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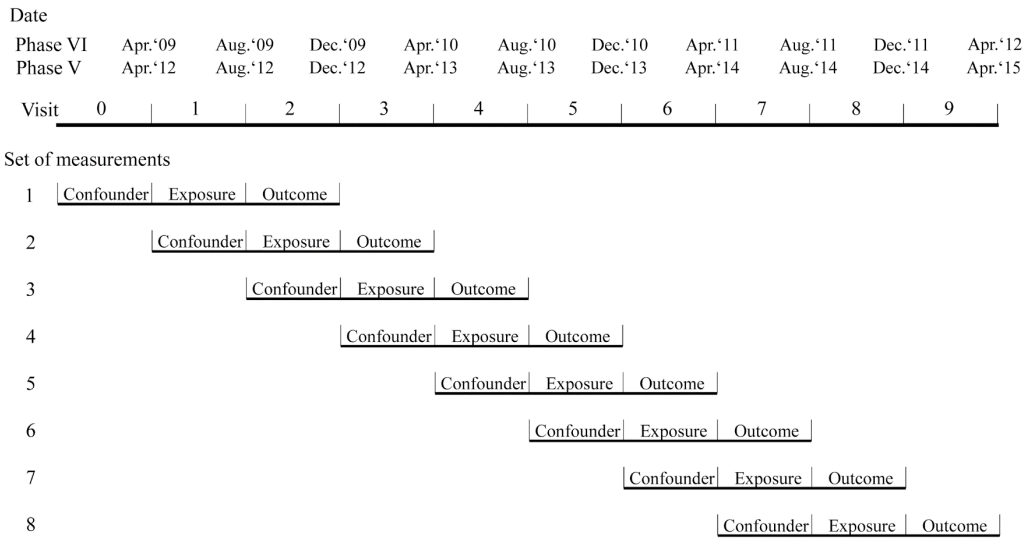
Data structure

We used set-level data for analysis with generalized estimating equations. Data were collected at enrollment (Visit 0) and every 4 months during the 3-year observational period (Visits 1-9). We defined 8 imbricated sets of measurements from 9 visits, and each set consisted of 3 consecutive visits for confounders, exposure, and outcome (Supplemental Figure 6).

Methods

All confounders except for pre-dialysis potassium were obtained at the visit for confounders, and pre- and post-dialysis K were obtained at the visit for exposure. Outcome was defined as death from any cause between the end of exposure visit and the end of outcome visit. We estimated odds ratio using generalized estimating equations with a robust sandwich estimator. We constructed unadjusted model and 3 adjusted models as in the Cox hazards regression analysis. Model 1 was adjusted for sex, age, body mass index, comorbidities, and medications. Model 2 was adjusted for serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, and type of vascular access. Model 3 was adjusted for confounders in Model 2 plus pre-dialysis serum potassium.

Data structure for generalized estimating equations



Note: We defined 8 imbricated sets of measurements from 9 visits during the 3-year observational period. We defined confounders at the first visit, exposure at the second visit, and outcome at the third visit to avoid a reversal of time course.

Supplemental Table 1. Distribution of participants according to baseline dialysate potassium and baseline post-dialysis serum potassium concentrations

	Post-dialysis K (mEq/L)				
Dialysate K (mEq/L)	<3.0	≥3.0 to <3.5	≥3.5 to <4.0	≥4.0	Total
<1.5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
≥1.5 to <2.0	1 (0.3%)	0 (0%)	2 (0.1%)	0 (0%)	3 (0.1%)
≥2.0 to <2.5	361 (97%)	1689 (96%)	1364 (96%)	390 (94%)	3804 (96%)
≥2.5 to <3.0	1 (0.3%)	4 (0.2%)	3 (0.2%)	0 (0%)	8 (0.2%)
≥3.0	1 (0.3%)	4 (0.2%)	4 (0.3%)	1 (0.2%)	10 (0.3%)
missing	10 (3%)	55 (3%)	54 (4%)	23 (6%)	142 (4%)
Total	374 (100%)	1752 (100%)	1427 (100%)	414 (100%)	3967 (100%)

Note: Distribution of participants is noted based on baseline dialysate potassium and baseline post-dialysis K concentrations.

