Mercury, Fish Oils, and Risk of Acute Coronary Events and Cardiovascular Disease, Coronary Heart Disease, and All-Cause Mortality in Men in Eastern Finland

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Objective—Mercury has been suggested to have negative effects on cardiovascular health. We investigated the effects of high mercury content in hair on the risk of acute coronary events and cardiovascular and all-cause mortality in men from eastern Finland.

Methods and Results—The population-based prospective Kuopio Ischaemic Heart Disease Risk Factor Study (KIHD) cohort of 1871 Finnish men aged 42 to 60 years and free of previous coronary heart disease (CHD) or stroke at baseline was used. During an average follow-up time of 13.9 years, 282 acute coronary events and 132 cardiovascular disease (CVD), 91 CHD, and 525 all-cause deaths occurred. Men in the highest third of hair mercury content (>2.03 μg/g) had an adjusted 1.60-fold (95% CI, 1.24 to 2.06) risk of acute coronary event, 1.68-fold (95% CI, 1.15 to 2.44) risk of CVD, 1.56-fold (95% CI, 0.99 to 2.46) risk of CHD, and 1.38-fold (95% CI, 1.15 to 1.66) risk of any death compared with men in the lower two thirds. High mercury content in hair also attenuated the protective effects of high-serum docosahexaenoic acid plus docosapentaenoic acid concentration.

Conclusions—High content of mercury in hair may be a risk factor for acute coronary events and CVD, CHD, and all-cause mortality in middle-aged eastern Finnish men. Mercury may also attenuate the protective effects of fish on cardiovascular health. **(*Arterioscler Thromb Vasc Biol*. 2005;25:228-233.)**

Key Words: cardiovascular disease ■ fish ■ fish oils ■ mercury ■ mortality

Of all the heavy metals, mercury is said to be one of the most dangerous environmental poisons,[1] and it has no known physiological role in human metabolism. Heavy exposure to mercury also causes a number of effects in the human body, which may have negative impacts on cardiovascular health. Mercury as a transition metal can promote formation of free radicals. Mercury also has a very high affinity for thiol groups,[2] and it can bind selenium to form an insoluble complex.[3] All of these could reduce the antioxidative capacity and promote free radical stress and lipid peroxidation in the human body. These possible effects have raised interest in the adverse impact of mercury on the risk of cardiovascular disease (CVD).

The Kuopio Ischaemic Heart Disease Risk Factor Study (KIHD) was the first study to show that high mercury content in hair may promote progression of carotid atherosclerosis and be a significant risk factor for acute coronary events and mortality from coronary heart disease (CHD) and CVD in middle-aged men living in eastern Finland.[4,5] Similar results were observed in a recent European Multicenter Case-Control Study on Antioxidants, Myocardial Infarction, and Cancer of the Breast (EURAMIC) study concerning myocardial infarction.[6] In the KIHD and EURAMIC study populations, the beneficial effects of fish were also attenuated by high mercury content in fish.[6,7]

However, recent studies concerning the effects of mercury on CHD have been contradictory.[6,8] The purpose of the present study was to retest our previous findings in the KIHD study using a longer follow-up period. In addition, to determine whether mercury could attenuate the beneficial effects of fish oils, we wanted to investigate the interaction of mercury and serum n-3 end-product fatty acids docosahexaenoic acid (DHA), docosapentaenoic acid (DPA), and eicosapentaenoic acid (EPA) with the risk of acute coronary events and CVD, CHD, and all-cause mortality.

Methods

Study Population

Subjects were participants in the KIHD study.[9] This study was designed to investigate risk factors for CVD, atherosclerosis, and related outcomes in a population-based, randomly selected sample of men from eastern Finland.[9] Baseline examinations were performed between March 1984 and December 1989. The study sample was

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composed of 3235 men aged 42, 48, 54, or 60 years at baseline examination. Of these, 2682 (82.9%) participated. The baseline characteristics of the entire study population have been described previously.[9] The study protocol was approved by the research ethics committee of the University of Kuopio. All subjects gave their written informed consent for participation.

