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Promoting Sustainable Kidney Health: The Asia-Pacific and Beyond

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Urinary volatile organic compounds and kidney function

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Objectives : Volatile organic compounds(VOCs) are group of organic chemicals that easily evaporate at room temperature considered one of the indicators of environmental pollution. VOCs have been reported to be associated with obesity and metabolic diseases in previous studies. We aimed to evaluate the association of VOCs and kidney function.
Methods : We used the dataset from the Korea National Health and Nutrition Examination Survey (KNHANES) VIII (2019–2021). The urine creatinine-corrected VOCs concentration (BMA, 2MHA, 3,4MHA, PGA, MA, SPMA, 3HPMA, BPMA and DHBMA) was divided into tertile groups. CKD was defined as estimated glomerular filtration rate (eGFR) less than 60 mL/min/1.73m^2. The association between urinary VOCs concentration and CKD was analyzed through multiple linear regression model.
Results : A total of 1,319 participants was analyzed in this study. The urinary concentration of several VOCs (3,4MHA [3,4-Methylhexanoic Acid], PGA [Phenylglyoxylic Acid], MA [Maleic Acid], DHBMA [Dihydroxybenzene Mercapturic Acid]) have been found to have statistically significant association with reduced kidney function. ([3,4MHA] odds ratio(OR), 5.86; 95% confidence interval(95% CI), 1.30–26.45; p-value 0.023; [PGA] OR, 14.30; 95% CI, 1.53–133.78; p-value 0.014; [MA] OR, 5.38; 95% CI, 1.03–28.12; p-value 0.040; [DHBMA] OR, 4.14; 95% CI, 0.77–22.21; p-value 0.054).
Conclusions : We found that urinary VOCs concentration showed the association with declined kidney function which could be used to be a predictive marker of CKD.

Table 1_A1175.png

Table 1. Baseline characteristics according to eGFR

	Total	eGFR <60 mL/min/1.73m²		p-value
		No	Yes	
	1,319	1,294	25	
Age	48.17 ± 0.71	47.43 ± 0.7	57.73 ± 2.44	<0.001
≥20 and <30	15.69 (1.65)	15.91 (1.68)		
≥30 and <40	16.79 (1.51)	17.03 (1.52)		
≥40 and <50	19.89 (1.78)	20.18 (1.81)		
≥50 and <60	20.89 (1.83)	20.90 (1.85)	19.89 (7.88)	
≥60 and <70	16.34 (1.23)	16.29 (1.23)	20.13 (10.76)	
≥70	10.40 (1.00)	9.70 (0.98)	59.98 (9.97)	
Sex (%)				0.772
Male	50.65 (1.34)	50.60 (1.35)	53.75 (10.66)	
Female	49.35 (1.34)	49.40 (1.35)	46.25 (10.66)	
BMI (%)				
<18 kg/m²	2.63 (0.61)	2.67 (0.62)		
18≤ <25 kg/m²	59.85 (1.47)	59.77 (1.51)	65.20 (12.43)	
25≤ <30 kg/m²	30.45 (1.41)	30.38 (1.44)	34.80 (12.43)	
≥30 kg/m²	7.08 (1.09)	7.18 (1.10)		
Smoking status (%)				0.715
Never smoker	58.87 (1.51)	58.78 (1.54)	65.02 (8.94)	
Ex-smoker	23.09 (1.28)	23.19 (1.30)	16.48 (7.59)	
Current smoker	18.03 (1.39)	18.03 (1.40)	18.50 (7.28)	
Alcohol consumption (%)				-
Never	23.36 (1.52)	22.80 (1.50)	62.62 (9.55)	
Mild	68.02 (1.65)	68.45 (1.64)	37.38 (9.55)	
Heavy	8.63 (0.93)	8.75 (0.94)		
Physical activity (%)				0.008
No	52.41 (1.82)	51.99 (1.84)	82.60 (8.68)	
Yes	47.59 (1.82)	48.01 (1.84)	17.40 (8.68)	
Income level (%)				0.016
Q1	11.36 (1.35)	11.13 (1.37)	27.79 (11.01)	
Q2	23.78 (1.88)	23.58 (1.90)	38.09 (11.63)	
Q3	27.82 (2.24)	27.84 (2.27)	26.80 (10.31)	
Q4	37.03 (2.91)	37.45 (2.93)	7.32 (5.59)	
Residential area (%)				0.980
Urban	48.33 (2.87)	48.33 (2.89)	47.98 (14.32)	
Rural	51.67 (2.87)	51.67 (2.89)	52.02 (14.32)	
Comorbidities (%)				
Hypertension	26.31 (1.63)	25.54 (1.63)	81.04 (10.09)	<0.001
Diabetes mellitus	11.44 (1.02)	11.26 (1.02)	24.00 (10.20)	0.097
Triglyceride (mg/dL)	130.12 ± 4.82	130.11 ± 5.05	134.76 ± 9.53	0.111

Data are presented as the mean±standard deviation, or %(standard error)
Abbreviation: eGFR, estimated glomerular filtration rate; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol

Table 1_A1175.png

Table 2. The risk of declined kidney function according to urinary VOCs concentration

