

**Electronic Supplementary Material 1**

**Table E1.** Population characteristics of included (n=7,662) vs. excluded (n=1,462) sample

Covariate	Median (IQR) or percent (included sample)	Median (IQR) or percent (excluded sample)	p-value <sup>a</sup>
Age (years)	42 (29, 62)	46 (29, 72)	0.004**
Missing (%)	-	0.0%	
Female (%)	57.5%	51.3%	0.006**
Missing (%)	-	0.0%	
Race		0.0%	0.03*
Non-Hispanic White	38.5%	36.3%	
Non-Hispanic Black	30.3%	30.4%	
Mexican American	26.4%	28.9%	
Other	4.8%	4.5%	
Missing (%)	-	0.0%	
BMI	-	-	0.10
>18 kg/m <sup>2</sup>	1.4%	2.8%	
18-25 kg/m <sup>2</sup>	37.8%	40.7%	
>25 kg/m <sup>2</sup>	60.8%	55.8%	
Missing (%)	-	0.7%	
Diabetes (%)	7.7%	9.9%	0.03*
Missing (%)	-	0.1%	
Hypertension (%)	26.8%	30.6%	0.07
Missing (%)	-	4.8%	
eGFR (ml/min /1.73m <sup>2</sup> )	75 (64, 87)	62 (0, 81)	<.001***
Missing (%)	-	1.0%	
Taking Statin (%)	1.3%	1.0%	0.86
Missing (%)	-	0.0%	
Active smoker	26.8%	24.6%	0.84
Missing (%)	-	7.6%	
Percent Calories from Saturated Fat	10.5 (8.1, 13.0)	10.5 (8.0, 13.2)	0.13
Missing (%)	-	37.2%	
Grams of Alcohol per Day	0 (0, 0)	0 (0,0)	<.001
Missing (%)	-	37.2%	

1. Abbreviations: BMI = Body Mass Index; eGFR = estimated glomerular filtration rate; IQR = interquartile range

2. Note: Somers D (continuous variables) or  $\chi^2$  (categorical variables) p-value compared to included sample; \* = <0.05; \*\* = <0.01; \*\*\* = <0.001

<sup>a</sup> p-value are adjusted for complex survey design and population weights

**Table E2.** Associations between control variables with Lp(a) and LDL-C in univariate, multivariate, and multivariate with interaction term models when excluding samples with Lp(a)=0

