total-TEQ value of blood (pg TEQ per g lipid). Further, we can deduce liver dioxin levels, by the equation of y = 1.74x + 52.9 with a correlation coefficient of 0.73, with x = total-TEQ value of blood. Iida *et al.* (1999) also demonstrated the presence of a good correlation between the blood and liver in levels of several congeners of PCDDs, PCDFs and Co-PCBs, although they did not study on total-TEQ.

We recently clarified that about 50% of the total-TEQ of dioxins ingested are excreted, 22% in feces and 29% in sebum (Kitamura et al., 2001). The fate of the remaining 50% is not known. One possibility is accumulation in the body. Therefore, we examined the effect of age on dioxin levels and it was revealed that total-TEQ and the major five congeners contributing largely to the total-TEQ increased with age in bile, blood and liver. Accumulation rate of dioxins was estimated to be 0.99, 0.70 and 1.91 pg total-TEQ/ g lipid / year in bile, blood and liver, respectively. However, it is necessary to pay attention to that these rates might be largely affected by historical exposure size. The accumulation rate was about 2 times higher in the liver than in the bile or blood. It is noteworthy that dioxins are estimated to be present at age naught in the blood and liver, however, they appear in bile after about age 20. Two possible mechanisms can be considered: secretion to bile might occur after accumulation of dioxins in liver at some levels, or metabolism of dioxins might change after age 20.

It was calculated that daily secretion of dioxins from bile is 54 pg, which corresponds to 30~40% of the total ingestion of dioxins of the Japanese, based on the data from a study by the Ministry of Health and Welfare (Toyoda *et al.*, 1999). Since our previous study (Kitamura *et al.*, 2001) indicated that 80% of dioxins to which intestines are exposed might be absorbed, prevention of absorption from intestines would be one important approach to reducing body burden of dioxins. Aozasa *et al.* (2000) reported efficient elimination of dioxins by feeding chitosan-bound chlorophilline to rats. This line of study may be useful to reduce body burden of dioxins in humans.

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Table 1. Diagnoses at death

Female		Male	
Age	Disease	Age	Disease
29	Acute myelocytic leukemia	21	Cerebral palsy
33	Spinal cord tumor	50	Brain tumor
53	Polyarteritis	52	Dissecting aneurysm
58	Pancreatic carcinoma	63	Acute cardiac infarction
73	Rheumatoid arthritis	63	Lung cancer
74	Malignant lymphoma, Diabetes mellitus	65	Pulmonary fibrosis
75	Thalamic hemorrhage	66	Pancreatic carcinoma
76	Acute myelocytic leukemia	67	Hepatoma, Gastric cancer
77	Urinary bladder cancer	68	Primary biliary cirrhosis
83	Cor pulmonale	68	Urothelial cancer
84	Urothelial cancer	68	Malignant lymphoma, Colon cancer
85	Ovarian cancer	68	Prostate cancer
		73	Lung cancer
		77	Hepatoma, Malignant lymphoma
		77	Lung cancer

