

Supplemental Material

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Supplemental Item 1: Categorization of Social Determinants of Health for sub-group analysis in MDRD and CRIC

1. Income

a. **MDRD Study:** Total household gross yearly income was reported as a categorical variable. To better evaluate income for sub-group analysis, we took the midpoint of each income range, and divided by the number of people supported in part or in whole from the household income. For the \$ <7,500 and > 75,000 categories which have no midpoints, we used the median household yearly income in place of the mid-point of the interval. To define cut-off points for sub-group analysis, we took into account federal poverty levels at the time of the MDRD study.

Original variable description for total household income	Total household income as relation to federal poverty level in 1990	Income per persons in household sub-groups for MDRD
\$ < 7,500	~ 1 x federal poverty level	Less than or equal to \$6,800 vs greater than \$6,800
\$ 7,500 – 14,999	~ 1-2 x federal poverty level	
\$ 15,000 – 24,999	~ 3 x federal poverty level	
\$ 25,000 – 39,999	~ 4-6 x federal poverty level	
\$ 40,000 – 49,999	~ 7 x federal poverty level	
\$ 50,000 – 74,999	~ 8-11 x federal poverty level	
\$ > = 75,000	~ 12 x federal poverty level	
Federal poverty level around time of MDRD study = \$6,652.		

b. **CRIC:** Total household gross yearly income was reported as a categorical variable. We did not estimate income per persons in household in CRIC, as number of persons supported in part or in whole from household income was not reported. Median splits was used to define cut-off points for sub-group analysis.

Original variable description for total household income	Income sub-groups for CRIC
\$ < 20,000	Less than \$50,000 vs greater than or equal to \$50,000
\$ 20,000 – 50,000	
\$ 50,000 – 100,000	
\$ > 100,000	

2. Education level

Original variable description	MDRD and CRIC
College graduate with professional	College graduate or more
College graduate	

At least one year of college	Some college education
High school graduate	High school graduate
Completed 10-11 years of school	Less than high school education
Completed 7-9 years of school	
Completed <7 years of school	
Variables were matched to subgroups based on description of education level. Variables in the same subgroup are given the same colour.	

3. Employment Status

Original variable description	MDRD	CRIC
Full time	Employed	Employed
Part time	Employed	Employed
Unemployed not due to disability	Unemployed	Unemployed
Unemployed due to disability	Disability	Not captured
Retired due to disability	Disability	Not captured
Laid Off	Not captured	Disability
Medical Leave	Not captured	Disability
Retired not due to disability	Employed	Employed
Other	Employed	Employed
Student	Employed	Employed
Homemaker	Employed	Employed
Variables were matched to subgroups based on description of employment status. Variables in the same subgroup are given the same colour.		

4. Marital status

Original variable description	MDRD	CRIC
Single	Not-married	Not-married
Married	Married	Married
Domestic Partner	Not captured	Married
Separated	Not-married	Not-married
Divorced	Not-married	Not-married
Widowed	Not-married	Not-married
Variables were matched to subgroups based on description of marital status. Variables in the same subgroup are given the same colour.		

Supplemental Table 1: measured GFR assessment in the MDRD Study and CRIC

Study	Measured GFR assessment
MDRD	GFR was measured by the urinary clearance of ^{125}I – iothalamate based on a time-weighted mean of four serum activity measurements and a volume-weighted mean of four urine activity measurements. GFR measurements were indexed to body surface area ($\text{mL}/\text{min}/1.73\text{m}^2$). ¹
CRIC	GFR was measured using urinary clearance of ^{125}I – iothalamate based on a time-weighted average across up to four collection periods (after dropping the first period) and indexed to body surface area ($\text{mL}/\text{min}/1.73\text{ m}^2$). ²