	Model 1 - univariate			Model 2 - multivariate			Model 3 - multivariate with Interactions <sup>a,b,c</sup>		
a) Lp(a)	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value
Age (per year)	0.07	-0.01,0.14	0.07	0.08	-0.02,0.18	0.10	0.09	-0.01,0.18	0.06
Female	3.01	0.61,5.41	0.02*	2.86	0.37,5.35	0.03*			0.04
Race/ethnicity			<0.001***			<0.001***	2.71	0.21,5.20	<0.001***
Non-Hispanic White	21.46	19.18,23.73	-	21.67	19.36,23.98	-	-	-	-
Non-Hispanic Black	-5.1	-7.35,-2.85	-	-4.45	-6.67,-2.23	-	22.22	19.81,24.63	-
Mexican-American	-0.26	-4.95,4.44	-	-0.1	-4.43,4.23	-	-4.88	-7.05,-2.71	-
Other	0.07	-0.01,0.14	-	0.08	-0.02,0.18	-	0.11	-3.71,3.93	-
BMI	-	-	0.10	-	-	0.13	-	-	0.14
<18 kg/m <sup>2</sup>	-	-	-	-	-	-	-	-	-
18-25 kg/m <sup>2</sup>	5.95	0.43,11.48	-	6.3	0.22,12.39	-	6.80	1.20,12.40	-
>25 kg/m <sup>2</sup>	6.79	0.67,12.91	-	5.85	-0.32,12.02	-	6.37	0.69,12.05	-
Diabetes	1.51	-1.02,4.04	0.23	-1.07	-3.54,1.40	0.38	-0.58	-4.11,2.94	0.74
Hypertension	4.22	2.22,6.22	<0.001***	1.42	-0.25,3.09	0.09	1.08	-0.68,2.84	0.22
eGFR (per ml/min /1.73m <sup>2</sup> )	0.04	-0.03,0.10	0.24	0.02	-0.06,0.10	0.59	0.02	-0.06,0.10	0.58
Taking Statin	19.97	8.43,31.51	0.002**	20.25	9.03,31.47	0.001**	21.83	12.32,31.33	<0.001***
Active smoker	0.49	-1.47,2.46	0.61	0.49	-1.29,2.28	0.57	0.06	-1.78,1.91	0.94
Saturated Fat (per % kcal)	-0.32	-0.61,-0.03	0.03*	-0.27	-0.55,0.02	0.06	-0.27	-0.55,0.02	0.07
Daily Alcohol (per g)	0.02	-0.01,0.05	0.23	0.02	-0.01,0.05	0.17	0	-0.03,0.03	0.89
b) LDL-C									
	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value
Age (per year)	0.70	0.60,0.80	<0.001***	0.50	0.41,0.59	<0.001***	0.62	0.54,0.70	<0.001***
Female	-3.51	-6.33,-0.70	0.02*	-2.63	-5.08,-0.17	0.04*	-2.82	-5.31,-0.33	0.028*
Race/ethnicity			<0.001***			<0.001***			<0.001***
Non-Hispanic White	-14.08	-16.90,-11.25	-	-12.18	-15.38,-8.97	-			-
Non-Hispanic Black	-4.12	-6.87,-1.37	-	-0.53	-3.22,2.15	-	-12.79	-16.03,-9.55	-
Mexican-American	-0.35	-8.40,7.70	-	3.09	-3.37,9.55	-	-0.90	-3.50,1.70	-
Other	0.70	0.60,0.80	-	0.50	0.41,0.59	-	2.72	-3.14,8.58	-
BMI	-	-	<0.001***	-	-	<0.001***	-	-	<0.001***
<18 kg/m <sup>2</sup>	-	-	-	-	-	-	-	-	-
18-25 kg/m <sup>2</sup>	14.92	6.18,23.65	-	14.11	5.79,22.43	-	17.82	12.70,22.94	-
>25 kg/m <sup>2</sup>	35.35	26.92,43.77	-	30.19	21.75,38.62	-	32.12	26.38,37.86	-
Diabetes	14.11	10.78,17.44	<0.001***	0.08	-3.76,3.91	0.810.978	7.69	1.16,14.21	0.02*
Hypertension	16.28	13.14,19.42	<0.001***	5.15	1.85,8.46	0.004**	5.45	1.83,9.07	0.005**
eGFR (per ml/min /1.73m <sup>2</sup> )	-0.54	-0.65,-0.43	<0.001***	-0.11	-0.22,-0.01	0.04*	-0.11	-0.22,-0.01	0.04*
Taking Statin	10.75	-0.17,21.67	0.053	-6.64	-17.96,4.69	0.24	-7.68	-18.81,3.44	0.17
Active smoker	-0.95	-3.88,1.97	0.51	3.14	0.49,5.79	0.02*	2.91	0.43,5.38	0.02*
Saturated Fat (per % kcal)	0.33	-0.05,0.72	0.08	0.31	-0.04,0.66	0.08	0.32	-0.01,0.65	0.054
Daily Alcohol (per g)	-0.09	-0.12,-0.05	<0.001***	-0.06	-0.09,-0.03	0.001*	-0.06	-0.09,-0.02	0.002**

1. Abbreviations: CI = Confidence Interval; Lp(a) = Lipoprotein(a); LDL-C = Low-Density Lipoprotein Cholesterol; BMI = Body Mass Index; eGFR = estimated glomerular filtration rate

2. \* = <0.05; \*\* = <0.01; \*\*\* = <0.001

3. <sup>a</sup> In the Lp(a) model, interactions included between age and race/ethnicity, sex and race/ethnicity, race/ethnic and statin, diabetes and BMI, alcohol and smoking, and hypertension and smoking.

4. <sup>b</sup> In the LDL-C model, interactions included age<sup>2</sup>, between age and sex, age and diabetes, age and BMI, BMI and diabetes, eGFR and saturated fat content, eGFR and smoking, race/ethnicity and alcohol, and sex and BMI.

5. <sup>c</sup> Effect sizes between Lp(a) and LDL-C in Model 3 can only be compared if variables are transformed to the same linear or non-linear association with the outcome.

**Table E3.** Associations between Vitamins, Minerals, and Heavy Metals with Lp(a) and LDL-C in univariate, multivariate, and multivariate with interaction term models excluding samples with Lp(a)=0.

