

# Progression of Chronic Kidney Disease (CKD) in the Renal Research Institute (RRI)-CKD Study



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## OBJECTIVES

- Understanding CKD progression is critical in designing optimum clinical management
- There is little data from prospective cohort studies examining patterns and predictors of CKD progression
- Our aim was to examine patterns and predictors of CKD progression in a prospective CKD cohort

## PATIENTS & METHODS

- This study is a prospective observational study of adult patients with CKD Stage 3-5 conducted at 78 US nephrology clinics enrolled between 06/2000-01/2006
- Data on demographic, comorbidity, laboratory, and medication were collected at all clinic visits
- Glomerular filtration rate (GFR) was estimated using the 4-variable MDRD and CKD-EPI equations
- CKD progression was assessed by eGFR change per year and time to ESRD
- Multiple linear regression was used to assess association between eGFR slope and baseline characteristics
- Rate of progression was analyzed using linear mixed models to predict eGFR over time using all available data
- Time to ESRD and time to death was analyzed via Cox survival models

## RESULTS

**Table 1:** Patient characteristics, at enrollment, by stages of CKD (Stage 3: GFR  $\geq$  30 ml/min/1.73m<sup>2</sup>; Stage 4: 15  $\leq$  eGFR < 30 ml/min/1.73m<sup>2</sup>; Stage 5: eGFR < 15 ml/min/1.73m<sup>2</sup>)

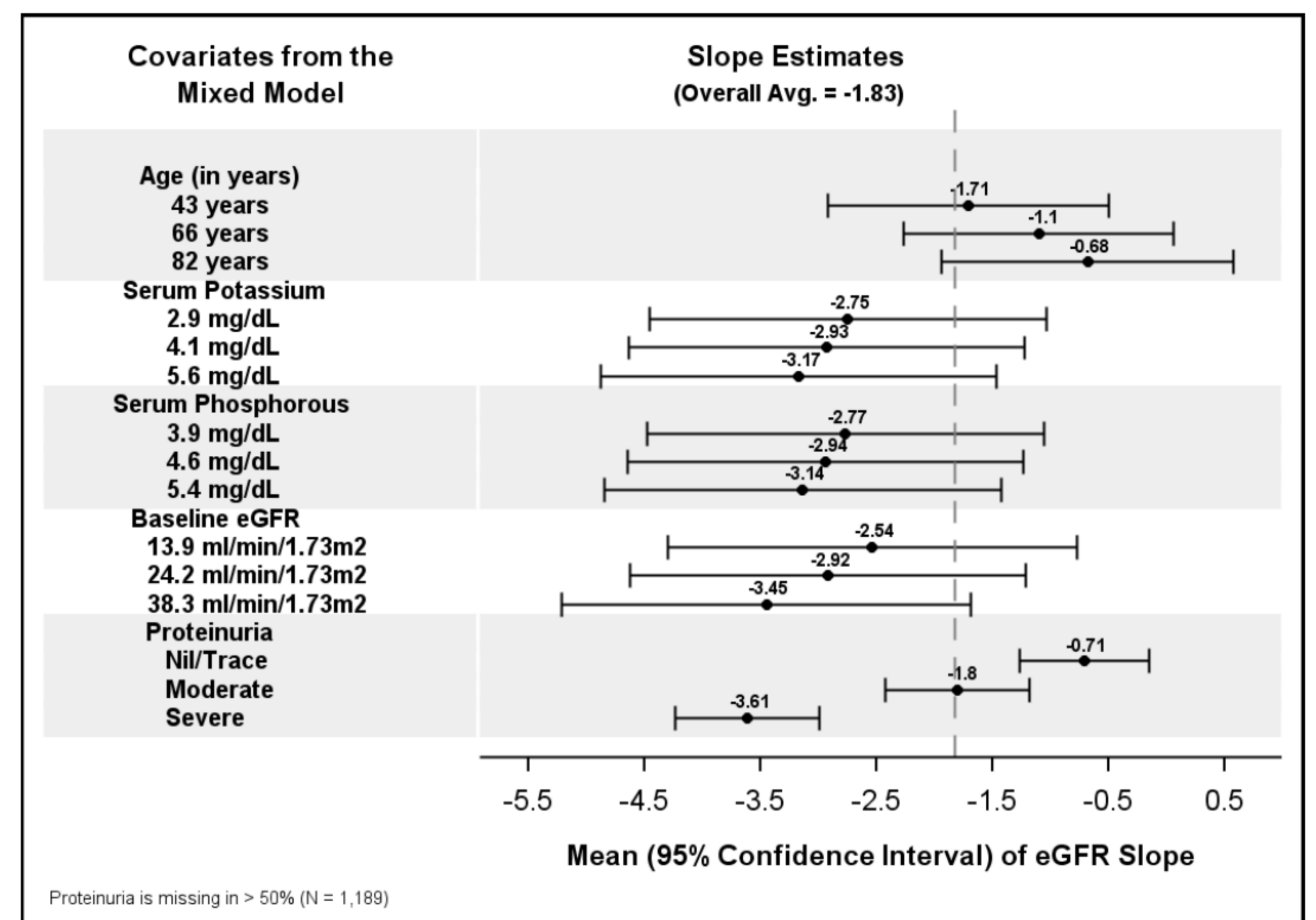
Variable	n	CKD Stage 3 (n = 605)	CKD Stage 4 (n = 1065)	CKD Stage 5 (n = 331)