Subjects with a history of CHD or stroke were excluded from the present analyses. Of the remaining men, data on serum DHA+DPA concentrations were available for 1842 men for the CVD death analyses and for 1871 men for the CHD death and acute coronary event analyses. Of these men, data on nutritional intake were missing for 14 men in the CVD death analyses and for 15 men in the CHD death and acute coronary event analyses. The cohort mean was used to replace missing values. Risk of all-cause mortality was estimated excluding only men without data on serum DHA+DPA concentrations; thus, the analyses for all-cause mortality included 2480 men.

Measurements

Subjects came to give hair and venous blood samples between 8 and 10 AM at the baseline examinations. They were instructed to abstain from ingesting alcohol for 3 days and from smoking and eating for 12 hours before giving the sample.

Mercury in hair was determined between May 1992 and August 1993 by flow injection analysis, cold vapor atomic absorption spectrometry, and amalgamation as described previously.[4] Hair samples were processed in a random order at the Department of Chemistry of the University of Kuopio.

Other Measurements

Detailed descriptions of the determination of serum lipids and lipoproteins,[10] serum selenium,[4] urinary excretion of nicotine metabolites,[10] and assessment of medical history and medications,[10] family history of diseases,[10] smoking,[10] alcohol consumption,[10] maximal oxygen uptake, and blood pressure[10] have been published previously. Serum fatty acids were measured with capillary gas chromatography (Hewlett Packard 5890 Series II with flame ionization detector and 7673 autosampler). The percent proportion of the sum of DHA and DPA in all fatty acids was calculated. Body mass index (BMI) was computed as the ratio of weight in kilograms to the square of height in meters.

Assessment of Nutrient Intake

Consumption of foods was assessed at the time of blood sampling during the baseline examinations phase of the KIHD study. To record their food intake quantitatively during the 4 days of data collection, subjects were instructed on the use of household measures. A nutritionist gave the instructions and checked the completed food intake records. Dietary intake of nutrients and foods was calculated using NUTRICA software (version 2.5; National Public Health Institute; Turku, Finland). The software is compiled using mainly Finnish values for the nutrient compositions of foods and takes into account losses of vitamins in food preparation. The database contains comprehensive data for 1300 food items and dishes and 30 nutrients. The residual method was used to adjust all nutrients for dietary energy intake.[11,12]

Ascertainment of Follow-Up Events

Deaths were ascertained by a computer link to the national death registry using the Finnish personal identification code (social security number). There were no losses to follow-up. All acute coronary event cases and all CVD, CHD, and all-cause deaths that occurred from the study entry to December 31, 2002, were included. CVD and CHD deaths were coded according to the Ninth International Classification of Diseases (code numbers 390 to 459 and 410 to 414, respectively) or the Tenth International Classification of Diseases (code numbers I00 to I99 and I20 to I25, respectively). Acute coronary events that occurred between 1984 and 1992 were registered as part of the multinational MONICA (MONItoring of Trends and Determinants in CArdiovascular Disease) project.[13] Data on coronary events between 1993 and 2002 were obtained by record linkage from the national computerized hospitalization registry. Diagnostic classification identical to that of the FINMONICA project was used. According to the diagnostic classification of the events, there were 148 definite and 77 probable acute coronary events and 57 typical prolonged coronary chest pain episodes. If a subject had multiple nonfatal coronary events during follow-up, the first was considered the end point. Of the 525 all-cause deaths, 257 were CVD-related and 268 non-CVD–related deaths.