	Model 1 - univariate			Model 2 - multivariate			Model 3 - multivariate with Interactions <sup>a,b,c</sup>		
a) Lp(a)	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value
Vitamin A	0.00	-0.09,0.09	0.97	0.03	-0.04,0.10	0.36	0.04	-0.03,0.12	0.25
Retinyl Esters	0.08	-0.14,0.30	0.46	0.10	-0.13,0.32	0.39	0.63	0.38,0.89	<0.001***
Vitamin B12	0.00	-0.00,0.00	0.21	0.00	-0.00,0.00	0.30	1.57	-0.25,3.38	0.09
Folate	-0.14	-0.28,0.00	0.06	-0.11	-0.27,0.05	0.18	-0.10	-0.26,0.07	0.23
RBC Folate	-0.01	-0.02,-0.00	0.04*	0.00	-0.01,0.01	0.38	-0.01	-0.02,0.01	0.32
Vitamin C	-1.62	-4.68,1.45	0.29	-1.03	-4.25,2.19	0.52	-0.81	-4.12,2.51	0.62
Vitamin E	0.00	-0.00,0.00	0.06	0.00	0.00,0.01	0.005**	0.01	0.00,0.01	<0.001***
Lycopene	0.11	-0.02,0.25	0.09	0.18	0.05,0.30	0.007**	0.19	0.07,0.32	0.004**
Lutein	0.22	0.12,0.33	<0.001***	0.16	0.05,0.26	0.005**	4.66	2.20,7.11	0.001**
$\beta$ -cryptoxanthin	0.14	-0.02,0.31	0.09	0.18	0.00,0.36	0.049*	3.16	0.95,5.37	0.007**
$\beta$ -carotene	0.04	0.01,0.07	0.009**	0.04	-0.00,0.07	0.054	1.83	0.42,3.23	0.01*
$\alpha$ -carotene	0.03	-0.10,0.16	0.61	0.09	-0.03,0.21	0.14	0.10	-0.02,0.22	0.09
Selenium	-0.04	-0.12,0.04	0.31	0.03	-0.06,0.12	0.49	3.66	-6.76,14.07	0.48
Ferritin	-0.05	-0.08,-0.01	0.007**	-0.01	-0.04,0.02	0.38	-1.01	-3.64,1.63	0.44
Transferrin Saturation	-0.15	-0.27,-0.03	0.02*	-0.06	-0.17,0.05	0.29	-0.06	-0.17,0.06	0.33
Calcium	0.17	-2.27,2.61	0.89	0.13	-1.92,2.19	0.90	0.19	-1.94,2.33	0.85
Lead	0.62	0.10,1.14	0.02*	0.42	-0.11,0.95	0.12	0.41	-0.13,0.94	0.13
b) LDL-C	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value
Vitamin A	0.63	0.49,0.76	<0.001***	0.44	0.31,0.57	<0.001***	0.51	0.41,0.62	<0.001***
Retinyl Esters	2.12	1.71,2.53	<0.001***	1.79	1.40,2.17	<0.001***	2.79	2.40,3.19	<0.001***
Vitamin B12	0.00	-0.00,0.00	0.29	0.00	-0.00,0.00	0.77	-0.78	-4.32,2.76	0.65
Folate	0.19	-0.00,0.38	0.054	-0.16	-0.36,0.05	0.12	-0.16	-0.38,0.06	0.13
RBC Folate	0.02	0.01,0.03	<0.001***	-0.01	-0.02,-0.00	0.02*	-0.01	-0.02,-0.00	0.01*
Vitamin C	-2.70	-6.11,0.72	0.12	-4.01	-7.71,-0.31	0.04*	-4.99	-8.49,-1.48	0.007**
Vitamin E	0.04	0.03,0.04	<0.001***	0.03	0.02,0.03	<0.001***	0.06	0.06,0.06	<0.001***
Lycopene	0.78	0.64,0.93	<0.001***	1.03	0.90,1.17	<0.001***	0.99	0.85,1.12	<0.001***
Lutein	0.82	0.69,0.95	<0.001***	0.72	0.62,0.83	<0.001***	16.84	14.30,19.37	<0.001***
$\beta$ -cryptoxanthin	0.64	0.37,0.90	<0.001***	0.75	0.52,0.98	<0.001***	10.32	7.93,12.72	<0.001***
$\beta$ -carotene	0.20	0.11,0.28	<0.001***	0.15	0.08,0.22	<0.001***	7.22	5.39,9.06	<0.001***
$\alpha$ -carotene	0.51	0.22,0.79	0.001**	0.39	0.12,0.66	0.007**	4.28	2.67,5.90	<0.001***
Selenium	0.28	0.15,0.41	<0.001***	0.25	0.14,0.35	<0.001***	0.29	0.20,0.38	<0.001***
Ferritin	-0.02	-0.06,0.02	0.33	0.03	-0.01,0.06	0.11	0.03	-0.00,0.06	0.07
Transferrin Saturation	-0.12	-0.28,0.03	0.11	-0.04	-0.18,0.09	0.52	0.14	-0.00,0.28	0.06
Calcium	6.28	1.66,10.89	0.01	9.19	5.66,12.72	<0.001***	10.08	6.50,13.65	<0.001***
Lead	1.73	1.14,2.33	<0.001***	0.49	-0.18,1.15	0.07	2.72	0.40,5.04	0.02*

1. Abbreviations: CI = Confidence Interval; Lp(a) = Lipoprotein(a); LDL-C = Low-Density Lipoprotein Cholesterol; RBC = Red Blood Cell

2. \* = <0.05, \*\* = <0.01, \*\*\* = <0.001

3. <sup>a</sup> In the Lp(a) model, vitamin, mineral, and lead covariates transformed as follows (otherwise linear): Retinyl Esters<sup>4</sup>, RBC-folate<sup>4</sup>, vitamin E<sup>4</sup>, ln(vitamin B12), ln(lutein), ln( $\beta$ -cryptoxanthin), ln( $\beta$ -carotene), ln(selenium), ln(ferritin). Interactions were present including between vitamin A and statins, vitamin A and saturated fat, retinyl esters and statins, retinyl esters and saturated fat, vitamin C and BMI, vitamin E and statin, vitamin E and hypertension, lycopene and saturated fat,  $\alpha$ -carotene and diabetes, selenium and race/ethnicity, calcium and sex, and calcium and hypertension.

