

# Supplementary Materials: Association Between Blood Mercury Concentration and Prevalence of Borderline Hypercholesterolemia among Adolescents: the Korea National Health and Nutrition Examination Survey (KNHANES) 2010-2013 and 2016

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**Table S1.** Classification of lipid and lipoprotein levels (mg/dL) in adolescents.

		Acceptable	Borderline	Overt
Dyslipidemia <sup>a</sup>				
Hypercholesterolemia	TC	< 170	170-199	≥ 200
Hypertriglyceridemia	TG	< 90	90-129	≥ 130
Hyper-LDL cholesterolemia	LDL-cholesterol	< 110	110-129	≥ 130
Hypo-HDL cholesterolemia	HDL-cholesterol	> 45	40-45	< 40

Abbreviations: TC, total cholesterol; TG, triglyceride; LDL, low-density lipoprotein; HDL, high-density lipoprotein. <sup>a</sup> Dyslipidemia was defined as any one or more of hypercholesterolemia, hyper-LDL cholesterolemia, hypertriglyceridemia, or hypo-HDL cholesterolemia.

**Table S2.** Baseline characteristics of the study participants according to TG and HDL-cholesterol levels.

	TG				HDL-Cholesterol			
	Acceptable ( <i>n</i> = 1,025)	Borderline high ( <i>n</i> = 347)	High ( <i>n</i> = 187)	<i>p</i> <sup>a</sup>	Acceptable ( <i>n</i> = 1,133)	Borderline low ( <i>n</i> = 240)	Low ( <i>n</i> = 186)	<i>p</i> <sup>a</sup>
Age, mean ± SE, years	14.2 ± 0.1	14.2 ± 0.2	14.0 ± 0.2	0.421	14.0 ± 0.1	14.4 ± 0.2	14.5 ± 0.2	0.002
10-12 years, n (%)	336 (32.8)	122 (35.2)	66 (35.3)	0.153	405 (35.7)	70 (29.2)	49 (26.3)	0.008
13-15 years, n (%)	387 (37.8)	114 (32.9)	67 (35.8)		395 (34.9)	91 (37.9)	82 (44.1)	
16-18 years, n (%)	302 (29.5)	111 (32.0)	54 (28.9)		333 (29.4)	79 (32.9)	55 (29.6)	
Sex								
Boys, n (%)	546 (53.3)	169 (48.7)	91 (48.7)	0.734	550 (48.5)	136 (56.7)	120 (64.5)	0.002
Girls, n (%)	479 (46.7)	178 (51.3)	96 (51.3)		583 (51.5)	104 (43.3)	66 (35.5)	
BMI, mean ± SE, kg/m <sup>2</sup>	20.2 ± 0.1	21.5 ± 0.2	23.1 ± 0.4	<0.0001	20.3 ± 0.1	22.1 ± 0.3	22.4 ± 0.3	<0.0001
Normal weight, n (%)	867 (84.6)	254 (73.2)	108 (57.8)	<0.0001	944 (83.3)	171 (71.3)	114 (61.3)	<0.0001
Overweight and obesity, n (%)	158 (15.4)	93 (26.8)	79 (42.2)		189 (16.7)	69 (28.8)	72 (38.7)	
Smoking status								
Never smokers, n (%)	910 (88.8)	306 (88.2)	172 (92.0)	0.224	1,017 (89.8)	208 (86.7)	163 (87.6)	0.424
Smokers, n (%)	115 (11.2)	41 (11.8)	15 (8.0)		116 (10.2)	32 (13.3)	23 (12.4)	
Household income level								
Quintile 1, n (%)	127 (12.4)	58 (16.7)	31 (16.6)	0.595	154 (13.6)	34 (14.2)	28 (15.1)	0.851
Quintile 2, n (%)	200 (19.5)	76 (21.9)	46 (24.6)		228 (20.1)	53 (22.1)	41 (22.0)	
Quintile 3, n (%)	235 (22.9)	66 (19.0)	42 (22.5)		256 (22.6)	52 (21.7)	35 (18.8)	
Quintile 4, n (%)	214 (20.9)	77 (22.2)	31 (16.6)		232 (20.5)	45 (18.8)	45 (24.2)	
Quintile 5, n (%)	249 (24.3)	70 (20.2)	37 (19.8)		263 (23.2)	56 (23.3)	37 (19.9)	
Physical activity								
Inactive, n (%)	461 (45.0)	158 (45.5)	84 (44.9)	0.435	538 (47.5)	95 (39.6)	70 (37.6)	0.002
Minimally active, n (%)	308 (30.0)	114 (32.9)	62 (33.2)		327 (28.9)	93 (38.8)	64 (34.4)	
Active, n (%)	256 (25.0)	75 (21.6)	41 (21.9)		268 (23.7)	52 (21.7)	52 (28.0)	
Menstruation (for girls)								
Premenarcheal, n (%)	102 (21.3)	39 (21.9)	28 (29.2)	0.345	130 (22.3)	24 (23.1)	15 (22.7)	0.623