Statistical Analysis

Data are presented as means (SD). Comparisons between groups were performed using ANOVA. Pearson's correlation coefficients were used to estimate the correlations of hair mercury content with fish intake and risk factors for CVD (all as continuous variables). Associations between hair mercury content and acute coronary event and CVD, CHD, and all-cause death were analyzed using Cox proportional hazards regression models. Subjects were divided into thirds according to the mean mercury content in hair of the 1871 subjects without previous CHD (<0.84, 0.84 to 2.03, and >2.03 μg/g). The same grouping was used in all analyses. Prespecified covariates included age and examination year (model 1). In the second model, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol, BMI, family history of ischemic heart disease, systolic blood pressure, maximal oxygen uptake, urinary excretion of nicotine metabolites, and serum selenium were also adjusted for (model 2). Further analyses adjusted for serum DHA+DPA as proportion of all fatty acids in serum (model 3) and finally for dietary intakes of saturated fatty acids, fiber, and vitamins C and E (model 4). Interactions between hair mercury content and serum DHA+DPA were assessed by stratified analysis and the use of a cross-product term. In the stratified analyses, associations between serum DHA+DPA and acute coronary event and CVD, CHD, and any death were assessed separately within 2 levels of hair mercury content. Statistical significance of the interactions on a multiplicative scale was assessed by likelihood ratio tests using a cross-product term. All tests of statistical significance were 2-sided. Data were analyzed using SPSS 11.5 for Windows (SPSS Inc).

Results

At the beginning of the follow-up, the mean (±SD) age of the subjects was 52.4 (5.3) years. During the average follow-up time of 13.9 years (range of follow-up 0.3 to 17.8 years), 282 acute coronary events and 132 CVD, 91 CHD, and 525 all-cause deaths occurred.

The baseline characteristics of the subjects are presented in Table 1. The intake of fish in men in the highest third of hair mercury content was >2× higher than in the lowest third (65 versus 30 g per day; P for difference <0.001). High mercury content in hair was most strongly associated with the intake of fish ($r=0.27$; $P<0.001$) and serum DHA+DPA concentration ($r=0.25$; $P<0.001$). The associations between mercury and other factors were weak.

Associations Between Mercury Content in Hair and Risk of Acute Coronary Events and CVD, CHD, and Any Death

The mean (±SD) mercury content of hair was 1.9 (1.9) μg/g ranging from 0 to 15.7 μg/g. The proportion of subjects with an undetectable amount of mercury was 3.3%. In the Cox proportional hazards model adjusted for age, examination year, serum HDL and LDL cholesterol, family history of ischemic heart disease, systolic blood pressure, BMI, maximal oxygen uptake, urinary excretion of nicotine metabolites, serum selenium, serum DHA+DPA, and intake of alcohol, saturated fatty acids, fiber, and vitamins C and E, men in the

TABLE 1. Baseline Characteristics of the 1871 Study Participants According to Mercury Content in Hair