<b>Demographics</b>				
Age	2176	63 15	64 15	61 14
Gender: Male	2172	60% (368)	56% (594)	43% (143)
Caucasian, Non-Hispanic	2173	64% (391)	70% (744)	57% (189)
African -American	2173	26% (162)	19% (206)	28% (92)
<b>Vitals Signs</b>				
Body Mass Index (kg/m <sup>2</sup> )	1738	29 (14, 61.1)	28 (15, 72.4)	28 (18, 64.0)
Systolic Blood Pressure (mmHg)	2143	138 21	139 22	144 24
<b>Comorbidities</b>				
Diabetes	2168	44% (270)	49% (517)	48% (157)
Hypertension	2182	56% (343)	50% (536)	51% (168)
Coronary Artery Disease	2182	25% (155)	29% (309)	19% (64)
Cerebrovascular Disease	2182	12% (75)	15% (157)	11% (36)
Peripheral Artery Disease	2182	12% (71)	14% (144)	10% (33)
Any Cardiovascular Disease	2182	44% (270)	53% (563)	44% (147)
<b>Labs</b>				
Estimated GFR (ml/min/1.73m <sup>2</sup> )	2012	38 8	22 4	12 2
Serum Albumin (g/dL)	1679	4 1	4 0.4	4 0.6
Serum Sodium (mEq/L)	2076	140 (117, 150)	141 (107, 150)	141 (129, 159)
BUN	2097	34 13	49 18	66 22
<b>Medication Use (yes/no)</b>				
ACEi or A-II Receptor Blockers	2182	56% (348)	53% (563)	43% (141)
Aspirin	2182	32% (197)	32% (344)	21% (68)
Beta Blocker	2182	39% (238)	41% (432)	34% (113)
Calcium Channel Blocker	2182	36% (222)	47% (501)	55% (182)
Diuretics	2182	44% (269)	49% (525)	55% (182)
Erythropoietin	2182	10% (63)	23% (243)	32% (106)
Statin	2182	39% (243)	39% (419)	34% (113)
None/Mild proteinuria	1271	28% (174)	21% (224)	16% (54)
Moderate proteinuria	1271	16% (100)	16% (174)	11% (39)
Severe proteinuria	1271	17% (108)	21% (227)	25% (84)