4. <sup>b</sup> In the LDL-C model, vitamin, mineral, and lead covariates were transformed as follow (otherwise linear): vitamin A<sup>2</sup>, Retinyl Esters<sup>3</sup>, ln(vitamin B12), vitamin C<sup>3</sup>, vitamin E<sup>4</sup>, ln(lutein), ln( $\beta$ -cryptoxanthin), ln( $\beta$ -carotene),ln( $\alpha$ -carotene), selenium<sup>2</sup>, transferrin saturation<sup>4</sup>, and ln(lead). Interactions were present, including vitamin A and diabetes, vitamin A and race/ethnicity, retinyl esters and eGFR, retinyl

esters and saturated fat, RBC-folate and statin, RBC-folate and race/ethnicity, vitamin C and race/ethnicity, vitamin E and hypertension, lycopene and BMI, lycopene and diabetes, lycopene and saturated fat, lycopene and eGFR, lutein and saturated fat,  $\beta$ -cryptoxanthin and race/ethnicity,  $\beta$ -cryptoxanthin and saturated fat,  $\beta$ -carotene and sex,  $\beta$ -carotene and diabetes,  $\beta$ -carotene and race/ethnicity,  $\beta$ -carotene and saturated fat,  $\alpha$ -carotene and age,  $\alpha$ -carotene and race/ethnicity,  $\alpha$ -carotene and diabetes,  $\alpha$ -carotene and saturated fat, selenium and hypertension, transferrin saturation and sex, calcium and age, calcium and saturated fat, lead and eGFR, and lead and sex.

5. <sup>c</sup> Effect sizes between Lp(a) and LDL-C in Model 3 can only be compared if variables are transformed to the same linear or non-linear association with the outcome.

**Table E4.** Associations between Vitamins, Minerals, and Heavy Metals with Lp(a) and LDL-C at ln(x + 1) transformed outcomes in univariate, multivariate, and multivariate with interaction term models.