Abbreviations: dialysate K, dialysate potassium; post-dialysis K, post-dialysis serum potassium

Supplemental Table 2. Participants according to the combination categories of pre-dialysis and post-dialysis serum potassium concentrations

pre-dialysis K	post-dialysis K(mEq/L)				
(mEq/L)	<3.0	≥3.0 to <3.5	≥3.5 to <4.0	≥4.0	Total
<4.0	1566 (55%)	1192 (42%)	88 (3%)	24 (1%)	2870 (100%)
≥4.0 to <5.5	1102 (6%)	9439 (55%)	5882 (34%)	847 (5%)	17270 (100%)
≥5.5	20 (0.4%)	822 (15%)	2992 (56%)	1538 (29%)	5372 (100%)
Total	2688 (11%)	11453 (45%)	8962 (35%)	2409 (9%)	25512 (100%)

Note: The numbers of participants in pre- and post-dialysis potassium categories are shown.

Abbreviations: pre-dialysis K, pre-dialysis serum potassium; post-dialysis K, post-dialysis serum potassium

Supplemental Table 3. Factors related to post-dialysis serum potassium concentration

	post-dialysis K (mEq/L)	95% CI	P-value
Pre-dialysis K (mEq/L)	0.38	0.37 – 0.38	<0.01
Male sex	0.09	0.08 – 0.11	<0.01
Age (10 years)	-0.01	-0.02 – -0.01	<0.01
Body weight (10 kg)	0.07	0.07 – 0.08	<0.01
Vintage (years)			
<0.5	ref.		
0.5 - <3	0.00	-0.02 – 0.01	0.9
3 - <10	-0.02	-0.03 – -0.001	0.04
≥10	-0.04	-0.05 – -0.02	<0.01
Dialysis duration (30 min)	-0.03	-0.04 – -0.03	<0.01
Blood flow rate (50 ml/min)	-0.14	-0.15 – -0.13	<0.01
Vascular access			
arteriovenous fistula	ref.		
arteriovenous graft	0.02	0.00 – 0.04	0.03
others	0.01	-0.02 – 0.05	0.6
Dialysate potassium (mEq/L)			
<1.5	0.03	-0.53 – 0.58	0.9
≥1.5 to <2.5	ref.		
≥2.5	0.02	-0.06 – 0.11	0.6
Dialysate bicarbonate (mEq/L)			
<30	0.07	0.06 – 0.08	<0.01
≥30 to <35	ref.		
≥35	0.04	0.03 – 0.05	<0.01

Note: Effect sizes were estimated with linear regression model adjusted for baseline covariates of sex, age, comorbidities, and medications and time-varying covariates of pre-dialysis serum potassium, body weight, nutritious markers, C-reactive protein, dialysis vintage, treatment duration, and type of vascular access.

Abbreviations: dialysate K, dialysate potassium; post-dialysis K, post-dialysis serum potassium; 95% CI, 95% confidence interval; ref., reference

Supplemental Table 4. Missing values and multiple imputation

	Complete	Imputed	Total
Age	26190 (100%)	3 (0%)	26193
Sex	26160 (100%)	33 (0.1%)	26193
Height	24596 (94%)	1597 (6%)	26193
Body weight	25333 (97%)	860 (3%)	26193
Pre-dialysis K	25841 (99%)	352 (1%)	26193
Post-dialysis K	25533 (97%)	660 (3%)	26193
Serum albumin	25174 (96%)	1019 (4%)	26193
C-reactive protein	17234 (66%)	8959 (34%)	26193
Normalized protein catabolic rate	24194 (92%)	1999 (8%)	26193
Dialysis duration	24211 (92%)	1982 (8%)	26193
Vascular access	26089 (100%)	104 (0.4%)	26193
Vintage	24517 (94%)	1676 (7%)	26193

Abbreviations: dialysate K, dialysate potassium; post-dialysis K, post-dialysis serum potassium

Supplemental Table 5. Association of post-dialysis serum potassium concentration with all-cause mortality