Postmenarcheal, n (%)	377 (78.7)	139 (78.1)	68 (70.8)		453 (77.7)	80 (76.9)	51 (77.3)	
Total energy intake, mean $\pm$ SE, kcal/day	2,209.9 $\pm$ 31.3	2,153.6 $\pm$ 58.0	2,141.6 $\pm$ 80.2	0.126	2,171.0 $\pm$ 30.7	2,204.6 $\pm$ 75.6	2,273.5 $\pm$ 83.9	0.099
Survey year								
2010, n (%)	193 (18.8)	83 (23.9)	47 (25.1)	0.332	215 (19.0)	57 (23.8)	51 (27.4)	0.166
2011, n (%)	236 (23.0)	57 (16.4)	41 (21.9)		245 (21.6)	51 (21.3)	38 (20.4)	
2012, n (%)	218 (21.3)	65 (18.7)	35 (18.7)		241 (21.3)	49 (20.4)	28 (15.1)	
2013, n (%)	202 (19.7)	84 (24.2)	32 (17.1)		224 (19.8)	55 (22.9)	39 (21.0)	
2016, n (%)	176 (17.2)	58 (16.7)	32 (17.1)		208 (18.4)	28 (11.7)	30 (16.1)	
Blood Hg concentration, mean $\pm$ SE, $\mu$ g/L	2.1 $\pm$ 0	2.1 $\pm$ 0.1	2.0 $\pm$ 0.1	0.841	2.1 $\pm$ 0	2.0 $\pm$ 0.1	2.2 $\pm$ 0.1	0.687

Abbreviations: HDL, high-density lipoprotein; SE, standard error; BMI, body mass index; Hg, mercury. <sup>a</sup> *p*-value was calculated using ANOVA test for continuous variable and Rao-Scott Chi-Square test for categorical variable.

