

# 2016 SCIENTIFIC REPORT



MINISTRY OF FOOD AND DRUG SAFETY

National Institute  
of Food and Drug Safety Evaluation

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## Risk Assessment of Lead

Lead (Pb) is a common environment-derived contaminant. The public is exposed to Pb mainly through food and drinking water, and partly through soil, dust, and the atmosphere. Pb is absorbed through the digestive organs, and the degree of absorption may vary with the physicochemical state of food or Pb. The absorption of Pb is influenced by physiological factors such as age, nutrients (e.g., calcium, iron), pregnancy, and fasting, and physicochemical characteristics such as the size, solubility, and type of Pb. Certain foods have been found to reduce the absorption of water-soluble Pb compounds. In a Pb absorption experiment using radioisotopes, general adults absorbed an average of 8% Pb, while fasting people absorbed about an average of 60% Pb. The absorbed Pb mainly accumulates in soft tissues and bones. The half-lives of Pb absorbed in blood and bone are known to be 30 days and 10–30 years, respectively. Pb is excreted mainly through the urine and stool, and a very small quantity of Pb is excreted through sweat, saliva, hair, nails, and breast milk.

This risk assessment for Pb was conducted in the following four stages in accordance with the Regulations on Risk Assessment Methods and Procedures as well as the Risk Assessment Guide: Hazard identification, hazard characterization, exposure assessment, and risk characterization. The  $BMDL_{01}$  (0.50  $\mu\text{g}/\text{kg}$  bw/day) was applied as the HBGV for Pb.

Target foods were selected from the 2008–2010 (three years) Integrated Database, and this study covered 89% of the total food intakes of Koreans. Food commodities were purchased across Korea between 2012 and 2015. A total of 33,148 cases (agricultural: 11,297, livestock: 9,397, fishery: 6,630, and processed foods: 5,824) for 403 items (agricultural: 136, livestock: 20, fishery: 106, and processed foods: 141) were collected for analysis.

The analysis of Pb in food was performed using Inductively Coupled Plasma-Mass

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Spectrometry (ICP-MS), and the absence of Pb in the analyte indicated that the Pb concentration was lower than the detection limit of the assay. In risk assessment, half of the detection limit was applied to the undetected result (GEMS/Food- Euro, 1995).

The Pb detection rate in the agricultural products was 83.5%. The Pb concentration was <0.1 mg/kg in most agricultural products, and the average Pb level in agricultural products was  $0.013 \pm 0.027$  mg/kg.

The Pb detection rate in the livestock products was 75.0%. The Pb concentration was <0.05 mg/kg in most livestock products, and the average Pb level in livestock products was  $0.004 \pm 0.006$  mg/kg.

The Pb detection rate in the fishery products was 68.5%, and the average Pb level in all fishery products was  $0.082 \pm 0.186$  mg/kg.

The Pb detection rate in processed foods was 77.3%, and the average Pb level in all processed foods was  $0.016 \pm 0.073$  mg/kg.

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**Table 1.** Pb concentration

Categories	Items	Cases	Concentration Levels (mg/kg)							
			No detection cases	Detection rate (%)	Average	Deviation	Min	P50	P95	Max
Agricultural Products	136	11,297	1,869	83.5	0.013	0.027	<0.000	0.005	0.049	0.832
Livestock products	20	9,397	2,345	75.0	0.004	0.006	<0.000	0.002	0.014	0.191
Fishery products	106	6,630	2,087	68.5	0.082	0.186	<0.000	0.029	0.321	6.903
Processed foods	141	5,824	1,320	77.3	0.016	0.073	<0.000	0.004	0.048	2.996
<b>Total Foods</b>	<b>403</b>	<b>33,148</b>	<b>7,621</b>	<b>77.0</b>	<b>0.025</b>	<b>0.095</b>	<b>&lt;0.000</b>	<b>0.005</b>	<b>0.106</b>	<b>6.903</b>

\* If there is a value below the third decimal point, it is indicated as <0.000.

Results of the risk assessment show that dietary exposure to Pb remained at safe levels within the health-based guidance values (HBGVs). Average daily exposures in Korean population to Pb was 0.210 µg/kg bw/day. The contribution rates of Pb in agricultural products, fishery foods, livestock products, and processed foods were 40% (0.085 µg/kg bw/day), 29% (0.061 µg/kg bw/day), 2% (0.004 µg/kg bw/day), and 29% (0.060 µg/kg bw/day), respectively.