Post-dialysis K (mEq/L)	HR	95% CI
2.1	1.7	0.9 - 3.3
2.2	1.6	0.9 - 2.9
2.3	1.5	0.9 - 2.6
2.4	1.4	0.9 - 2.3
2.5	1.3	0.9 – 2.0
2.6	1.3	0.9 - 1.8
2.7	1.2	0.9 - 1.6
2.8	1.1	0.9 - 1.5
2.9	1.1	0.8 - 1.3
3.0	1.0	0.8 - 1.2
3.1	1.0	0.8 - 1.2
3.2	0.9	0.8 - 1.1
3.3	0.9	0.8 - 1.1
3.4	1.0	0.9 – 1.0
3.5 (ref.)	1.0	1.0 – 1.0
3.6	1.0	1.0 - 1.1
3.7	1.1	1.0 - 1.2
3.8	1.1	0.9 - 1.2
3.9	1.1	0.9 - 1.2
4.0	1.1	0.9 - 1.3
4.1	1.1	0.9 - 1.3
4.2	1.1	0.8 - 1.3
4.3	1.0	0.8 - 1.4
4.4	1.0	0.8 - 1.4
4.5	1.0	0.7 - 1.5

Note: This table describes the categorical results of Figure 3. Post-dialysis serum potassium was assessed as a continuous variable. The model was adjusted for baseline confounders of sex, age, body mass index, comorbidities, and medications, and time-varying confounders of serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, dialysate bicarbonate, type of vascular access, and pre-dialysis serum potassium.

Abbreviations: post-dialysis K, post-dialysis serum potassium; HR, hazard ratio; 95% CI, 95% confidence interval; ref., reference

Supplemental Table 6. Association of post-dialysis serum potassium concentration with sudden cardiac death and unknown death

Post-dialysis K (mEq/L)	HR	95% CI
2.1	2.3	0.7 - 7.2
2.2	2.1	0.8 - 5.9
2.3	1.9	0.8 - 4.8
2.4	1.7	0.8 - 3.9
2.5	1.6	0.8 - 3.2
2.6	1.4	0.8 - 2.7
2.7	1.3	0.8 - 2.2
2.8	1.2	0.8 - 1.8
2.9	1.1	0.7 - 1.6
3.0	1.0	0.7 - 1.4
3.1	0.9	0.7 - 1.3
3.2	0.9	0.7 - 1.2
3.3	0.9	0.7 - 1.1
3.4	0.9	0.8 – 1.0
3.5 (ref.)	1.0	1.0 – 1.0
3.6	1.1	1.0 - 1.2
3.7	1.1	1.0 - 1.3
3.8	1.2	0.9 - 1.4
3.9	1.2	0.9 - 1.5
4.0	1.2	0.9 - 1.5
4.1	1.2	0.8 - 1.6
4.2	1.2	0.8 - 1.7
4.3	1.2	0.7 - 1.8
4.4	1.2	0.7 – 2.0
4.5	1.2	0.6 - 2.1

Note: This table describes the categorical result of Supplemental Figure 2. Post-dialysis serum potassium was assessed as a continuous variable. The model was adjusted for baseline confounders of sex, age, body mass index, comorbidities, and medications, and time-varying confounders of serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, dialysate bicarbonate, type of vascular access, and pre-dialysis serum potassium.

Abbreviations: post-dialysis K, post-dialysis serum potassium; HR, hazard ratio; 95% CI, 95% confidence interval; ref., reference