Table 2. PCDD / PCDF / Co-PCB Levels in Bile,Blood and Liver

	Mean ± SD (pg / g lipid)			Mean ± SD (pg TEQ / g lipid)		
	Bile	Blood	Liver	Bile	Blood	Liver
2,3,7,8-TCDD	3.6 ± 3.5	2.6 ± 2.0	8.0 ± 6.5	3.6 ± 3.5	2.6 ± 2.0	8.0 ± 6.5
1,2,3,7,8-PeCDD	10.5 ± 8.3	9.9 ± 6.4	24.4 ± 16.8	10.5 ± 8.3	9.9 ± 6.4	24.4 ± 16.8
1,2,3,4,7,8-HxCDD	2.9 ± 2.9	4.1 ± 3.1	10.8 ± 6.1	0.3 ± 0.3	0.4 ± 0.3	1.1 ± 0.6
1,2,3,6,7,8-HxCDD	29.7 ± 24.7	41.1 ± 24.9	101.4 ± 52.7	3.0 ± 2.5	4.1 ± 2.5	10.1 ± 5.3
1,2,3,7,8,9-HxCDD	4.2 ± 3.2	6.1 ± 4.8	12.7 ± 6.3	0.4 ± 0.3	0.6 ± 0.5	1.3 ± 0.6
1,2,3,4,6,7,8-HpCD	20.0 ± 47.4	43.0 ± 111.8	143.9 ± 170.4	0.2 ± 0.5	0.4 ± 1.1	1.4 ± 1.7
OCDD	305.1 ± 595.7	548.4 ± 614.7	2646.9 ± 3856.6	0.0 ± 0.1	0.1 ± 0.1	0.3 ± 0.4
2,3,7,8-TCDF	1.1 ± 1.2	0.9 ± 1.0	2.4 ± 1.8	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.2
1,2,3,7,8-PeCDF	0.6 ± 0.6	0.9 ± 0.7	3.0 ± 2.3	0.0 ± 0.0	0.0 ± 0.0	0.2 ± 0.1
2,3,4,7,8-PeCDF	19.7 ± 16.4	17.7 ± 13.0	61.3 ± 40.1	9.9 ± 8.2	8.8 ± 6.5	30.6 ± 20.1
1,2,3,4,7,8-HxCDF	5.6 ± 4.2	8.4 ± 6.7	32.2 ± 19.3	0.6 ± 0.4	0.8 ± 0.7	3.2 ± 1.9
1,2,3,6,7,8-HxCDF	6.4 ± 6.4	10.5 ± 9.3	53.9 ± 38.2	0.6 ± 0.6	1.1 ± 0.9	5.4 ± 3.8
2,3,4,6,7,8-HxCDF	2.8 ± 2.4	5.9 ± 7.0	26.8 ± 19.2	0.3 ± 0.2	0.6 ± 0.7	2.7 ± 1.9
1,2,3,7,8,9-HxCDF	0.3 ± 0.5	0.7 ± 0.8	2.7 ± 2.4	0.0 ± 0.1	0.1 ± 0.1	0.3 ± 0.2
1,2,3,4,6,7,8-HpCD	2.2 ± 3.1	5.3 ± 6.2	53.0 ± 61.6	0.0 ± 0.0	0.1 ± 0.1	0.5 ± 0.6
1,2,3,4,7,8,9-HpCD	0.2 ± 0.6	0.7 ± 1.1	8.0 ± 6.6	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.1
OCDF	0.3 ± 0.6	0.7 ± 1.1	8.2 ± 10.7	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
3,3',4,4'-TCB	34.2 ± 78.4	62.4 ± 62.4	209.9 ± 369.2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
3,3'4,4',5-PeCB	124.8 ± 104.6	122.4 ± 71.3	352.8 ± 180.0	12.5 ± 10.5	12.2 ± 7.1	35.3 ± 18.0
3,3'4,4'5,5'-HxCB	126.7 ± 244.4	121.0 ± 87.5	274.4 ± 162.1	1.3 ± 2.4	1.2 ± 0.9	2.7 ± 1.6
PCDDs	376.0 ± 648.8	655.2 ± 723.9	2948.1 ± 4017.7	18.0 ± 13.8	18.1 ± 10.9	46.6 ± 25.7
PCDFs	39.1 ± 30.6	51.6 ± 39.2	251.4 ± 129.1	11.5 ± 9.3	11.6 ± 8.4	43.2 ± 24.5
Co-PCBs	285.6 ± 309.2	305.8 ± 180.9	837.1 ± 491.4	13.7 ± 11.1	13.5 ± 7.6	38.0 ± 19.0
Total	700.7 ± 773.1	1012.6 ± 826.2	4036.6 ± 4110.3	43.2 ± 30.9	43.1 ± 24.2	127.8 ± 57.4