Supplemental Table 2. Social Determinants of Health Categories by Race Groups

a. MDRD Study

<i>Social determinants of health</i>	Black (N=197)	non-Black (N=1,431)	P-value
Total Gross Annual household Income – no. (%)			
Less than \$7,500	21 (11%)	47 (3%)	<0.001
\$7,500 - \$14,999	28 (14%)	107 (7%)	
\$15,000 - \$24,999	39 (20%)	205 (14%)	
\$25,000 - \$39,999	40 (20%)	311 (22%)	
\$40,000 - \$49,999	15 (8%)	199 (14%)	
\$50,000 - \$74,999	24 (12%)	277 (19%)	
Greater than or equal to \$75,000	12 (6%)	202 (14%)	
NA	18 (9%)	83 (6%)	
Number of people supported from income	2.7 ± 1.7	2.5 ± 1.2	0.047
Household income per person supported – no. (%)			
≤6800	45 (23%)	144 (10%)	<0.001
>6800	134 (68%)	1,198 (84%)	
NA	18 (9%)	89 (6%)	
Education category – no. (%)			
College graduate with professional degree	34 (17%)	296 (21%)	<0.001
College graduate	25 (13%)	247 (17%)	
At least one year of college	51 (26%)	379 (26%)	
High school graduate	51 (26%)	379 (26%)	
Completed 10 th -11 th grade	23 (12%)	72 (5%)	
Completed 7 th -9 th grade	8 (4%)	41 (3%)	
Completed less than 7 th grade	4 (2%)	16 (1%)	
NA	1 (1%)	1 (0%)	
Employment status – no. (%)			
Homemaker	2 (1%)	13 (1%)	<0.001
Full time	106 (54%)	806 (56%)	
Part time	13 (7%)	153 (11%)	
Unemployed not due to disability	25 (13%)	118 (8%)	
Unemployed due to disability	20 (10%)	48 (3%)	
Retired not due to disability	22 (11%)	198 (14%)	
Retired due to disability	9 (5%)	87 (6%)	
Other	0 (0%)	3 (0%)	
Student	0 (0%)	4 (0%)	
NA	0 (0%)	1 (0%)	
Marital status – no. (%)			
Unmarried	94 (48%)	372 (26%)	<0.001
NA	103 (52%)	1,059 (74%)	

b. CRIC

<i>Social determinants of health</i>	Black (N=528)	non-Black (N=895)	P-value
Total Gross Annual household income – no. (%)			
\$20,000 or under	185 (35%)	202 (23%)	<0.001
\$20,001 - \$50,000	143 (27%)	223 (25%)	
\$50,001 - \$100,000	92 (17%)	218 (24%)	
More than \$100,000	26 (5%)	129 (14%)	
Don't wish to answer	82 (16%)	123 (14%)	
Education Category – no. (%)			
Less than high school education	104 (20%)	398 (44%)	<0.001
High school graduate	178 (34%)	223 (25%)	
Some college education	122 (23%)	140 (16%)	
College graduate or more	124 (23%)	133 (15%)	
NA	0 (0%)	1 (0%)	
Employment Status – no. (%)			
Full-time	139 (26%)	368 (41%)	<0.001
Part Time	48 (9%)	99 (11%)	
Unemployed	60 (11%)	54 (6%)	
Not working due to disability	100 (19%)	78 (9%)	
Retired	166 (31%)	252 (28%)	
Other (including student and homemaker)	15 (3%)	44 (5%)	
Marital status – no. (%)			
Not-married	296 (56%)	288 (32%)	<0.001
Married	232 (44%)	607 (68%)	

Supplemental Table 3. Effect of social determinants of health, estimated protein intake and creatinine excretion on the coefficient for Black race in GFR estimating equations

Models	MDRD		CRIC	
	Coefficient for Black race (SE)	95% CI of coefficient for Black race	Coefficient for Black race (SE)	95% CI of coefficient for Black race
Base	0.190 (0.015)	(0.162, 0.219)	0.118 (0.013)	(0.093, 0.144)
+ <i>HH income</i>	0.201 (0.015)	(0.171, 0.231)	0.130 (0.013)	(0.105, 0.156)
+ <i>Number supported per HH</i>	0.191 (0.015)	(0.162, 0.219)	NA	NA
+ <i>Education level</i>	0.195 (0.015)	(0.166, 0.224)	0.126 (0.013)	(0.100, 0.153)
+ <i>Employment status</i>	0.193 (0.015)	(0.164, 0.222)	0.130 (0.013)	(0.104, 0.156)
+ <i>Marital status</i>	0.188 (0.015)	(0.159, 0.217)	0.124 (0.013)	(0.098, 0.150)
+ <i>Joint SDH</i>	0.200 (0.016)	(0.169, 0.230)	0.136 (0.014)	(0.109, 0.163)
+ <i>EPI from UUN</i>	0.204 (0.014)	(0.176, 0.232)	0.140 (0.014)	(0.113, 0.167)
+ <i>Joint SDH + EPI from UUN</i>	0.213 (0.015)	(0.183, 0.242)	0.152 (0.014)	(0.124, 0.180)
+ <i>UcrV</i>	0.156 (0.014)	(0.128, 0.183)	0.104 (0.013)	(0.078, 0.130)
+ <i>Joint SDH + UcrV</i>	0.161 (0.015)	(0.132, 0.189)	0.118 (0.014)	(0.091, 0.146)