Characteristic	Hair Mercury Content (μg/g)			*P* for Heterogeneity
	<0.84	0.84–2.03	≥2.03	
No. of subjects	624	625	622	
No. of events (n [% of subjects])				
Acute coronary event (282)*	72 (11.5%)	82 (13.1%)	128 (29.6%)	<0.001
CVD death (132)†	43 (7.0%)	30 (4.8%)	59 (9.8%)	0.002
CHD death (91)*	30 (4.8%)	20 (3.2%)	41 (6.6%)	0.021
Any death (525)‡	115 (16.7%)	124 (17.2%)	286 (26.8%)	<0.001
Nutritional factors§				
Fish intake (g per day)§	30 (38)	43 (47)	65 (67)	<0.001
Fiber intake (g per day)¶	25.5 (9.1)	25.2 (8.8)	25.5 (8.5)	NS
Saturated fatty acid intake (% of total energy)¶	17.5 (4.0)	17.7 (4.0)	18.4 (4.3)	<0.001
Vitamin C intake (mg per day)¶	74.6 (49.5)	75.2 (53.1)	73.8 (55.1)	NS
Vitamin E intake (mg per day)¶	9.2 (2.9)	9.1 (3.1)	8.9 (3.0)	NS
Alcohol intake (g per week)	66 (118)	76 (120)	78 (111)	NS
Biochemical and other risk factors				
Age (years)	51.2 (5.8)	52.3 (5.3)	53.7 (4.5)	<0.001
BMI (kg/m^2)	26.4 (3.3)	26.8 (3.4)	27.1 (3.7)	0.001
Systolic blood pressure (mm Hg)	134 (16)	134 (16)	136 (17)	0.028
Diastolic blood pressure (mm Hg)	89 (10)	89 (11)	90 (11)	NS
Fasting serum insulin (mU/L)	10.9 (6.7)	11.1 (6.4)	11.5 (6.9)	NS
Fasting blood glucose (mmol/L)	4.7 (1.0)	4.7 (0.8)	4.8 (1.0)	NS
Serum total cholesterol (mmol/L)	5.70 (1.02)	5.81 (1.06)	6.08 (1.04)	<0.001
Serum LDL cholesterol (mmol/L)	3.85 (0.94)	3.94 (0.97)	4.22 (1.00)	<0.001
Serum HDL cholesterol (mmol/L)	1.26 (0.27)	1.30 (0.29)	1.34 (0.31)	<0.001
Serum triglycerides (mmol/L)	1.31 (0.75)	1.27 (0.77)	1.22 (0.74)	NS
Maximal oxygen uptake (L per minute)‖	2.6 (0.6)	2.6 (0.6)	2.5 (0.6)	0.020
Urea nicotine metabolites (mg per day)	5.8 (10.1)	5.0 (9.1)	6.2 (9.2)	NS
Serum selenium (μg/L)**	117.2 (16.5)	117.4 (19.3)	117.0 (17.6)	NS
Serum DHA+DPA (% of total fatty acids)	2.74 (0.68)	3.04 (0.72)	3.26 (0.86)	<0.001
Percentage of total				
Smokers (%)	29.1	26.1	34.6	0.004
Hypertension (%)	30.8	30.0	34.9	NS
Diabetes (%)	3.0	4.2	5.1	NS
Family history of ischemic heart disease (%)	44.1	47.4	46.3	NS

All values are means (±SD).

*Counted from 1871 men free of CHD at baseline; †counted from 1842 men free of CHD or stroke at baseline; ‡counted from 2480 men; §4-day mean; ¶measured from 1856 men; ‖measured from 1693 men; **measured from 1851 men.

highest third of mercury content in hair had a 1.60-fold (95% CI, 1.24 to 2.06) risk of acute coronary event, 1.68-fold (95% CI, 1.15 to 2.44) risk of CVD death, 1.56-fold (95% CI, 0.99 to 2.46) risk of CHD death, and 1.38-fold (95% CI, 1.15 to 1.66) risk of any death, compared with men in the combined lower 2 thirds (Table 2). For each microgram of mercury in hair, the risk of acute coronary event increased, on average, by 11% (95% CI, 6% to 17%, $P<0.001$), the risk of CVD death by 10% (95% CI, 2% to 19%, $P=0.017$), the risk of CHD death by 13% (95% CI, 3% to 23%, $P=0.007$) and the risk of any death by 5% (95% CI, 1% to 9%, $P=0.018$).

Interaction of Hair Mercury Content and Serum DHA+DPA

In men with low mercury content in hair, high proportion of serum DHA+DPA was associated with a decreased risk. The age, examination year, serum HDL and LDL cholesterol, family history of ischemic heart disease, systolic blood pressure, BMI, maximal oxygen uptake, urinary excretion of nicotine metabolites, serum selenium, hair mercury, alcohol, saturated fatty acids, fiber, and vitamins C and E intake adjusted change in risk for each percentage unit increase in DHA+DPA proportion of all fatty acids in serum in high and