Table 3. Comparisons of PCDD / PCDF/ Co-PCB Levels among Bile, Blood and Liver

	Bile / Blood			Liver / Blood			Liver / Bile		
	Mean	±	SD	Mean	±	SD	Mean	±	SD
pg /g lipid									
2,3,7,8-TCDD	1.5	±	1.5	3.3	±	2.7	3.7	±	5.1
1,2,3,7,8-PeCDD	1.1	±	0.6	3.2	±	3.2	3.1	±	2.4
1,2,3,4,7,8-HxCDD	0.7	±	0.4	3.7	±	2.9	7.0	±	6.0
1,2,3,6,7,8-HxCDD	0.7	±	0.5	3.1	±	2.5	6.5	±	7.1
1,2,3,7,8,9-HxCDD	0.8	±	0.7	3.1	±	2.6	4.4	±	4.6
1,2,3,4,6,7,8-HpCDD	0.7	±	0.6	9.3	±	12.1	24.8	±	41.0
OCDD	0.8	±	1.1	7.2	±	6.6	20.4	±	33.2
2,3,7,8-TCDF	1.5	±	1.8	2.1	±	1.3	2.6	±	2.3
1,2,3,7,8-PeCDF	0.8	±	1.2	3.9	±	3.7	6.4	±	10.5
2,3,4,7,8-PeCDF	1.1	±	0.6	4.2	±	2.2	4.9	±	4.8
1,2,3,4,7,8-HxCDF	0.8	±	0.5	5.4	±	3.6	7.9	±	5.1
1,2,3,6,7,8-HxCDF	0.7	±	0.5	7.6	±	6.7	15.2	±	16.2
2,3,4,6,7,8-HxCDF	0.7	±	0.6	7.3	±	5.8	16.3	±	16.9
1,2,3,7,8,9-HxCDF	0.7	±	1.7	4.0	±	5.0	5.6	±	8.7
1,2,3,4,6,7,8-HpCDF	0.5	±	0.6	21.6	±	34.3	39.6	±	58.6
1,2,3,4,7,8,9-HpCDF	0.5	±	1.1	8.5	±	8.8	12.3	±	13.3
OCDF	0.1	±	0.2	6.1	±	10.7	18.9	±	33.9
3,3',4,4'-TCB	0.8	±	1.2	8.1	±	13.7	13.6	±	27.0
3,3'4,4',5-PeCB	1.1	±	0.7	3.8	±	2.7	4.8	±	4.0
3,3'4,4'5,5'-HxCB	0.9	±	0.9	2.9	±	1.8	6.8	±	7.2
Congener group-pg TEQ/g lipid									
PCDDs	1.0	±	2.1	1.9	±	1.9	2.7	±	4.5
PCDFs	0.9	±	1.4	3.5	±	4.3	3.7	±	5.8
Co-PCBs	1.0	±	1.5	2.0	±	1.4	2.7	±	3.3
Total	1.1	±	2.8	2.6	±	3.2	3.2	±	7.3

Table 4. Daily Secretion of Dioxins into Bile

	pg TEQ/day
PCDDs	22.8 ± 23.2
PCDFs	14.3 ± 14.3
Co-PCB	16.7 ± 17.7
Total	53.9 ± 52.5

Table 5. Relation between age and ~~total~~ TEQ

Dioxin congeners	Organ	Regression equation* a	Regression equation* b	Correlation coefficient	P value
20 congeners (total)	Bile	0.991	-20.870	0.520	<0.01
	Blood	0.704	-2.370	0.473	<0.05
	Liver	1.910	4.360	0.539	<0.01
2,3,7,8-TCDD	Bile	0.082	-1.739	0.386	<0.05
	Blood	0.048	-0.567	0.402	<0.05
	Liver	0.182	-3.820	0.467	<0.05
1,2,3,7,8-PeCDD	Bile	0.203	-2.761	0.407	<0.05
	Blood	0.185	-2.088	0.479	<0.05
	Liver	0.238	8.857	0.236	>0.05
1,2,3,6,7,8-HxCDD	Bile	0.065	-1.261	0.438	<0.05
	Blood	0.031	2.074	0.210	>0.05
	Liver	0.099	3.699	0.313	>0.05
2,3,4,7,8-PeCDF	Bile	0.206	-3.548	0.421	<0.05
	Blood	0.199	-4.102	0.511	<0.01
	Liver	0.494	-1.526	0.411	<0.05
3,3'4,4',5-PeCB	Bile	0.280	-5.732	0.446	<0.05
	Blood	0.089	6.459	0.208	>0.05
	Liver	0.474	4.370	0.440	<0.05

* Regression equation, $y = ax + b$ pg TEQ /g lipid

Legends to Figures

Fig. 1.