	Model 1 - univariate			Model 2 - multivariate			Model 3 - multivariate with Interactions <sup>a,b,c</sup>		
a) Lp(a)	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value
Vitamin A	-0.0012	-0.0049,0.0025	0.50	0.0017	-0.0023,0.0057	0.40	0.0023	-0.0018,0.0065	0.26
Retinyl Esters	-0.0066	-0.0227,0.0096	0.41	-0.0055	-0.0208,0.0098	0.47	0.03	0.0166,0.0435	<0.001***
Vitamin B12	0.0001	-0.0000,0.0002	0.17	0	-0.0000,0.0001	0.48	0.0724	-0.0506,0.1953	0.24
Folate	-0.0058	-0.0142,0.0026	0.17	-0.0055	-0.0151,0.0041	0.25	-0.0056	-0.0157,0.0045	0.27
RBC Folate	-0.0007	-0.0012,-0.0001	0.03*	-0.0003	-0.0010,0.0003	0.26	-0.0003	-0.0011,0.0006	0.54
Vitamin C	0.0158	-0.1288,0.1604	0.82	0.0141	-0.1308,0.1589	0.84	0.0213	-0.1219,0.1644	0.76
Vitamin E	0.0000	-0.0002,0.0001	0.92	0.0001	-0.0001,0.0002	0.49	0.0003	0.0001,0.0005	0.002**
Lycopene	0.0049	0.0003,0.0095	0.04*	0.0074	0.0027,0.0121	0.003**	0.0078	0.0032,0.0124	0.002**
Lutein	0.0144	0.0082,0.0205	<0.001***	0.0113	0.0053,0.0173	0.001**	0.3441	0.2133,0.4750	<0.001***
$\beta$ -cryptoxanthin	0.0117	0.0035,0.0198	0.007**	0.0111	0.0041,0.0182	0.003**	0.1685	0.0793,0.2576	0.001**
$\beta$ -carotene	0.0049	0.0029,0.0069	<0.001***	0.004	0.0018,0.0061	0.001**	0.1537	0.0820,0.2255	<0.001***
$\alpha$ -carotene	0.0146	0.0049,0.0244	0.005**	0.0147	0.0053,0.0241	0.004**	0.0153	0.0060,0.0246	0.002**
Selenium	-0.0032	-0.0071,0.0007	0.11	-0.0001	-0.0041,0.0038	0.94	-0.01	-0.4993,0.4793	0.97
Ferritin	-0.0016	-0.0030,-0.0003	0.02*	-0.0003	-0.0017,0.0012	0.69	-0.0007	-0.1210,0.1197	0.99
Transferrin Saturation	-0.006	-0.0114,-0.0006	0.03*	-0.0025	-0.0082,0.0031	0.37	-0.0025	-0.0083,0.0034	0.39
Calcium	-0.0322	-0.1792,0.1148	0.67	-0.0305	-0.1706,0.1095	0.66	-0.0265	-0.1641,0.1110	0.69
Lead	0.0241	-0.0037,0.0519	0.086	0.0264	-0.0008,0.0535	0.06	0.0259	-0.0014,0.0532	0.06
b) LDL-C	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value	B	95% CI	p-value
Vitamin A	0.0052	0.0043,0.0062	<0.001***	0.0036	0.0027,0.0046	<0.001***	0.0044	0.0034,0.0053	<0.001***
Retinyl Esters	0.0172	0.0128,0.0216	<0.001***	0.0141	0.0098,0.0184	<0.001***	0.0246	0.0210,0.0281	<0.001***
Vitamin B12	0	-0.0000,0.0000	0.34	0	-0.0000,0.0000	0.85	0.0007	-0.0235,0.0249	0.95
Folate	0.0025	0.0008,0.0041	0.005**	-0.0006	-0.0024,0.0011	0.45	-0.0008	-0.0024,0.0009	0.35
RBC Folate	0.0002	0.0001,0.0003	<0.001***	-0.0001	-0.0002,0.0000	0.02*	-0.0001	-0.0002,0.0000	0.07
Vitamin C	-0.0265	-0.0599,0.0069	0.02	-0.0393	-0.0714,-0.0073	<0.001***	-0.0514	-0.0860,-0.0169	0.005**
Vitamin E	0.0003	0.0002,0.0003	<0.001***	0.0002	0.0002,0.0003	<0.001***	0.0006	0.0005,0.0006	<0.001***
Lycopene	0.0073	0.0062,0.0084	<0.001***	0.0095	0.0087,0.0103	<0.001***	0.0091	0.0081,0.0100	<0.001***
Lutein	0.007	0.0058,0.0081	<0.001***	0.0063	0.0052,0.0073	<0.001***	0.1448	0.1196,0.1700	<0.001***
$\beta$ -cryptoxanthin	0.0058	0.0038,0.0078	<0.001***	0.0069	0.0051,0.0088	<0.001***	0.0912	0.0703,0.1122	<0.001***
$\beta$ -carotene	0.0019	0.0014,0.0025	<0.001***	0.0016	0.0010,0.0021	<0.001***	0.0701	0.0526,0.0875	<0.001***
$\alpha$ -carotene	0.0051	0.0029,0.0072	<0.001***	0.0043	0.0021,0.0065	0.001**	0.0423	0.0294,0.0552	<0.001***
Selenium	0.0024	0.0014,0.0035	<0.001***	0.0023	0.0015,0.0031	<0.001***	0.0029	0.0023,0.0035	<0.001***
Ferritin	-0.0002	-0.0006,0.0001	0.16	0.0002	-0.0001,0.0005	0.20	0.0002	-0.0001,0.0005	0.14
Transferrin Saturation	-0.0014	-0.0027,-0.0002	0.03*	-0.0007	-0.0019,0.0005	0.26	0.0013	0.0003,0.0024	0.02*
	0.0542	0.0190,0.0893	0.004**	0.0785	0.0529,0.1041	<0.001***	0.0886	0.0602,0.1169	<0.001***
Lead	0.0143	0.0088,0.0199	<0.001***	0.0039	-0.0016,0.0095	0.16	0.0197	-0.0003,0.0398	0.053

1. Abbreviations: CI = Confidence Interval; Lp(a) = Lipoprotein(a); LDL-C = Low-Density Lipoprotein Cholesterol; RBC = Red Blood Cell

2. \* = <0.05, \*\* = <0.01, \*\*\* = <0.001

3. <sup>a</sup> In the Lp(a) model, vitamin, mineral, and lead covariates transformed as follows (otherwise linear): Retinyl Esters<sup>4</sup>, RBC-folate<sup>4</sup>, vitamin E<sup>4</sup>, ln(vitamin B12), ln(lutein), ln( $\beta$ -cryptoxanthin), ln( $\beta$ -carotene), ln(selenium), ln(ferritin). Interactions were present including between vitamin A and statins, vitamin A and saturated fat, retinyl esters and statins, retinyl esters and saturated fat, vitamin C and BMI, vitamin E and statin, vitamin E and hypertension, lycopene and saturated fat,  $\alpha$ -carotene and diabetes, selenium and race/ethnicity, calcium and sex, and calcium and hypertension.

