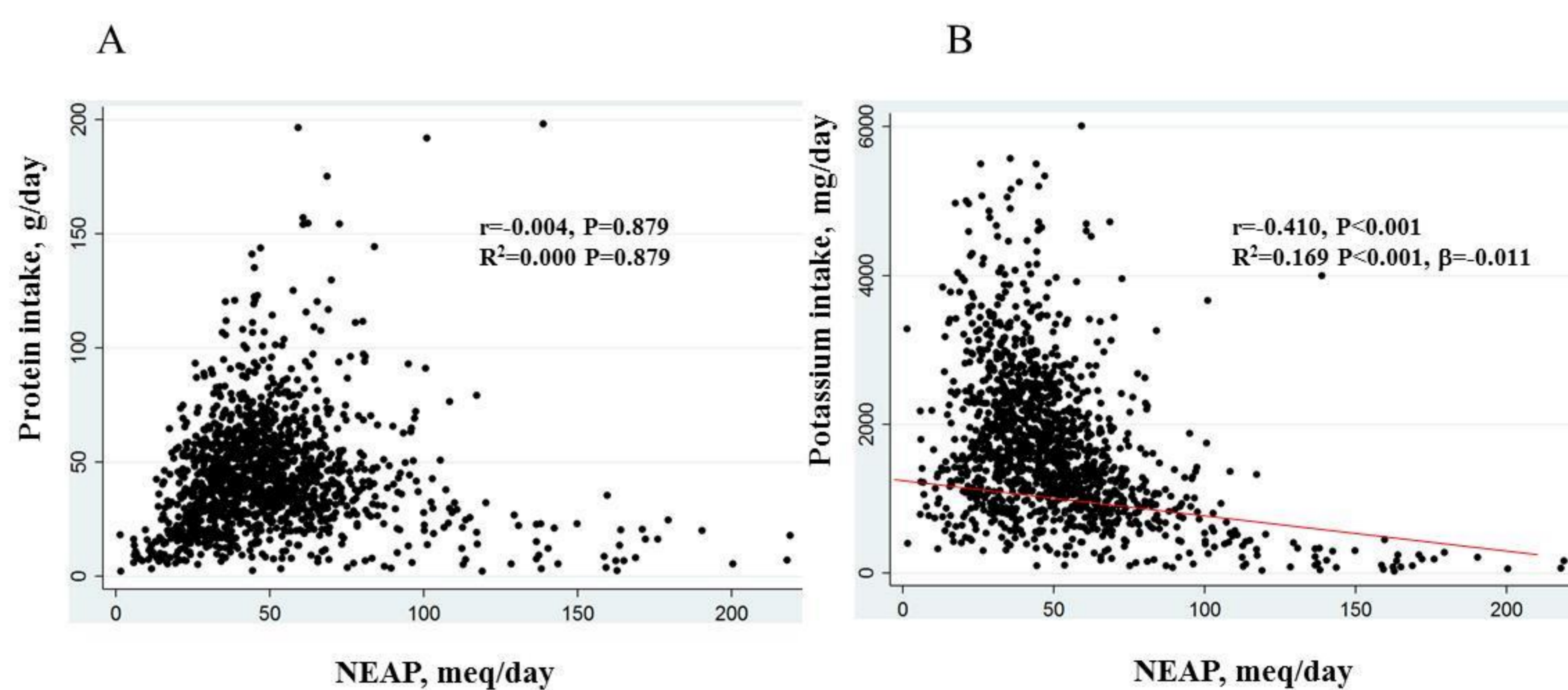


Fig 1. Correlations between net endogenous acid production (NEAP) and nutrient intakes. (A) protein intake, and (B) potassium intake. The straight-line represents the best-fit lines obtained by linear regression analysis.