The margin of exposure was 2.4 when Pb exposure through foods was compared to the toxicity standard values. Among the food groups, the margin of exposure of Pb was 5.9 through agricultural products, 125 through livestock products, 8.2 through fishery products, and 8.3 through processed foods.

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**Table 2.** Pb exposure through food intake

Categories		Exposure Levels ( $\mu\text{g}/\text{kg}$ bw/day)							
		All ages	$\leq 2$ years	3–6 years	7–12 years	13–19 years	20–64 years	$\geq 65$ years	
Agricultural products	Cereals	0.014	0.031	0.028	0.022	0.014	0.012	0.018	
	Root and tuber crops	0.007	0.025	0.016	0.009	0.005	0.007	0.007	
	Beans	0.002	0.003	0.003	0.002	0.001	0.002	0.004	
	Seeds and nuts	Peanuts or nuts	<0.000	0.001	<0.000	<0.000	<0.000	<0.000	<0.000
		Seeds	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000
		Sum	<0.000	0.001	<0.000	<0.000	<0.000	<0.000	<0.000
	Fruits	Kernel fruits	0.016	0.048	0.034	0.018	0.008	0.015	0.016
		Citrus fruits	0.003	0.018	0.012	0.005	0.004	0.003	0.002
		Stone fruits	0.001	0.006	0.004	0.002	0.001	0.001	0.001
		Berries	0.005	0.022	0.014	0.006	0.003	0.005	0.002
		Tropical fruits	0.001	0.009	0.005	0.002	0.001	0.001	<0.000
		Sum	0.026	0.103	0.069	0.033	0.017	0.025	0.021
	Vegetables	Green head vegetables	0.001	0.001	0.001	0.001	0.001	0.001	0.002
		Green vegetables	0.021	0.015	0.014	0.011	0.009	0.022	0.040
		Leaf and stem vegetables	0.003	0.003	0.003	0.003	0.002	0.003	0.002
		Root vegetables	0.004	0.005	0.005	0.005	0.004	0.004	0.004
		Cucurbitaceous fruit vegetables	0.006	0.011	0.010	0.007	0.004	0.007	0.006
		Others than cucurbitaceous fruit vegetables	0.001	0.003	0.002	0.001	0.001	0.002	0.001
		Sum	0.036	0.038	0.035	0.028	0.021	0.039	0.055
	Mushrooms	<0.000	0.001	<0.000	<0.000	<0.000	<0.000	<0.000	
Livestock products	Beef	0.001	0.001	0.001	0.001	0.001	0.001	<0.000	
	Pork	0.002	0.001	0.002	0.002	0.002	0.002	<0.000	
	Other edible meats	<0.000	0	0	0	<0.000	<0.000	<0.000	
	Chicken	0.001	0.001	0.001	0.001	0.001	0.001	<0.000	
	Other poultry	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000	
	Chicken eggs	<0.000	0.001	0.001	0.001	0.001	<0.000	<0.000	
	Other eggs	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000	
	Other animals	<0.000	0	0	0	<0.000	<0.000	0	



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Categories	Exposure Levels ( $\mu\text{g}/\text{kg}$ bw/day)						
	All ages	$\leq 2$ years	3–6 years	7–12 years	13–19 years	20–64 years	$\geq 65$ years
Braised foods	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000
Liquors	0.003	<0.000	<0.000	<0.000	0.001	0.005	0.001
Dried fish and shells	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000	<0.000
Other foods	0.006	0.013	0.015	0.011	0.010	0.006	0.002
Nonstandard general processed foods	0.001	0.002	0.002	0.001	0.002	0.001	0.001
Dairy products	0.001	0.023	0.014	0.006	0.004	0.001	0.001
Processed meat products	<0.000	0.002	0.002	0.001	0.001	<0.000	<0.000

\* If there is a value below the third decimal point, it is indicated as “<0.000.” If the actual value is zero, it is indicated as “0.”

Pb absorption in the body is influenced by various factors. In particular, certain foods are known to reduce Pb absorption in the body. In addition, iron or calcium deficiency is associated with an increase in blood Pb concentrations. Thus, maintaining an adequate nutritional condition will help reduce Pb exposure.

This report is based on published research reports. Therefore, the data in this report will be reassessed when new information has been identified or when sufficient monitoring data are available.

**Key words:** Lead, Analysis, Food, Source of exposure, Exposure Level, Risk Assessment, Toxicity, Benchmark Dose, Margin of Exposure