		N (%)	Model 1	Model 2	Model 3	Model 4	Model 5
BMA	Tertile 1	1.06 (0.52)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	1.91 (0.72)	1.81 (0.67, 4.90)	1.06 (0.35, 3.17)	1.14 (0.39, 3.33)	1.25 (0.43, 3.64)	1.27 (0.43, 3.76)
	Tertile 3	1.26 (0.65)	1.18 (0.28, 4.99)	0.44 (0.11, 1.76)	0.475 (0.12, 1.95)	0.44 (0.10, 1.94)	0.45 (0.10, 2.03)
	P for trend		0.757	0.173	0.235	0.206	0.225
2MHA	Tertile 1	1.52 (0.69)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	1.07 (0.58)	0.70 (0.17, 2.93)	0.55 (0.14, 2.17)	0.62 (0.16, 2.48)	0.59 (0.15, 2.26)	0.59 (0.15, 2.30)
	Tertile 3	1.6 (0.63)	1.05 (0.39, 2.86)	1.04 (0.38, 2.81)	1.06 (0.27, 4.08)	1.33 (0.34, 5.12)	1.37 (0.36, 5.31)
	P for trend		0.892	0.898	0.952	0.739	0.709
3,4MHA	Tertile 1	0.41 (0.21)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	1.97 (0.78)	4.88 (1.38, 17.29)	4.70 (1.35, 16.39)	4.27 (1.27, 14.42)	3.57 (1.05, 12.11)	3.68 (1.08, 12.59)
	Tertile 3	1.67 (0.62)	4.11 (1.13, 14.88)	4.82 (1.31, 17.70)	5.49 (1.14, 26.33)	5.48 (1.20, 25.08)	5.86 (1.30, 26.45)
	P for trend		0.042	0.011	0.036	0.032	0.023
PGA	Tertile 1	0.08 (0.08)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	1.41 (0.62)	17.35 (1.94, 155.10)	14.10 (1.58, 125.70)	11.88 (1.36, 103.56)	12.56 (1.35, 116.55)	13.00 (1.39, 121.71)
	Tertile 3	3.05 (0.97)	38.16 (4.77, 305.54)	15.757 (1.91, 130.30)	14.13 (1.58, 126.71)	16.38 (1.65, 162.92)	14.30 (1.53, 133.78)
	P for trend		<0.001	0.006	0.031	0.0188	0.014
MA	Tertile 1	0.23 (0.2)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	2.31 (1.07)	10.07 (1.44, 70.50)	6.70 (0.92, 48.53)	8.52 (1.31, 55.49)	8.29 (1.44, 47.94)	8.65 (1.33, 56.08)
	Tertile 3	1.87 (0.62)	8.09 (1.32, 49.62)	4.19 (0.65, 26.92)	4.43 (0.77, 25.55)	5.42 (1.09, 26.85)	5.38 (1.03, 28.12)
	P for trend		0.007	0.204	0.172	0.037	0.040
SPMA	Tertile 1	0.51 (0.3)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	0.84 (0.43)	1.63 (0.35, 7.59)	0.58 (0.11, 3.11)	0.49 (0.09, 2.65)	0.47 (0.08, 2.50)	0.22 (0.01, 4.29)
	Tertile 3	3.2 (1.03)	6.39 (1.80, 22.67)	1.65 (0.37, 7.38)	1.41 (0.25, 7.85)	1.31 (0.27, 6.30)	3.164 (0.30, 33.22)
	P for trend		0.001	0.221	0.395	0.425	0.232
3HPMA	Tertile 1	0.78 (0.34)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	1.29 (0.66)	1.66 (0.44, 6.32)	0.79 (0.19, 3.21)	0.78 (0.20, 3.12)	0.74 (0.19, 2.93)	0.69 (0.17, 2.73)
	Tertile 3	2.2 (0.81)	2.85 (0.93, 8.70)	1.13 (0.35, 3.60)	1.01 (0.32, 3.12)	0.90 (0.29, 2.81)	0.86 (0.26, 2.81)
	P for trend		0.054	0.713	0.907	0.951	0.917
BPMA	Tertile 1	1.7 (0.83)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	1.33 (0.51)	0.78 (0.23, 2.67)	0.46 (0.12, 1.71)	0.59 (0.18, 1.93)	0.50 (0.16, 1.53)	0.45 (0.15, 1.31)
	Tertile 3	1.11 (0.61)	0.65 (0.16, 2.71)	0.24 (0.06, 0.95)	0.24 (0.06, 0.92)	0.20 (0.06, 0.70)	0.20 (0.06, 0.70)
	P for trend		0.549	0.048	0.032	0.010	0.011
DHBMA	Tertile 1	0.24 (0.17)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
	Tertile 2	1.17 (0.57)	4.85 (0.83, 28.26)	2.38 (0.36, 15.73)	2.33 (0.37, 14.63)	1.79 (0.28, 11.62)	1.62 (0.28, 9.49)
	Tertile 3	3.11 (1.18)	13.19 (2.73, 63.77)	5.19 (0.94, 28.53)	5.32 (1.02, 27.85)	4.44 (0.85, 23.26)	4.14 (0.77, 22.21)
	P for trend		0.001	0.042	0.0263	0.043	0.054

Abbreviation: VOCs, volatile organic compounds; BMA, Benzene Metabolites Acetate; 2MHA, 2-Methylhippuric Acid; 3,4MHA, 3,4-Methylhexanoic Acid; PGA, Phenylglyoxylic Acid; MA, Maleic Acid; SPMA, S-Phenylmercapturic Acid; 3HPMA, 3-Hydroxypropylmercapturic Acid; BPMA, Benzylmercapturic Acid; DHBMA, Dihydroxybenzene Mercapturic Acid
Model 1 was non-adjusted.
Model 2 was adjusted for age and sex.
Model 3 was adjusted for variables in model 2 and BMI, smoking history, alcohol consumption, hypertension and diabetes mellitus
Model 4 was adjusted for variables in model 3 and window opening status
Model 4 was adjusted for variables in model 4 and indoor air quality