**Table 2:** Baseline predictors of patient-specific eGFR slope over follow-up time. Outcome (Y) for linear regression was eGFR slope (previously calculated for each patient) and for logistic regression Y was eGFR slope < -4 ml/min/1.73m<sup>2</sup>

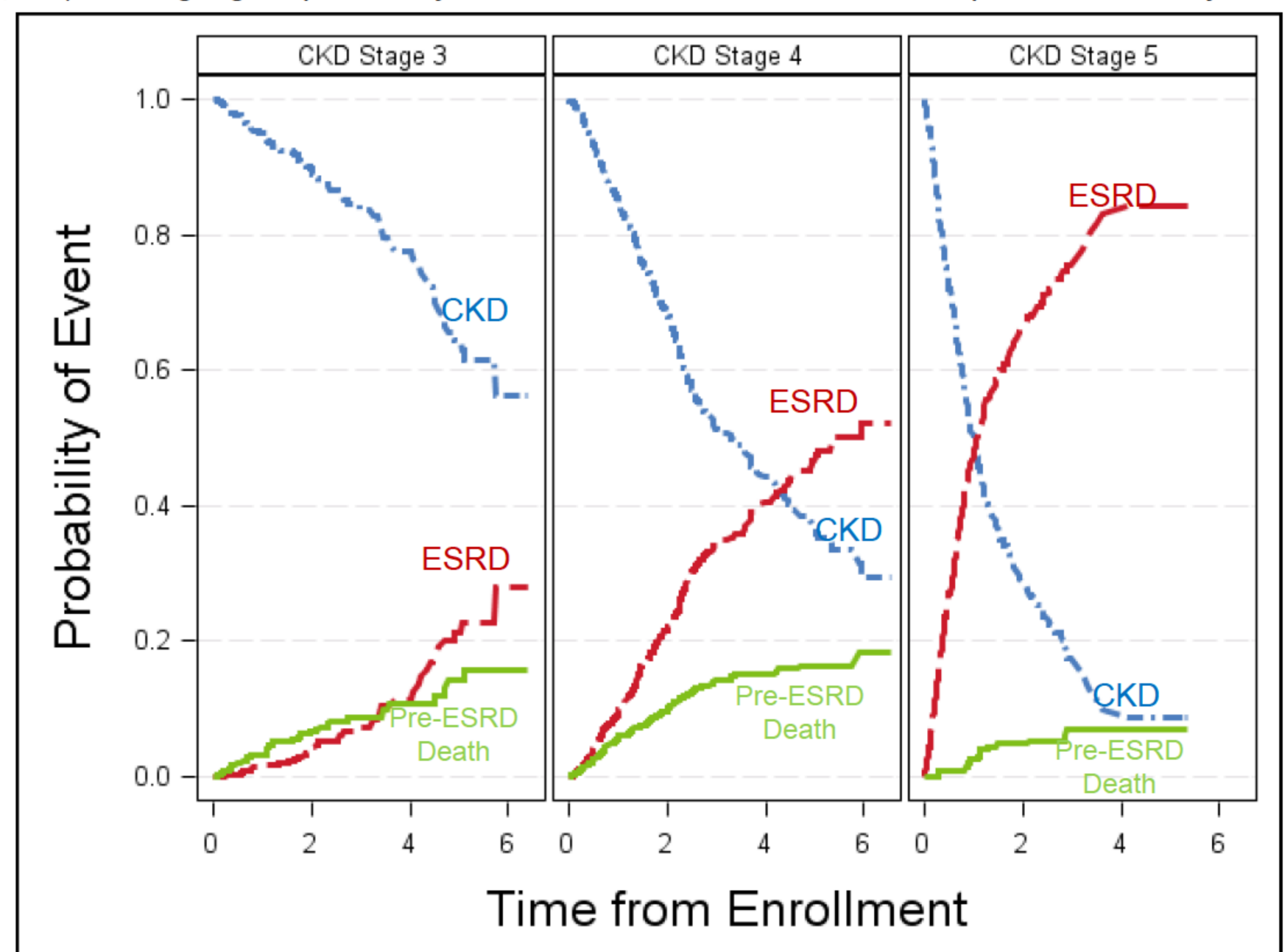
Without Proteinuria (n=1,123*)	Predicting eGFR Slope (Linear Regression)		Predicting eGFR Slope (Logistic Regression)	
	Estimate	p-value	Odds Ratio	p-value
Age	0.06	<0.0001	0.98	0.0001
Race: Black	-0.96	0.0198	1.98	<0.0001
Gender: Male	-0.74	0.0234	1.34	0.0393
Diabetes	-0.86	0.0095	1.71	0.0002
Systolic Blood Pressure (per 10 mm/Hg)	-0.29	0.0003	--	--
Serum CO <sub>2</sub> (mEq/L)	0.13	0.0019	0.97	0.0450
Serum Albumin (g/dL)	3.14	<0.0001	0.38	<0.0001
Serum Sodium (per 5 mmol/L)	-0.89	0.0002	--	--
History of Cardiovascular Disease	--	--	1.35	0.0437
With Proteinuria (n=707*)	Predicting eGFR Slope (Linear Regression)		Predicting eGFR Slope (Logistic Regression)	
	Estimate	p-value	Odds Ratio	p-value
Age	0.04	0.0033	0.98	0.0085
Race: Black	-0.46	0.3702	1.91	0.0031
Gender: Male	-0.11	0.7851	1.09	0.6363
Diabetes	-0.74	0.0723	1.62	0.0095
Systolic Blood Pressure (per 10 mm/Hg)	-0.19	0.0461	--	--
Serum CO <sub>2</sub> (mEq/L)	0.11	0.0327	0.98	0.2889
Serum Albumin (g/dL)	2.32	<0.0001	0.50	0.0004
Serum Sodium (per 5 mmol/L)	-0.82	0.0031	--	--
History of Cardiovascular Disease	--	--	1.40	0.0803
Moderate Proteinuria	-0.87	0.0703	1.55	0.4939
Severe Proteinuria	-2.46	<0.0001	3.13	<0.0001

\*Sample size reduced due to missing blood pressure (n=26), serum albumin (n=152), serum CO<sub>2</sub> (n=76), Serum Na<sup>+</sup> (n=45) and proteinuria (n=538)

**Figure 1:** Estimates of eGFR slope (ml/min/1.73m<sup>2</sup> per year) by covariate subgroups. For continuous variable (e.g., age, potassium), the categories are based on quartiles of the covariate values. Estimates were based on repeated measures models of eGFR over time, adjusted for the mean value or proportions of each factor included in final model (n=2,006)



**Figure 2:** Cumulative incidence of death, ESRD and active CKD, by CKD stage (n = 2,182) showing higher probability of ESRD in this referred cohort compared to mortality



## CONCLUSION

- Even though proteinuria is a strong predictor of progression, it is not regularly measured. This represents a deficiency in this important practice pattern
- This prospective cohort of referred CKD patients likely typifies patterns of progression in US nephrology practices and identifies important modifiable risk factors for CKD progression and the outcome of ESRD

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