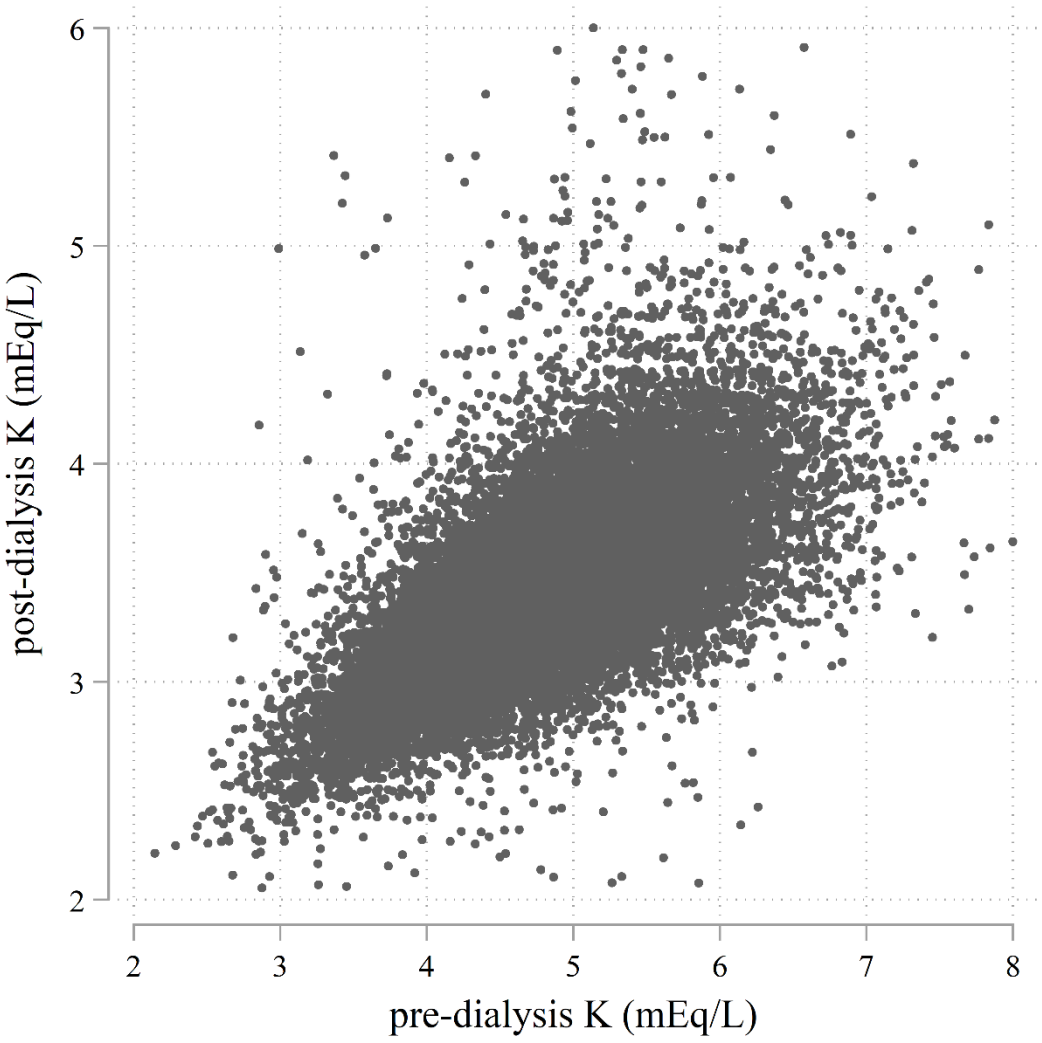
Supplemental Table 7. Association of post-dialysis serum potassium with all-cause mortality using generalized estimating equations

	Unadjusted model		Model 1		Model 2		Model 3	
Post-dialysis K (Range, mEq/L)	HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value	HR (95% CI)	P-value
Low group (1.9-2.9)	1.84 (1.44–2.34)	<0.01	1.61 (1.22-2.13)	<0.01	1.54 (1.16-2.04)	<0.01	1.01 (0.73-1.39)	0.95
Medium-low group (3.0-3.4)	ref.		ref.		ref.		ref.	
Medium-high group (3.5-3.9)	1.04 (0.86–1.27)	0.69	1.18 (0.94-1.48)	0.15	1.15 (0.91-1.44)	0.25	1.2 (0.94-1.55)	0.15
High group (4.0-8.0)	1.24 (0.93–1.66)	0.15	1.43 (1.03-1.98)	0.03	1.34 (0.96-1.87)	0.09	1.33 (0.92-1.93)	0.13

Note: Model 1 was adjusted for sex, age, body mass index, comorbidities, and medications. Model 2 was adjusted for serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, and type of vascular access. Model 3 was adjusted for confounders in Model 2 plus pre-dialysis serum potassium.