Dioxin TEQ: Relationship among blood, bile and liver. Open circles indicate bile and blood TEQ, and closed circle liver and blood TEQ of each autopsy sample.

Fig.2.

Relationships between age and total-TEQ, and age and major five dioxin congeners. 2a), total-TEQ in bile, blood and liver: 2b), 2,3,7,8-TCDD in bile, blood and liver: 2c), 1,2,3,7,8-PeCDD in bile, blood and liver: 2d), 1,2,3,6,7,8-HxCDD in bile, blood and liver: 2e), 2,3,4,7,8-PeCDF in bile, blood and liver: 2f), 3,3'4,4',5-PeCB in bile, blood and liver.

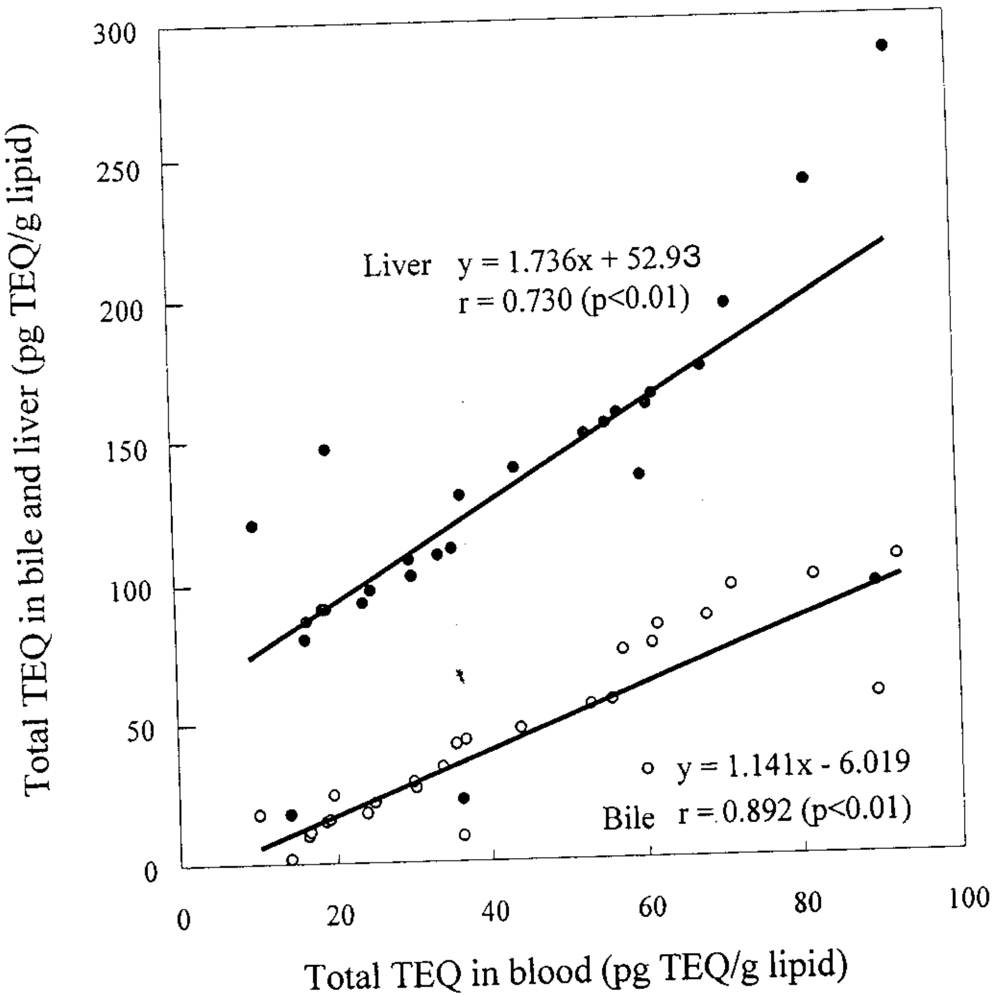

Fig.1. Kitamura et al.