Estimates are expressed in natural log form. Base model shows Black race coefficient estimates for regression of log mGFR on age, sex, race and log Scr. Each subsequent row shows estimates when SDH factors, EPI from UUN and urine creatinine excretion are added to the base model alone or together with other covariates. EPI from UUN and urine creatinine excretion were expressed as natural logs in these models. Abbreviations: HH, household; EPI from UUN, estimated protein intake from urine urea nitrogen; UcrV, urine creatinine excretion; Scr, serum creatinine; SDH, social determinants of health; Joint SDH, all social determinants of health.

Supplemental Table 4. Effect of social determinants of health, estimated protein intake and creatinine excretion on age and sex coefficients in GFR estimating equations

Models	MDRD				CRIC			
	Age		Sex		Age		Sex	
	β (SE)	95% CI	β (SE)	95% CI	β (SE)	95% CI	β (SE)	95% CI
Base	-0.005 (0.000)	(-0.005, -0.004)	-0.300 (0.010)	(-0.320, -0.280)	-0.006 (0.001)	(-0.007, -0.005)	-0.308 (0.014)	(-0.335, -0.282)
+ <i>HH income</i>	-0.005 (0.000)	(-0.006, -0.004)	-0.298 (0.010)	(-0.318, -0.278)	-0.006 (0.001)	(-0.007, -0.005)	-0.294 (0.014)	(-0.321, -0.268)
+ <i>Number supported per HH</i>	-0.005 (0.000)	(-0.005, -0.004)	-0.300 (0.010)	(-0.320, -0.280)	NA	NA	NA	NA
+ <i>Education level</i>	-0.005 (0.000)	(-0.005, -0.004)	-0.294 (0.010)	(-0.314, -0.274)	-0.006 (0.001)	(-0.007, -0.005)	-0.304 (0.014)	(-0.331, -0.278)
+ <i>Employment status</i>	-0.004 (0.000)	(-0.005, -0.003)	-0.294 (0.011)	(-0.315, -0.273)	-0.006 (0.001)	(-0.007, -0.004)	-0.292 (0.014)	(-0.319, -0.265)
+ <i>Marital status</i>	-0.005 (0.000)	(-0.005, -0.004)	-0.301 (0.010)	(-0.321, -0.281)	-0.006 (0.001)	(-0.007, -0.005)	-0.304 (0.014)	(-0.331, -0.277)
+ <i>Joint SDH</i>	-0.004 (0.000)	(-0.005, -0.003)	-0.293 (0.011)	(-0.315, -0.272)	-0.006 (0.001)	(-0.007, -0.004)	-0.285 (0.014)	(-0.312, -0.257)
+ <i>EPI from UUN</i>	-0.005 (0.000)	(-0.005, -0.004)	-0.289 (0.010)	(-0.308, -0.270)	-0.006 (0.001)	(-0.007, -0.005)	-0.295 (0.014)	(-0.323, -0.268)
+ <i>Joint SDH + EPI from UUN</i>	-0.004 (0.000)	(-0.005, -0.003)	-0.282 (0.011)	(-0.303, -0.261)	-0.006 (0.001)	(-0.007, -0.004)	-0.276 (0.014)	(-0.304, -0.248)
+ <i>UcrV</i>	-0.003 (0.000)	(-0.004, -0.003)	-0.172 (0.013)	(-0.197, -0.147)	-0.005 (0.001)	(-0.006, -0.004)	-0.254 (0.015)	(-0.283, -0.225)
+ <i>Joint SDH + UcrV</i>	-0.003 (0.000)	(-0.004, -0.002)	-0.160 (0.013)	(-0.186, -0.134)	-0.005 (0.001)	(-0.006, -0.004)	-0.241 (0.015)	(-0.270, -0.211)