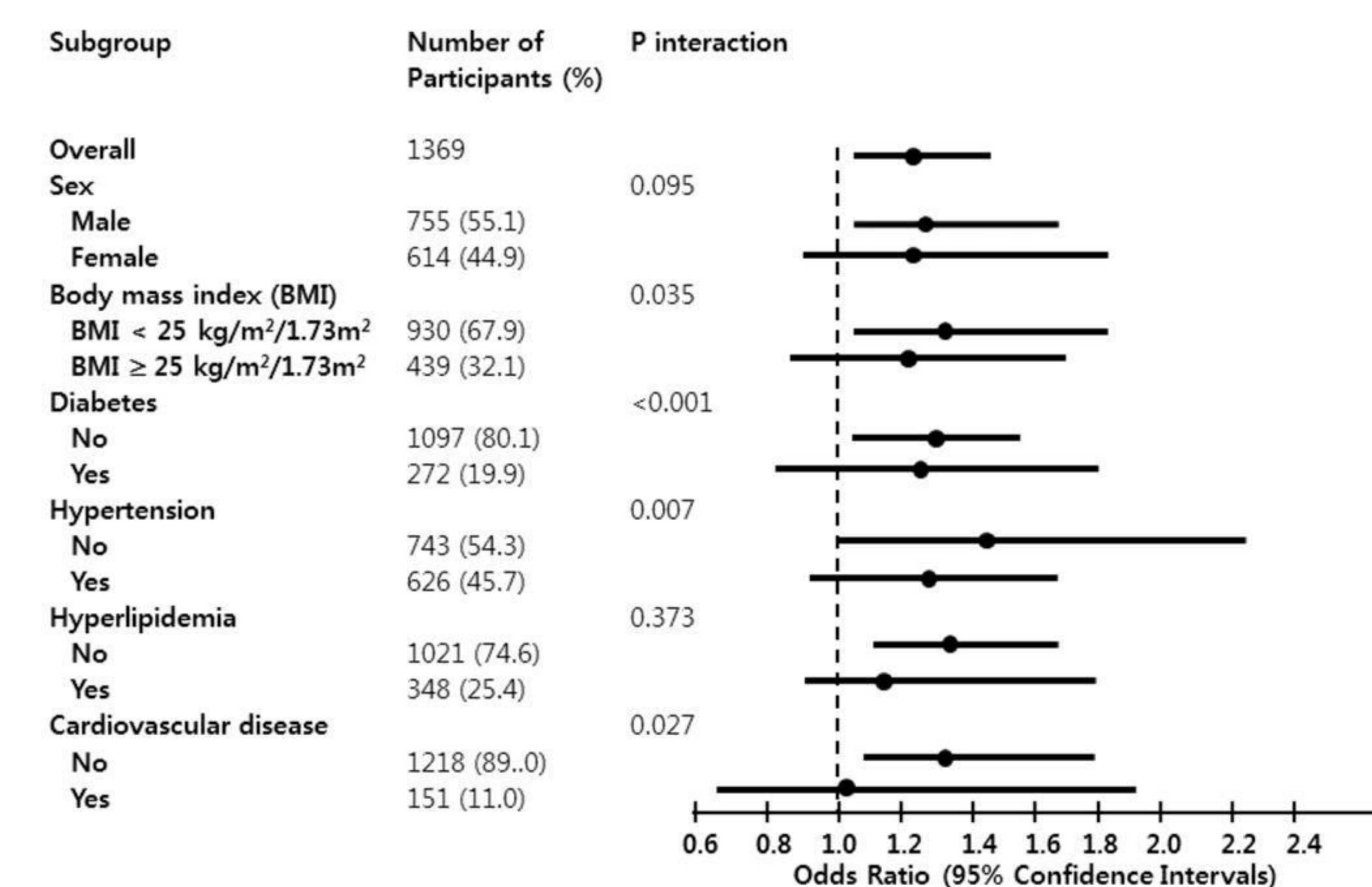


Fig 2. Forest plot of dietary net endogenous acid production (NEAP) and chronic kidney disease in overall participants and subgroups. Odds ratios (95% confidence intervals) were per quartile of NEAP. Odds ratios were adjusted for age, sex, total caloric intake, dietary sodium intake, body mass index, smoking, education state, health-enhancing physical activity, hypertension, diabetes, hyperlipidemia, and cardiovascular disease (Model 2).

Conclusion

Dietary acid load was associated with CKD. Among the nutrients related to dietary acid load, potassium intake was negatively associated with CKD, but protein intake was not associated with CKD in elderly adults.