TABLE 2. Relative Risk (RR) and 95% CI of Acute Coronary Events and CVD and CHD Death, and Any Death in Men in Thirds of Hair Mercury Content

	Lowest Third RR	Middle Third RR (95% CI)	Highest Third RR (95% CI)	*P* for Trend	Highest vs lower Two Thirds Combined RR (95% CI)
Incidence of acute coronary event					
Model 1*	1	1.02 (0.74–1.41)	1.61 (1.20–2.17)	0.001	1.59 (1.25–2.03)
Model 2†	1	1.04 (0.75–1.44)	1.55 (1.14–2.11)	0.003	1.52 (1.19–1.94)
Model 3‡	1	1.08 (0.77–1.50)	1.67 (1.22–2.30)	0.001	1.60 (1.24–2.06)
Model 4§	1	1.07 (0.77–1.49)	1.66 (1.20–2.29)	0.001	1.60 (1.24–2.06)
Incidence of CVD death					
Model 1*	1	0.65 (0.40–1.04)	1.24 (0.83–1.87)	0.213	1.53 (1.08–2.18)
Model 2†	1	0.61 (0.38–0.99)	1.17 (0.77–1.79)	0.364	1.49 (1.04–2.15)
Model 3‡	1	0.67 (0.41–1.08)	1.36 (0.88–2.11)	0.126	1.67 (1.15–2.43)
Model 4§	1	0.66 (0.41–1.07)	1.35 (0.87–2.11)	0.141	1.68 (1.15–2.44)
Incidence of CHD death					
Model 1*	1	0.59 (0.33–1.05)	1.17 (0.72–1.89)	0.416	1.50 (0.99–2.29)
Model 2†	1	0.57 (0.32–1.03)	1.07 (0.65–1.77)	0.650	1.41 (0.91–2.18)
Model 3‡	1	0.63 (0.35–1.13)	1.27 (0.75–2.16)	0.296	1.61 (1.03–2.53)
Model 4§	1	0.61 (0.34–1.10)	1.21 (0.71–2.06)	0.398	1.56 (0.99–2.46)
Incidence of any death					
Model 1*	1	0.93 (0.72–1.20)	1.36 (1.09–1.70)	0.001	1.41 (1.19–1.69)
Model 2†	1	0.88 (0.68–1.14)	1.23 (0.98–1.54)	0.025	1.31 (1.10–1.57)
Model 3‡	1	0.92 (0.71–1.19)	1.30 (1.03–1.65)	0.007	1.37 (1.14–1.64)
Model 4§	1	0.92 (0.71–1.19)	1.31 (1.03–1.66)	0.007	1.38 (1.15–1.66)

*Adjusted for age and examination years; †adjusted for model 1 and HDL and LDL cholesterol, BMI, family history of ischemic heart disease, systolic blood pressure, maximal oxygen uptake, urinary excretion of nicotine metabolites, serum selenium, and alcohol intake; ‡adjusted for model 2 and serum DHA+DPA as proportion of all fatty acids in serum; §adjusted for model 3 and intake of saturated fatty acids, fiber, and vitamins C and E.

low hair mercury groups are shown in Table 3. There was a significant decrease in the risk of acute myocardial infarction and CVD and CHD death in men in the low hair mercury group (<2.03 μg/g), whereas no association was observed in men with high hair mercury content. No difference in risk was observed in all-cause mortality. The *P* value for interaction between mercury content in hair and DHA+DPA with respect to the risk of acute coronary events was 0.018, with CVD death 0.067, CHD death 0.005, and with any death 0.836. The decreases in risks were lower if EPA was included

TABLE 3. Relative Risk (RR) Associated With Each Percentage Unit Increase in DHA+DPA Proportion of All Fatty Acids in Serum