Abbreviations: post-dialysis K, post-dialysis serum potassium; HR, hazard ratio; 95% CI, 95% confidence interval; ref., reference

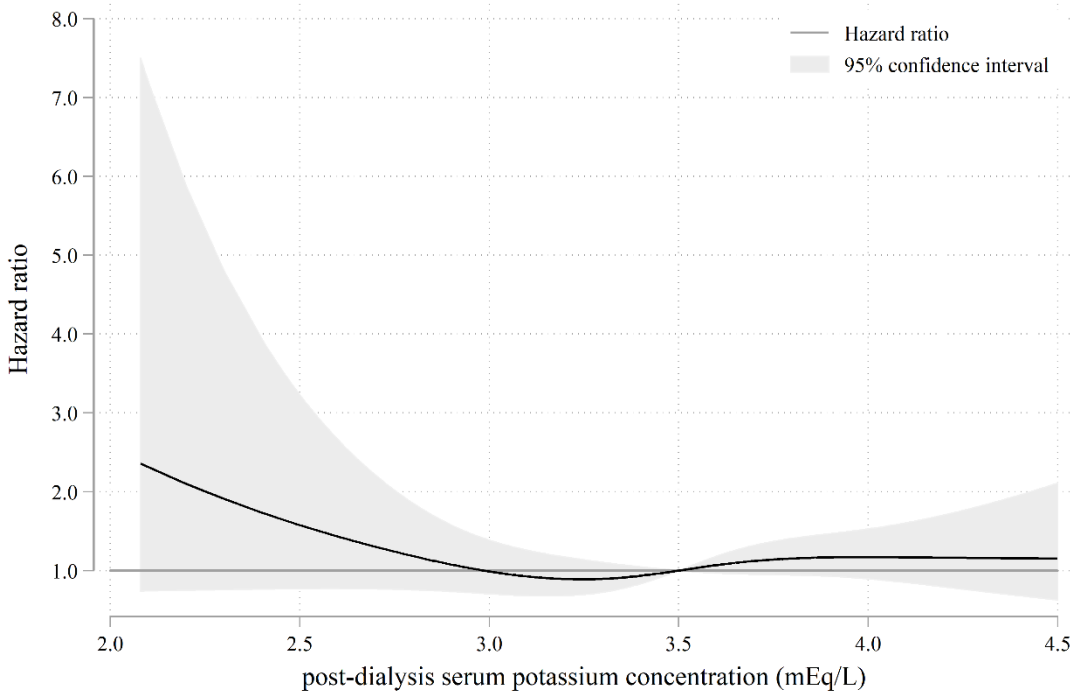
Supplemental Figure 1. Correlation of pre-dialysis K and post-dialysis K



Note: Pre- and post-dialysis serum potassium levels were measured before and after a single dialysis session.

Abbreviations: dialysate K, dialysate potassium; post-dialysis K, post-dialysis serum potassium

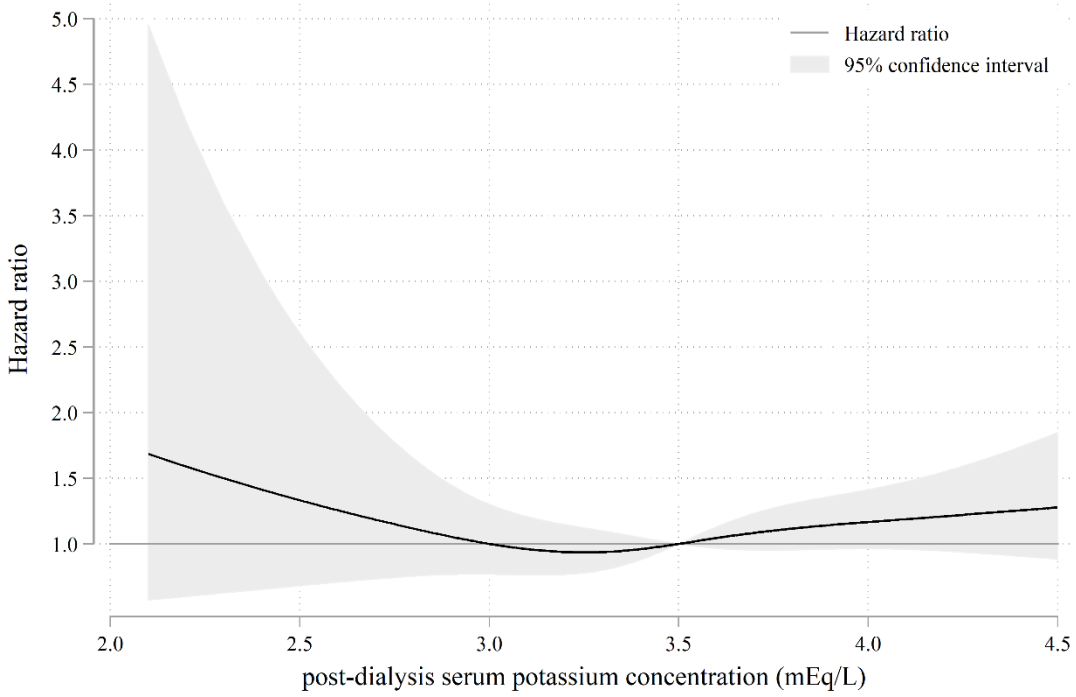
Supplemental Figure 2. Association of post-dialysis serum potassium concentration, assessed as a continuous variable, with sudden cardiac death, unknown death