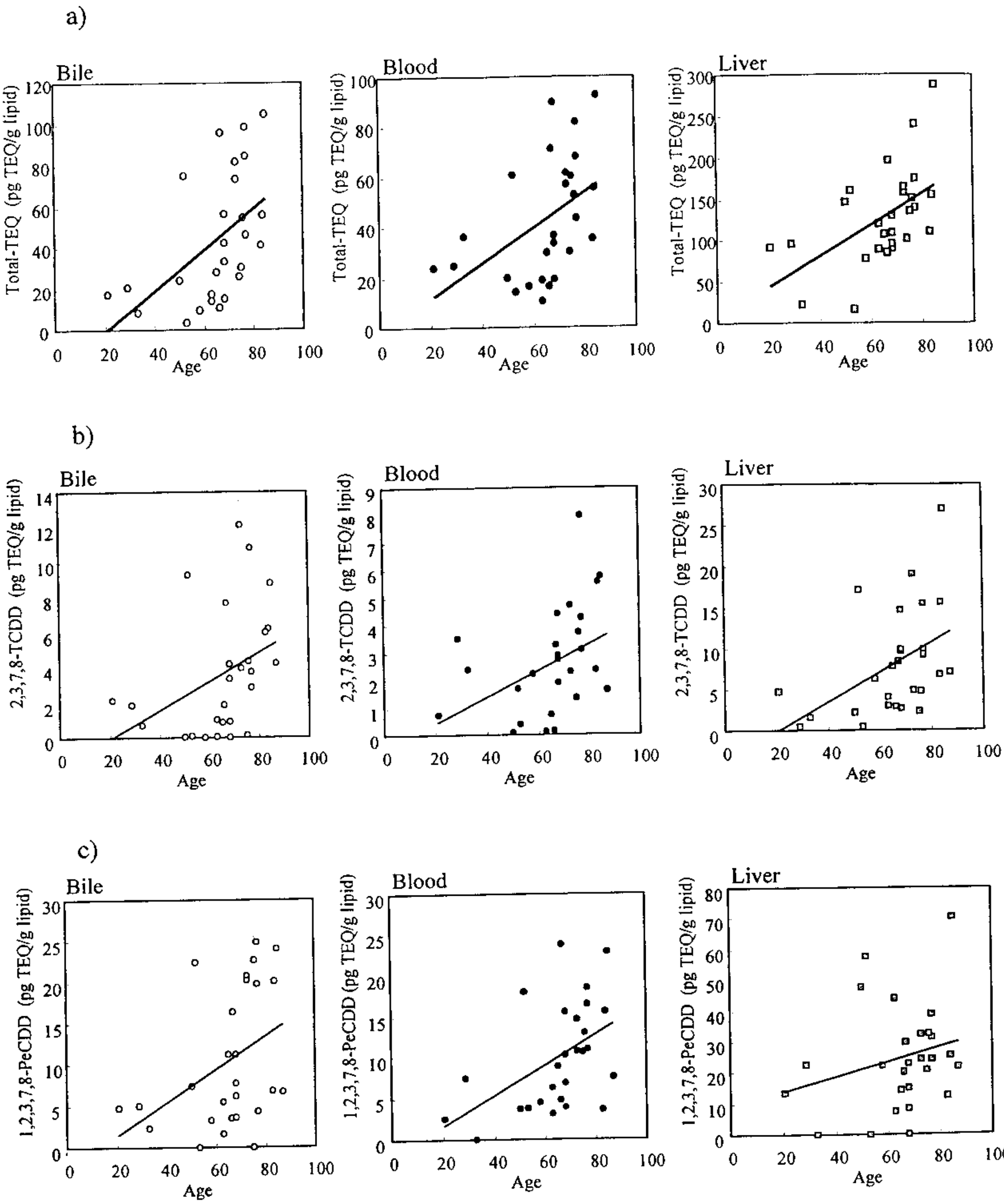

Fig. 2-1, Kitamura et al