4. <sup>b</sup> In the LDL-C model, vitamin, mineral, and lead covariates were transformed as follow (otherwise linear): vitamin A<sup>2</sup>, Retinyl Esters<sup>3</sup>, ln(vitamin B12), vitamin C<sup>3</sup>, vitamin E<sup>4</sup>, ln(lutein), ln( $\beta$ -cryptoxanthin), ln( $\beta$ -carotene),ln( $\alpha$ -carotene), selenium<sup>2</sup>, transferrin saturation<sup>4</sup>, and ln(lead). Interactions were present, including vitamin A and diabetes, vitamin A and race/ethnicity, retinyl esters and eGFR, retinyl

esters and saturated fat, RBC-folate and statin, RBC-folate and race/ethnicity, vitamin C and race/ethnicity, vitamin E and hypertension, lycopene and BMI, lycopene and diabetes, lycopene and saturated fat, lycopene and eGFR, lutein and saturated fat,  $\beta$ -cryptoxanthin and race/ethnicity,  $\beta$ -cryptoxanthin and saturated fat,  $\beta$ -carotene and sex,  $\beta$ -carotene and diabetes,  $\beta$ -carotene and race/ethnicity,  $\beta$ -carotene and saturated fat,  $\alpha$ -carotene and age,  $\alpha$ -carotene and race/ethnicity,  $\alpha$ -carotene and diabetes,  $\alpha$ -carotene and saturated fat, selenium and hypertension, transferrin saturation and sex, calcium and age, calcium and saturated fat, lead and eGFR, and lead and sex.

5. <sup>c</sup> Effect sizes between Lp(a) and LDL-C in Model 3 can only be compared if variables are transformed to the same linear or non-linear association with the outcome.

**Table E5.** Associations between Vitamins, Minerals, and Heavy Metals with Lp(a) and LDL-C as quartiles in univariate and multivariate models.

A. Lp(a)

	Model 1 - univariate			Model 2 - multivariate		
	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value
Vitamin A						
Quartile 1	0.003	-0.001,0.007	0.16	0.001	-0.004,0.005	0.71
Quartile 3	0.000	-0.004,0.004	0.91	0.001	-0.003,0.006	0.59
Quartile 4	0.002	-0.002,0.006	0.25	0.003	-0.001,0.008	0.15
Retinyl Esters						
Quartile 1	0.005	-0.013,0.023	0.59	0.006	-0.013,0.024	0.55
Quartile 3	-0.004	-0.022,0.015	0.68	-0.002	-0.021,0.017	0.84
Quartile 4	0.017	-0.001,0.034	0.06	0.017	-0.002,0.036	0.08
Vitamin B12						
Quartile 1	0.000	-0.000,0.000	0.23	0.000	-0.000,0.000	0.25
Quartile 3	0.000	-0.000,0.000	0.33	0.000	-0.000,0.000	0.38
Quartile 4	0.000	-0.000,0.000	0.30	0.000	-0.000,0.000	0.33
Folate						
Quartile 1	0.0100	-0.001,0.020	0.06	0.009	-0.003,0.020	0.14
Quartile 3	0.0010	-0.010,0.012	0.90	0.012	-0.000,0.024	0.05
Quartile 4	-0.011	-0.022,0.001	0.07	0.000	-0.013,0.013	0.99
RBC Folate						
Quartile 1	0.001	0.000,0.001	0.002**	0.001	-0.000,0.001	0.06
Quartile 3	-0.001	-0.001,-0.000	0.048*	0.000	-0.000,0.001	0.28
Quartile 4	-0.001	-0.002,-0.001	<0.001***	0.000	-0.001,0.001	0.99
Vitamin C						
Quartile 1	-0.016	-0.157,0.126	0.83	-0.036	-0.189,0.118	0.65
Quartile 3	-0.118	-0.265,0.030	0.12	0.058	-0.102,0.218	0.48
Quartile 4	-0.31	-0.460,-0.161	<0.001***	-0.107	-0.274,0.061	0.21
Vitamin E						
Quartile 1	0.000	0.000,0.000	0.02*	0.000	-0.000,0.000	0.18
Quartile 3	0.000	-0.000,0.000	0.12	0.000	-0.000,0.000	0.45
Quartile 4	0.000	-0.000,0.000	0.44	0.000	0.000,0.000	<0.001***
Lycopene						
Quartile 1	-0.006	-0.012,-0.000	0.04*	-0.007	-0.013,-0.000	0.04*
Quartile 3	0.003	-0.002,0.009	0.24	0.004	-0.002,0.011	0.19
Quartile 4	0.011	0.006,0.017	<0.001***	0.016	0.009,0.022	<0.001***
Lutein						
Quartile 1	-0.008	-0.014,-0.002	0.01*	-0.006	-0.013,0.000	0.052
Quartile 3	0.006	0.000,0.012	0.03*	0.006	-0.001,0.012	0.08
Quartile 4	0.015	0.009,0.021	<0.001***	0.012	0.006,0.018	<0.001***
$\beta$ -cryptoxanthin						
Quartile 1	-0.001	-0.008,0.007	0.88	-0.005	-0.013,0.003	0.24
Quartile 3	-0.008	-0.016,-0.000	0.045*	0.004	-0.005,0.012	0.42
Quartile 4	-0.008	-0.015,0.000	0.06	0.013	0.004,0.022	0.003**
$\beta$ -carotene						
Quartile 1	-0.004	-0.008,-0.001	0.02*	-0.004	-0.008,-0.000	0.03*
Quartile 3	0.001	-0.002,0.005	0.35	0.002	-0.001,0.006	0.17
Quartile 4	0.005	0.002,0.008	0.001**	0.004	0.001,0.008	0.008**
$\alpha$ -carotene						
Quartile 1	-0.011	-0.022,0.000	0.052	-0.019	-0.034,-0.004	0.01*
Quartile 3	-0.002	-0.011,0.007	0.68	0.006	-0.005,0.017	0.30
Quartile 4	-0.008	-0.019,0.003	0.15	0.003	-0.009,0.014	0.64
Selenium						