Note: The thick black line shows the HR of all-cause mortality. The reference (HR = 1) is 3.5 mEq/L. The grey area shows the 95% confidence interval. The model was adjusted for baseline confounders of sex, age, body mass index, comorbidities, and medications, and time-varying confounders of serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, dialysate bicarbonate, type of vascular access, and pre-dialysis serum potassium.

Abbreviation: SCD, sudden cardiac death; Post-dialysis K, post-dialysis serum potassium

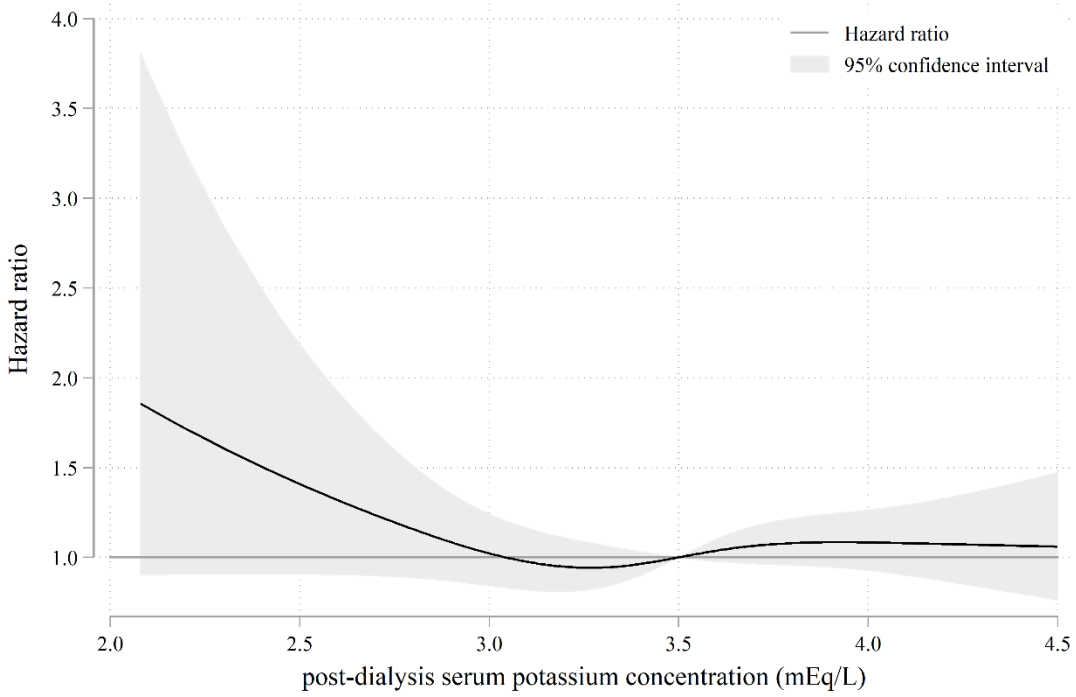
Supplemental Figure 3. Association of post-dialysis serum potassium concentration with all-cause mortality in participants with long treatment durations



Note: Participants with a weekly 12 hour or more treatment duration were included. The thick black line shows the HR of all-cause mortality. The reference (HR = 1) is 3.5 mEq/L. The grey area shows the 95% confidence interval. The model was adjusted for baseline confounders of sex, age, body mass index, comorbidities, and medications, and time-varying confounders of serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, dialysate bicarbonate, type of vascular access, and pre-dialysis serum potassium.