**Table S3.** Covariates according to blood Hg distribution.

	Blood Hg concentration			<i>p</i> <sup>a</sup>
	Tertile 1 ( <i>n</i> = 519)	Tertile 2 ( <i>n</i> = 520)	Tertile 3 ( <i>n</i> = 520)	
Age, mean ± SE, years	14.1 ± 0.1	14.2 ± 0.1	14.2 ± 0.1	0.745
10-12 years, n (%)	170 (32.8)	180 (34.6)	174 (33.5)	0.263
13-15 years, n (%)	184 (35.5)	177 (34.0)	207 (39.8)	
16-18 years, n (%)	165 (31.8)	163 (31.3)	139 (26.7)	
Sex				
Boys, n (%)	251 (48.4)	270 (51.9)	285 (54.8)	0.188
Girls, n (%)	268 (51.6)	250 (48.1)	235 (45.2)	
BMI, mean ± SE, kg/m <sup>2</sup>	20.5 ± 0.2	20.8 ± 0.2	21.3 ± 0.2	0.0004
Normal weight, n (%)	436 (84.0)	414 (79.6)	379 (72.9)	0.022
Overweight and obesity, n (%)	83 (16.0)	106 (20.4)	141 (27.1)	
Smoking status				
Never smokers, n (%)	472 (90.9)	454 (87.3)	462 (88.8)	0.396
Smokers, n (%)	47 (9.1)	66 (12.7)	58 (11.2)	
Household income level				
Quintile 1, n (%)	77 (14.8)	63 (12.1)	76 (14.6)	0.034
Quintile 2, n (%)	108 (20.8)	122 (23.5)	92 (17.7)	
Quintile 3, n (%)	133 (25.6)	109 (21.0)	101 (19.4)	
Quintile 4, n (%)	106 (20.4)	97 (18.7)	119 (22.9)	
Quintile 5, n (%)	95 (18.3)	129 (24.8)	132 (25.4)	
Physical activity				
Inactive, n (%)	252 (48.6)	227 (43.7)	224 (43.1)	0.102
Minimally active, n (%)	164 (31.6)	161 (31.0)	159 (30.6)	
Active, n (%)	103 (19.8)	132 (25.4)	137 (26.3)	
Menstruation (for girls)				
Premenarcheal, n (%)	46 (17.2)	65 (26.0)	58 (24.7)	0.010
Postmenarcheal, n (%)	222 (82.8)	185 (74.0)	177 (75.3)	
Total energy intake, mean ± SE, kcal/day	2090.2 ± 39.9	2170.5 ± 46.1	2300.6 ± 53.0	0.0002
Survey year				
2010, n (%)	62 (11.9)	107 (20.6)	154 (29.6)	<0.0001
2011, n (%)	108 (20.8)	109 (21.0)	117 (22.5)	
2012, n (%)	106 (20.4)	125 (24.0)	87 (16.7)	
2013, n (%)	133 (25.6)	99 (19.0)	86 (16.5)	
2016, n (%)	110 (21.2)	80 (15.4)	76 (14.6)	

Abbreviations: Hg, mercury; SE, standard error; BMI, body mass index. <sup>a</sup> *p*-value was calculated using ANOVA test for continuous variable and Rao-Scott Chi-Square test for categorical variable.

**Table S4.** Associations between blood Hg concentration and prevalence of hypercholesterolemia and hyper-LDL cholesterolmia according to sex.

	Concentration	Overall			Boys			Girls		
	range (µg/L)	Case/total	OR (95% CI) <sup>a</sup>	OR (95% CI) <sup>b</sup>	Case/total	OR (95% CI) <sup>a</sup>	OR (95% CI) <sup>b</sup>	Case/total	OR (95% CI) <sup>a</sup>	OR (95% CI) <sup>b</sup>
Hypercholesterolemia										
Continuous		525/1,559	1.39 (1.07, 1.80)	1.50 (1.15, 1.97)	224/806	1.63 (1.17, 2.28)	1.74 (1.23, 2.46)	301/753	1.28 (0.86, 1.89)	1.23 (0.80, 1.90)
Tertile 1	0.192–1.531	157/519	1.00 (Reference)	1.00 (Reference)	53/251	1.00 (Reference)	1.00 (Reference)	104/268	1.00 (Reference)	1.00 (Reference)
Tertiles 2 and 3	1.532–11.761	368/1,040	1.32 (0.99, 1.76)	1.41 (1.05, 1.90)	171/555	1.82 (1.19, 2.79)	2.02 (1.30, 3.14)	197/485	1.08 (0.73, 1.59)	1.01 (0.66, 1.54)
Hyper-LDL cholesterolmia										
Continuous		317/1,559	1.42 (1.05, 1.94)	1.37 (0.99, 1.90)	148/806	1.78 (1.20, 2.64)	1.65 (1.06, 2.57)	169/753	1.20 (0.75, 1.91)	1.13 (0.68, 1.87)
Tertile 1	0.192–1.531	94/519	1.00 (Reference)	1.00 (Reference)	32/251	1.00 (Reference)	1.00 (Reference)	62/268	1.00 (Reference)	1.00 (Reference)
Tertiles 2 and 3	1.532–11.761	223/1,040	1.23 (0.86, 1.76)	1.18 (0.82, 1.70)	116/555	1.94 (1.16, 3.24)	1.88 (1.10, 3.20)	107/485	0.91 (0.58, 1.43)	0.83 (0.51, 1.35)