	Quartile 1	0.004	0.001,0.008	0.02*	0.002	-0.002,0.005	0.41
	Quartile 3	-0.004	-0.008,-0.000	0.048*	0.001	-0.003,0.005	0.57
	Quartile 4	-0.005	-0.009,-0.002	0.005**	0.003	-0.001,0.007	0.09
<b>Ferritin</b>							
	Quartile 1	0.002	0.000,0.004	0.02*	0.001	-0.001,0.003	0.17
	Quartile 3	0.000	-0.002,0.002	0.90	0.001	-0.001,0.003	0.16
	Quartile 4	-0.004	-0.006,-0.002	<0.001***	-0.001	-0.003,0.001	0.21
<b>Transferrin Saturation</b>							
	Quartile 1	0.007	0.001,0.012	0.02*	0.005	-0.001,0.011	0.08
	Quartile 3	0.002	-0.004,0.008	0.54	0.005	-0.002,0.011	0.14
	Quartile 4	-0.010	-0.016,-0.004	0.001**	-0.003	-0.010,0.003	0.30
<b>Calcium</b>							
	Quartile 1	0.039	-0.113,0.191	0.62	0.054	-0.102,0.210	0.50
	Quartile 3	0.043	-0.114,0.199	0.59	-0.042	-0.205,0.120	0.61
	Quartile 4	0.093	-0.062,0.248	0.24	-0.019	-0.185,0.146	0.82
<b>Lead</b>							
	Quartile 1	-0.007	-0.030,0.016	0.55	-0.012	-0.038,0.015	0.38
	Quartile 3	0.012	-0.010,0.035	0.28	-0.006	-0.032,0.020	0.66
	Quartile 4	0.036	0.015,0.057	0.001**	0.015	-0.010,0.040	0.25

**B. LDL:**

		Model 1 – univariate			Model 2 – multivariate		
		$\beta$	95% CI	p-value	B	95% CI	p-value
<b>Vitamin A</b>							
	Quartile 1	-0.02	-0.024,-0.015	0<0.001***	-0.014	-0.019,-0.009	<0.001***
	Quartile 3	0.013	0.009,0.017	0<0.001***	0.009	0.004,0.013	<0.001***
	Quartile 4	0.03	0.026,0.034	<0.001***	0.024	0.019,0.029	<0.001***
<b>Retinyl Esters</b>							
	Quartile 1	-0.077	-0.101,-0.054	<0.001***	-0.090	-0.115,-0.065	<0.001***
	Quartile 3	0.056	0.035,0.076	<0.001***	0.061	0.039,0.082	<0.001***
	Quartile 4	0.118	0.098,0.137	<0.001***	0.117	0.096,0.138	<0.001***
<b>Vitamin B12</b>							
	Quartile 1	0.000	-0.000,0.000	0.89	0.000	-0.000,0.000	0.74
	Quartile 3	0.000	-0.000,0.000	0.28	0.000	-0.000,0.000	0.39
	Quartile 4	0.000	-0.000,0.000	0.70	0.000	-0.000,0.000	0.72
<b>Folate</b>							
	Quartile 1	-0.010	-0.022,0.003	0.14	0.005	-0.007,0.018	0.41
	Quartile 3	0.014	0.002,0.025	0.02*	0.000	-0.012,0.012	0.97
	Quartile 4	0.030	0.019,0.041	<0.001***	0.003	-0.009,0.015	0.59
<b>RBC Folate</b>							
	Quartile 1	-0.001	-0.002,-0.000	0.01*	0.001	0.000,0.002	0.03*
	Quartile 3	0.001	0.000,0.002	0.002**	0.000	-0.001,0.000	0.47
	Quartile 4	0.002	0.001,0.002	<0.001***	0.000	-0.001,0.000	0.17
<b>Vitamin C</b>							
	Quartile 1	0.1200	-0.027,0.266	0.11	0.182	0.019,0.344	0.03*
	Quartile 3	0.1190	-0.027,0.266	0.11	0.055	-0.104,0.214	0.50
	Quartile 4	0.1850	0.039,0.330	0.01*	0.028	-0.133,0.189	0.73
<b>Vitamin E</b>							
	Quartile 1	-0.003	-0.003,-0.003	<0.001***	-0.003	-0.003,-0.002	<0.001***
	Quartile 3	0.001	0.001,0.002	<0.001***	0.001	0.001,0.001	<0.001***
	Quartile 4	0.002	0.002,0.003	<0.001***	0.002	0.002,0.002	<0.001***
<b>Lycopene</b>							
	Quartile 1	-0.019	-0.025,-0.012	<0.001***	-0.044	-0.052,-0.037	<0.001***
	Quartile 3	0.011	0.005,0.017	<0.001***	0.030	0.023,0.037	<0.001***
	Quartile 4	0.026	0.020,0.032	<0.001***	0.059	0.052,0.066	<0.001***
<b>Lutein</b>							