Abbreviation: Post-dialysis K, post-dialysis serum potassium

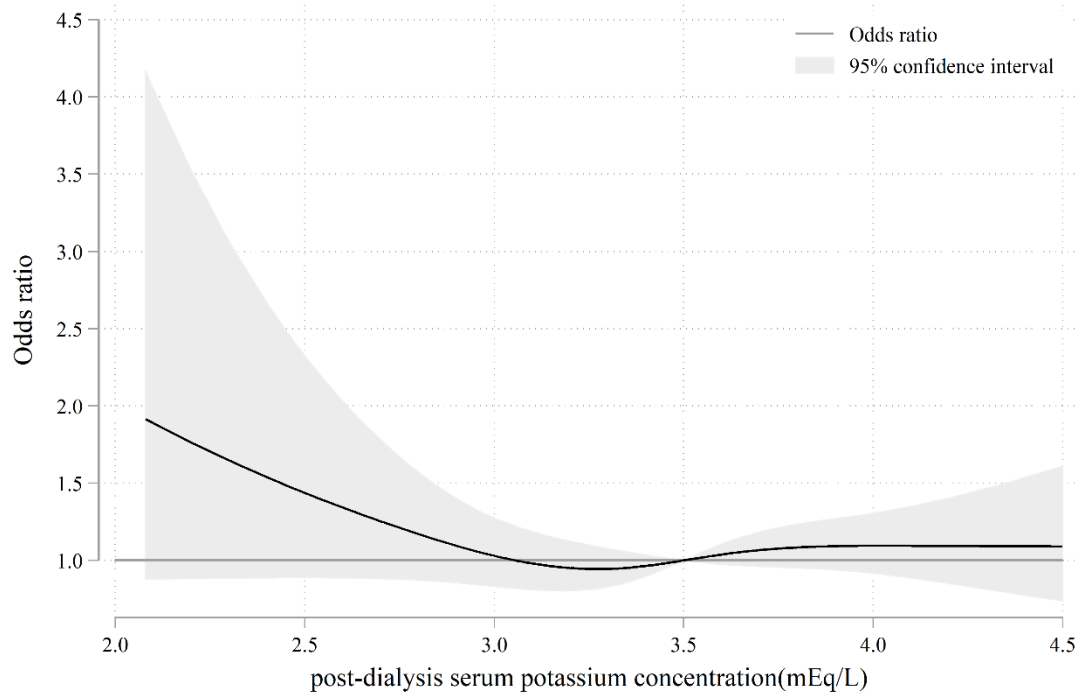
Supplemental Figure 4. Association of post-dialysis serum potassium concentration with all-cause mortality in participants with long treatment duration



Note: All participants were included regardless of treatment duration. The thick black line shows the HR of all-cause mortality. The reference (HR = 1) is 3.5 mEq/L. The grey area shows the 95% confidence interval. The model was adjusted for baseline confounders of sex, age, body mass index, comorbidities, and medications, and time-varying confounders of serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, dialysate bicarbonate, type of vascular access, and pre-dialysis serum potassium.

Abbreviation: Post-dialysis K, post-dialysis serum potassium

Supplemental Figure 5. Association of post-dialysis serum potassium concentration with all-cause mortality in logistic model



Note: The thick black line shows the odds ratio of all-cause mortality. The reference (odds ratio = 1) is 3.5 mEq/L. The grey area shows the 95% confidence interval. The model was adjusted for baseline confounders of sex, age, body mass index, comorbidities, and medications, and time-varying confounders of serum albumin, C-reactive protein, normalized protein catabolic rate, dialysis vintage, single-pool kt/v, dialysate bicarbonate, type of vascular access, and pre-dialysis serum potassium.

Abbreviation: Post-dialysis K, post-dialysis serum potassium