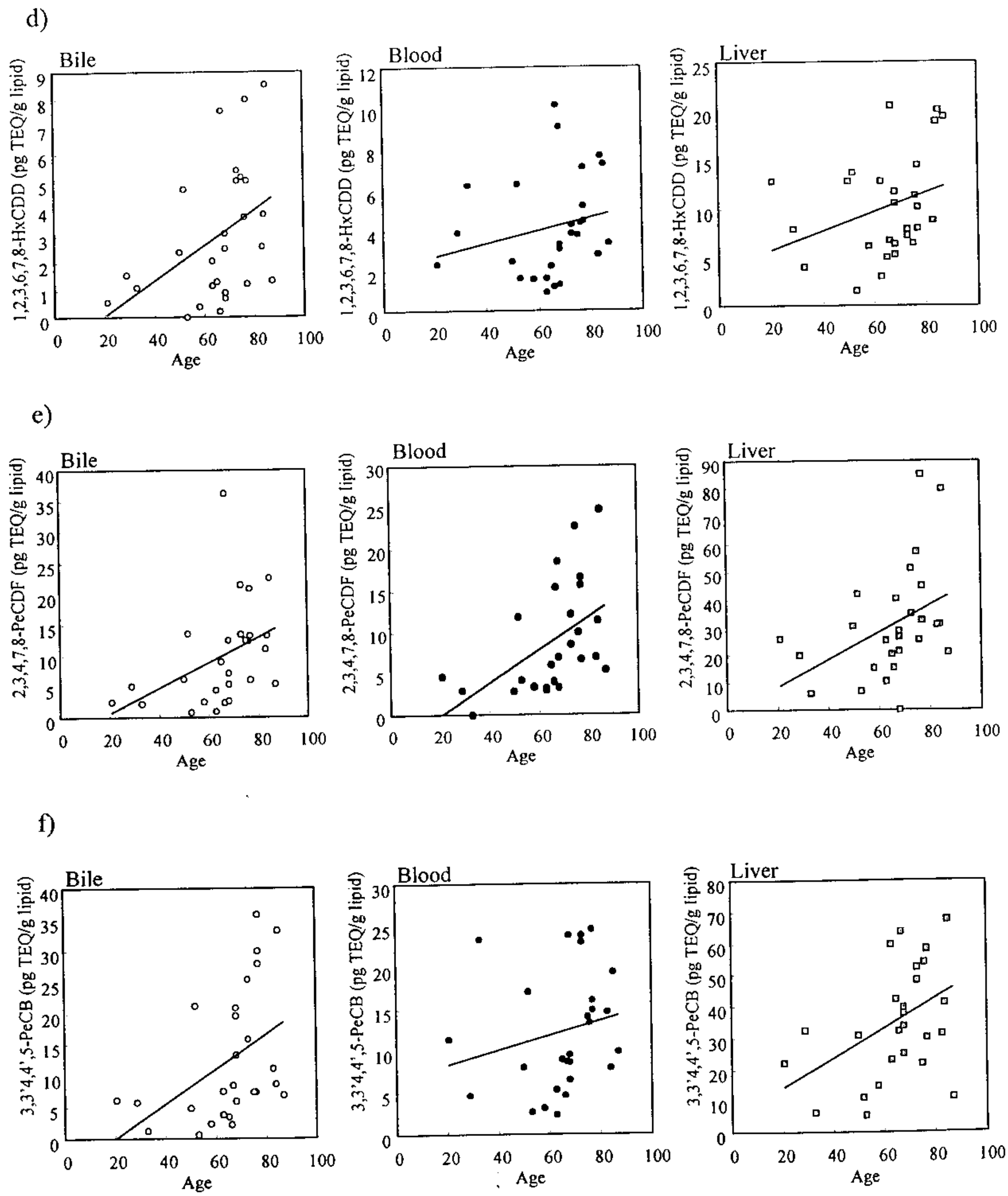

Fig. 2-2 Kitamura et al