	RR (95% CI)*	No. of Cases (% in group)	*P* for Interaction Between Hair Hg and DHA+DPA
Acute coronary event			0.023
Hair Hg <2.03 μg/g (n=1249)	0.69 (0.52–0.91)	154 (12.3)	
Hair Hg ≥2.03 μg/g (n=622)	1.06 (0.85–1.32)	128 (20.6)	
CVD death			0.067
Hair Hg <2.03 μg/g (n=1237)	0.59 (0.39–0.89)	73 (5.9)	
Hair Hg ≥2.03 μg/g (n=605)	0.87 (0.61–1.23)	59 (9.8)	
CHD death			0.005
Hair Hg <2.03 μg/g (n=1249)	0.43 (0.25–0.74)	50 (4.0)	
Hair Hg ≥2.03 μg/g (n=622)	1.05 (0.72–1.53)	41 (6.6)	
Any death			0.836
Hair Hg <2.03 μg/g (n=1412)	0.90 (0.74–1.10)	239 (16.9)	
Hair Hg ≥2.03 μg/g (n=1068)	0.87 (0.74–1.02)	286 (26.8)	

*Adjusted for age, examination year, serum HDL and LDL cholesterol, family history of ischaemic heart disease, systolic blood pressure, BMI, maximal oxygen uptake, urinary excretion of nicotine metabolites, serum selenium, hair mercury, alcohol, saturated fatty acids, fiber and vitamin C and E intake.

in addition to DHA+DPA. The *P* values for interaction were not appreciably affected ($P=0.034$, $P=0.064$, $P=0.007$, and $P=0.429$ for acute coronary events and CVD, CHD, and all-cause death, respectively).

Discussion

Our main finding was that high mercury content in hair is significantly associated with an increased risk of acute coronary events and CVD, CHD, and all-cause mortality in men living in eastern Finland. Furthermore, high mercury content in hair attenuated the beneficial effects of fish oils on the risk of acute coronary events and CVD and CHD mortality. The current data support our previous findings that a high mercury content in hair, indicating high mercury intake, is associated with increased risk of acute coronary events and CVD and CHD mortality.[4] The results of this study are also consistent with a recent report from the EURAMIC study, in which high mercury levels in toenails were associated with the risk of future myocardial infarction.[6] As in our study, in the EURAMIC study, high mercury content diminished the cardioprotective effect of DHA. However, contrary results were published in another recent report from the Health Professional Follow-Up Study.[8] Although mercury levels in toenails were significantly and positively correlated with fish consumption, no increased risk was found between high mercury content and CHD.[8] Furthermore, after the authors excluded dentists, who have an occupational exposure to elemental mercury, they found a positive, although not significant, association between mercury levels and CHD. The authors concluded that a weak relationship between mercury exposure, particularly from fish, and the risk of CHD could not be excluded.[8] Another contrary result was observed in a Swedish population-based prospective nested case-control study of 78 cases with myocardial infarction and 156 controls.[14] In this study, the concentration of mercury in erythrocytes was inversely associated with risk of myocardial infarction. However, compared with our study, the levels of mercury in subjects were low. Only 2 subjects had the erythrocyte mercury levels higher than the corresponding hair mercury levels of 2.0 μg/g in our study.[14]

Mercury is an environmental pollutant, the major sources of which include industry and burning of wastes and fossil fuels as well as industrial and household wastes.[1] Mercury exists in 3 forms: elemental mercury, inorganic mercury compounds, and organic mercury. Mercury eventually settles in waterways, where it is converted to the toxic (organic) methylmercury by bacteria and algae.[15] Methylmercury is rapidly accumulated by aquatic biota. Because fish are at the top of the aquatic food chain, they also have the highest concentrations of methylmercury.[2] This is seen especially well in large (and hence old) predatory fish, such as the Northern pike.[4] In humans, the major exposure to methylmercury occurs through food, and the major source is fish and fish products.[2] Methylmercury is almost totally absorbed in the gastrointestinal tract.[2] The long half-life[16] and the fact that the human body has no way of excreting mercury actively mean that mercury continues to accumulate in the human body throughout life.