Base model shows age and sex coefficient estimates for regression of log mGFR on age, sex, race and log Scr. Each subsequent row shows estimates when SDH factors, EPI from UUN and urine creatinine excretion are added to the base model alone or together with other covariates. EPI from UUN and urine creatinine excretion were expressed as natural logs in these models. Abbreviations: HH, household; EPI from UUN, estimated protein intake from urine urea nitrogen; UcrV, urine creatinine excretion; Scr, serum creatinine; SDH, social determinants of health; Joint SDH, all social determinant of health factors. Estimates are expressed in natural log form.

Supplemental Table 5. Associations of demographic factors, social determinants of health, estimated protein intake and creatinine excretion on serum creatinine after adjustment for measured GFR and GFR measurement error

Models	MDRD				CRIC			
	N	β (95% CI)	β Percentage difference (95% CI)	Partial correlation	N	β (95% CI)	β Percentage difference (95% CI)	Partial correlation
Age	1628	-0.07 (-0.08 , - 0.05)	-6.59 (-8.10 , - 5.05)	-0.19	1423	-0.07 (-0.09 , - 0.06)	-7.01 (-8.39 , - 5.60)	-0.23
Female sex	1628	-0.24 (-0.26 , - 0.23)	-21.72 (-23.09 , - 20.33)	-0.57	1423	-0.24 (-0.26 , - 0.22)	-21.19 (-22.61 , - 19.74)	-0.57
Black race	1628	0.15 (0.12 , 0.18)	16.74 (13.31 , 20.26)	0.24	1423	0.09 (0.07 , 0.11)	9.24 (6.85 , 11.68)	0.21
Household income	1521	0.02 (-0.02 , 0.05)	1.53 (-1.83 , 5.01)	0.02	1423	0.02 (0.00 , 0.04)	2.02 (-0.28 , 4.38)	0.03
Number of people supported	1622	0.02 (0.01 , 0.03)	1.87 (1.11 , 2.64)	0.11	NA	NA	NA	NA
Education				-0.16				0.04
College graduate or more	1626	Ref	Ref		1422	Ref	Ref	
Some college education	1626	-0.04 (-0.07 , - 0.02)	-4.27 (-6.74 , - 1.75)		1422	0.03 (0.00 , 0.05)	2.54 (-0.21 , 5.36)	
High school graduate	1626	-0.07 (-0.10 , - 0.05)	-6.82 (-9.11 , - 4.46)		1422	0.01 (-0.02 , 0.04)	0.96 (-2.25 , 4.29)	
Less than high school	1626	-0.10 (-0.14 , - 0.07)	-9.79 (-12.96 , - 6.50)		1422	0.01 (-0.02 , 0.04)	1.00 (-2.32 , 4.44)	
Current employment				-0.16				-0.01
Employed	1531	Ref	Ref		1423	Ref	Ref	
Unemployed	1531	-0.14 (-0.18 , - 0.10)	-13.21 (-16.42 , - 9.86)		1423	0.03 (-0.02 , 0.07)	2.93 (-1.49 , 7.55)	
Disability	1531	-0.07 (-0.09 , - 0.04)	-6.50 (-8.98 , - 3.96)		1423	-0.02 (-0.06 , 0.01)	-2.24 (-5.43 , 1.07)	
Married	1628	0.00 (-0.03 , 0.02)	-0.23 (-2.49 , 2.07)	-0.001	1423	0.02 (0.00 , 0.04)	2.22 (0.00 , 4.50)	0.05
EPI from UUN	1628	0.03 (0.02 , 0.04)	3.57 (2.19 , 4.97)	0.09	1350	0.02 (0.01 , 0.03)	2.08 (0.85 , 3.33)	0.07
Urine creatinine excretion	1628	0.18 (0.16 , 0.19)	19.13 (17.58 , 20.70)	0.56	1357	0.09 (0.07 , 0.11)	9.78 (7.61 , 12.00)	0.38

Each row in the table shows estimates of the regression of log Scr on a separate independent predictor variable, after adjusting for measured GFR and GFR measurement error. Independent variables used in each model are shown on the first column. Table also shows the partial correlation of each independent variable and log Scr, after adjusting for measured GFR. Continuous variables are expressed per interquartile range. Abbreviations: Scr, serum creatinine; GFR, glomerular filtration rate; EPI from UUN, estimated protein intake from urine urea nitrogen; SDH, social determinants of health. Estimates are expressed in natural log form.