	Quartile 1	-0.026	-0.033,-0.019	<0.001***	-0.030	-0.038,-0.022	<0.001***
	Quartile 3	0.016	0.010,0.022	<0.001***	0.016	0.009,0.022	<0.001***
	Quartile 4	0.035	0.029,0.041	<0.001***	0.035	0.029,0.042	<0.001***
<b>β-cryptoxanthin</b>							
	Quartile 1	-0.022	-0.032,-0.013	<0.001***	-0.033	-0.044,-0.022	<0.001***
	Quartile 3	0.017	0.009,0.025	<0.001***	0.020	0.010,0.029	<0.001***
	Quartile 4	0.030	0.022,0.037	<0.001***	0.040	0.031,0.049	<0.001***
<b>β-carotene</b>							
	Quartile 1	-0.016	-0.021,-0.012	<0.001***	-0.015	-0.019,-0.010	<0.001***
	Quartile 3	0.005	0.001,0.008	0.007**	0.003	-0.001,0.006	0.11
	Quartile 4	0.011	0.008,0.015	<0.001***	0.008	0.005,0.012	<0.001***
<b>α-carotene</b>							
	Quartile 1	-0.043	-0.060,-0.026	<0.001***	-0.031	-0.047,-0.014	<0.001***
	Quartile 3	0.019	0.006,0.031	0.005**	0.013	0.000,0.025	0.048*
	Quartile 4	0.029	0.017,0.042	<0.001***	0.022	0.010,0.034	<0.001***
<b>Selenium</b>							
	Quartile 1	-0.01	-0.014,-0.006	<0.001***	-0.010	-0.014,-0.006	<0.001***
	Quartile 3	0.01	0.007,0.014	<0.001***	0.010	0.006,0.014	<0.001***
	Quartile 4	0.018	0.014,0.022	<0.001***	0.018	0.014,0.022	<0.001***
<b>Ferritin</b>							
	Quartile 1	0.000	-0.002,0.002	0.89	-0.001	-0.003,0.001	0.26
	Quartile 3	0.000	-0.002,0.002	0.90	0.001	-0.001,0.003	0.40
	Quartile 4	0.000	-0.002,0.001	0.67	0.001	-0.000,0.003	0.15
<b>Transferrin Saturation</b>							
	Quartile 1	0.001	-0.005,0.007	0.70	0.000	-0.006,0.006	0.99
	Quartile 3	-0.002	-0.007,0.004	0.57	-0.001	-0.007,0.005	0.78
	Quartile 4	-0.003	-0.008,0.003	0.38	-0.002	-0.008,0.005	0.62
<b>Calcium</b>							
	Quartile 1	-0.192	-0.347,-0.036	0.02*	-0.411	-0.578,-0.244	<0.001***
	Quartile 3	0.113	-0.041,0.268	0.15	0.209	0.049,0.370	0.01*
	Quartile 4	0.473	0.319,0.628	<0.001***	0.592	0.428,0.756	<0.001***
<b>Lead</b>							
	Quartile 1	-0.026	-0.050,-0.003	0.03*	0.004	-0.020,0.028	0.75
	Quartile 3	0.008	-0.014,0.029	0.47	-0.018	-0.043,0.006	0.14
	Quartile 4	0.030	0.010,0.051	0.003**	-0.008	-0.032,0.016	0.50

1. Abbreviations: CI = Confidence Interval; Lp(a) = Lipoprotein(a); LDL-C = Low-Density Lipoprotein Cholesterol; RBC = Red Blood Cell

2. \* = <0.05, \*\* = <0.01, \*\*\* = <0.001

3. Lp(a) quartiles: 1 = 0 to 5 mg/dL n=2083, 2= 6 to 18 mg/dL, n=1821, 3= 19 to 36 mg/dL, n=1850, 4 = 37 to 210 mg/dL, n=1908.

4. LDL quartiles: 1 = 1.8 to 91.1 mg/dL = n=1916, 2 = 91.1 to 114.6 mg/dL, n=1915, 3 = 114.6 mg/dL to 141.3 mg/dL, n=1916, 4 = 141.3 mg/dL to 364.9 mg/dL, n=1915.