Mechanisms by which mercury is thought to increase the risk of CHD are the reduction of antioxidative capacity, in plasma and cells, and promotion of free radical stress and lipid peroxidation in cell membranes and lipoproteins. Because mercury is a transition metal, it can act as a catalyst in Fenton-type reactions, resulting in the formation of free radicals. Mercury also has a very high affinity for sulfhydryl groups, which results in inactivation of antioxidative thiolic compounds such as glutathione, catalase, and superoxide dismutase.[17] In addition, mercury forms an insoluble complex with selenium, thus binding selenium in an inactive form that cannot serve as a catalytic center (as selenocysteine) of glutathione peroxidase, an important scavenger of H_2O_2 and lipid peroxides.[3] The theory that mercury could elevate the risk of CHD through promotion of lipid peroxidation was supported by our earlier study in which high mercury content in hair and high mercury excretion in urine were associated with elevated titers of immune complexes containing oxidized LDL.[4] Mercury also inactivates paraoxonase,[18] an extracellular antioxidative enzyme in which a genetic defect is associated with an increased risk of acute myocardial infarction.[19] Other possible atherogenic effects of mercury may be the potentiation of ADP-induced platelet aggregation,[20] promotion of blood coagulation,[21] inhibition of endothelial-cell formation and migration,[22] and effects on apoptosis and the inflammatory responses.[23]

The beneficial effects of fish or fish oil consumption on CHD have been observed in some but not all studies.[24] Some investigators have speculated that the conflicting data could be attributable to differences in, for example, definitions of sudden death and the residual confounding of reference groups with less healthy lifestyle, experimental design, estimation of fish intake, or study populations.[24] One other explanation is that fish consumption reduces CHD mortality only in high-risk but not low-risk populations.[25] However, in only a few studies has high mercury intake been given as an explanation for lack of association between fish oil and CHD or myocardial infarction.[6,7] Alternatively, mercury from fish may affect the pathogenesis of CHD only after an unknown threshold of fish intake is exceeded. An important aspect to consider is the type of fish consumed. In our earlier study, the intake of lean local freshwater fish was associated with elevated mercury content in hair, whereas none of the fatty fish consumed were associated with increased hair mercury.[4] Furthermore, in another study, lower CHD mortality was observed in populations that consumed fatty fish but not lean fish.[26] Fatty fish are generally plankton-eating species, so their exposure to mercury is not as great as that of predatory fish. The current study supports the results of our previous study, in which high concentration of DHA+DPA in serum was associated with lower risk of acute coronary event in healthy middle-aged men but where high hair mercury content attenuated this protective effect.[7] However, we do not have an explanation for the observation that the reductions in the risks were not so great when EPA was included compared with DHA+DPA alone. The finding that high serum DHA+DPA concentration did not significantly reduce the risk of all-cause mortality may be attributable to a large proportion of noncardiovascular deaths in this category.

The limitation of this study is that it included only men. However, in the 11-year follow-up examinations of the KIHD study, women have also been included, so over time, the data about the effects of mercury in women as well will become available.

In conclusion, this prospective population-based study shows that high mercury content in hair is associated with increased risk of acute coronary events and CVD, CHD, and all-cause mortality, and that the beneficial effects of fish oils on the risk are negated by high mercury content in hair. Does this mean that contrary to the current recommendations for a healthy diet, we should not eat fish? No, but we should vary the type of fish we eat (plankton-eating, fatty fish is usually low in mercury, although it may contain other, lipid-soluble environmental pollutants) and avoid regular intake of large fish from lakes with known high mercury content. The recommendation to eat fish (particularly fatty fish) 2× per week[24] may be enough to get beneficial health effects of fish consumption without excessive exposure to the possible environmental contaminants in fish. Furthermore, the scientific community should put more emphasis on the possible negative effects of transition metals and pro-oxidants on human health.

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