Supplemental Table 6. Effect of social determinants of health, estimated protein intake and creatinine excretion on the association of Black race with serum creatinine after adjustment for measured GFR and GFR measurement error

Models	MDRD				CRIC			
	N	β (95% CI)	β Percentage difference (95% CI)	Partial correlation	N	β (95% CI)	β Percentage difference (95% CI)	Partial correlation
Base	1628	0.16 (0.13 , 0.18)	17.10 (14.39 , 19.88)	0.305	1423	0.10 (0.08 , 0.12)	10.52 (8.62 , 12.44)	0.298
+ <i>HH income</i>	1521	0.16 (0.14 , 0.19)	17.82 (14.98 , 20.73)	0.315	1423	0.10 (0.08 , 0.12)	10.74 (8.83 , 12.69)	0.298
+ <i>Number supported per HH</i>	1622	0.16 (0.13 , 0.18)	17.14 (14.43 , 19.91)	0.306	NA	NA	NA	NA
+ <i>education</i>	1626	0.16 (0.14 , 0.19)	17.53 (14.74 , 20.39)	0.309	1422	0.10 (0.08 , 0.12)	10.54 (8.56 , 12.56)	0.285
+ <i>employment</i>	1531	0.16 (0.13 , 0.18)	17.05 (14.25 , 19.93)	0.306	1423	0.11 (0.09 , 0.12)	11.08 (9.14 , 13.06)	0.306
+ <i>marital status</i>	1628	0.16 (0.13 , 0.18)	16.95 (14.19 , 19.78)	0.300	1423	0.10 (0.08 , 0.12)	10.82 (8.86 , 12.80)	0.296
+ <i>joint SDH</i>	1434	0.16 (0.14 , 0.19)	17.62 (14.61 , 20.70)	0.309	1422	0.11 (0.09 , 0.13)	11.22 (9.15 , 13.34)	0.292
+ <i>EPI from UUN</i>	1628	0.17 (0.14 , 0.19)	18.34 (15.55 , 21.20)	0.319	1350	0.11 (0.09 , 0.13)	11.65 (9.66 , 13.67)	0.314
+ <i>UcrV</i>	1628	0.14 (0.11 , 0.16)	14.57 (11.94 , 17.25)	0.277	1357	0.09 (0.08 , 0.11)	9.81 (7.90 , 11.76)	0.296
+ <i>Joint SDH + UcrV</i>	1434	0.13 (0.11 , 0.16)	14.33 (11.51 , 17.21)	0.273	1356	0.10 (0.08 , 0.12)	10.32 (8.21 , 12.46)	0.274
+ <i>Joint SDH + UcrV + EPI from UUN</i>	1087	0.13 (0.11 , 0.16)	14.13 (11.12 , 17.21)	0.259	1349	0.10 (0.08 , 0.12)	10.54 (8.43 , 12.69)	0.272

Base model shows Black race coefficient estimates for regression of log Scr on age, sex, race, mGFR and error. Each subsequent row shows estimates when SDH and EPI from UUN and urine creatinine excretion are added to the base model alone or together with other covariates. Table also shows the partial correlation of each model's independent variables and log Scr, after adjusting for measured GFR. EPI from UUN and urine creatinine excretion were expressed as natural logs in these models. Estimates are expressed in natural log form. Abbreviations: HH, household; EPI from UUN, estimated protein intake from urine urea nitrogen; Scr, serum creatinine; mGFR, measured glomerular filtration rate; UcrV, urine creatinine excretion; SDH, social determinants of health; Joint SDH, all social determinants of health.

References

1. Beck G, Berg R, Coggins C, et al. Design and statistical issues of the Modification of Diet in Renal Disease Trial. The Modification of Diet in Renal Disease Study Group. *Control Clin Trials*. 1991;12(5):566-586.
2. Anderson AH, Yang W, Hsu CY, et al. Estimating GFR among participants in the Chronic Renal Insufficiency Cohort (CRIC) Study. *Am J Kidney Dis*. 2012;60(2):250-261.