Abbreviations: LDL, low-density lipoprotein; OR, odds ratio; CI, confidence interval. <sup>a</sup> OR (95% CI) was calculated using univariate logistic regression. <sup>b</sup> OR (95% CI) was calculated using multivariate logistic regression adjusted for age (years, continuous), sex (for boys and girls combined), BMI (kg/m<sup>2</sup>, continuous), survey year (2010, 2011, 2012, 2013, and 2016), total energy intake (kcal/day, continuous), smoking status (never smokers and smokers), household income level (quintile 1, 2, 3, 4, and 5), physical activity (inactive, minimally active, and active), and menstruation (for girls, premenarcheal and postmenarcheal).

**Table S5.** Associations between blood Hg concentration and prevalence of overt hypercholesterolemia and hyper-LDL cholesterolmia according to sex.

Concentration range (µg/L)	Overall			Boys			Girls		
	Case/total	OR (95% CI) <sup>a</sup>	OR (95% CI) <sup>b</sup>	Case/total	OR (95% CI) <sup>a</sup>	OR (95% CI) <sup>b</sup>	Case/total	OR (95% CI) <sup>a</sup>	OR (95% CI) <sup>b</sup>
Overt hypercholesterolemia									
Continuous	130/1,164	1.47 (0.96, 2.25)	1.61 (1.03, 2.53)	53/635	2.13 (1.24, 3.66)	2.04 (1.15, 3.64)	77/529	1.20 (0.63, 2.30)	1.29 (0.64, 2.61)
Tertile 1	0.192–1.531	37/399	1.00 (Reference)	11/209	1.00 (Reference)	1.00 (Reference)	26/190	1.00 (Reference)	1.00 (Reference)
Tertiles 2 and 3	1.532–9.618	93/765	1.49 (0.89, 2.48)	42/426	2.30 (1.02, 5.19)	2.36 (1.00, 5.54)	51/339	1.19 (0.62, 2.29)	1.22 (0.63, 2.35)
Overt hyper-LDL cholesterolmia									
Continuous	93/1,335	1.85 (1.07, 3.21)	1.79 (1.04, 3.08)	39/697	3.92 (2.10, 7.35)	3.20 (1.55, 6.62)	54/638	1.03 (0.44, 2.42)	1.10 (0.47, 2.55)
Tertile 1	0.192–1.531	24/449	1.00 (Reference)	6/225	1.00 (Reference)	1.00 (Reference)	18/224	1.00 (Reference)	1.00 (Reference)
Tertiles 2 and 3	1.532–11.761	69/886	1.34 (0.74, 2.45)	33/472	3.09 (1.10, 8.73)	2.64 (0.94, 7.36)	36/414	0.88 (0.41, 1.89)	0.91 (0.43, 1.94)

Abbreviations: LDL, low-density lipoprotein; OR, odds ratio; CI, confidence interval. <sup>a</sup> OR (95% CI) was calculated using univariate logistic regression. <sup>b</sup> OR (95% CI) was calculated using multivariate logistic regression adjusted for age (years, continuous), sex (for boys and girls combined), BMI (kg/m<sup>2</sup>, continuous), survey year (2010, 2011, 2012, 2013, and 2016), total energy intake (kcal/day, continuous), smoking status (never smokers and smokers), household income level (quintile 1, 2, 3, 4, and 5), physical activity (inactive, minimally active, and active), and menstruation (for girls, premenarcheal and postmenarcheal).