The new-old exposure to lead: assessment of food contamination and estimation of dietary intake in a Northern Italy population

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Introduction

Lead is a heavy metals released in the environment after natural and anthropogenic activities. Since the ban of lead as fuel addictive in gasoline, lead exposure decreased in the last decades, especially from air, leaving food and water as major sources of human exposure. In this study, we aimed at characterizing lead content in foods consumed in our population in order to estimate dietary intake of these metals.

Methods

We assessed dietary habits of a Norther Italian community though the validated EPIC questionnaire, a semi-quantitative food frequency questionnaire (FFQ) specifically developed for the Central-Northern Italy population. We collected food samples during the period from October 2016 to February 2017, and we measured lead content using inductively coupled plasma-mass spectrometry. We then reported the concentrations of the investigated trace element according to the food consumption patterns and food categories typical of this Italian population, as assessed though the EPIC FFQ. We combined data on the estimated trace elements in foods and the EPIC FFQ to compute total daily element intake using the equation in Box 1. Accordingly, we estimated daily dietary lead intake for the total diet and for each food category by reporting median and interquartile ranges of intake.

$$Daily\ dietary\ exposure\ \left(\frac{\mu g}{day}\right) = \sum \frac{element\ food\ content\ \left(\frac{\mu g}{kg}\right) \times\ food\ intake\ \left(\frac{g}{day}\right)}{1000}$$

Box 1. Equation for element daily intake estimation

	Lead (µg/kg)		
Food (N)	50th	(IQR)	<LOD N (%)
Cereals (112)	7.28	(3.64 - 12.19)	7 (6.3)
Meat (86)	5.26	(2.40 - 9.56)	2 (2.3)
Milk & dairy products (72)	4.25	(1.92 - 8.35)	1 (1.4)
Eggs (9)	0.31	(0.01 - 0.86)	4 (44.4)
Fish & seafood (62)	6.20	(1.88 - 13.83)	2 (3.2)
Vegetables (201)	4.73	(1.89 - 13.28)	6 (3.0)
Legumes (43)	6.55	(1.49 - 10.90)	1 (2.3)
Potatoes (14)	3.63	(2.93 - 4.66)	0 (0.0)
Fresh fruits (60)	1.75	(0.67 - 3.09)	8 (15.4)
Dry fruits (45)	2.30	(0.01 - 4.11)	10 (27.0)
Sweets (79)	7.06	(3.58 - 15.70)	0 (0.0)
Oils and fats (23)	0.83	(0.25 - 2.64)	1 (4.3)
Beverages (102)	3.47	(0.98 - 10.44)	1 (1.0)

Table 1. Levels of lead in analyzed samples divided according to food categories. N: number of samples, IQR: interquartile range, LOD: limit of detection of 0.003 µg/kg for lead. Percentage of value below the LOD within each category.

Results

In the 908 analyzed food samples, highest lead contamination levels were found in seafood, vegetables, sweets and beverages. The estimated dietary intake was 12.94 µg/day (interquartile range-IQR 9.36-17.51 µg/day), corresponding to 0.186 (IQR 0.133-0.454) µg/kg of body weight/day, with major contribution from beverages and vegetables and cereals. Similar results were found in both sexes, with daily dietary intake of 14.13 µg/day (IQR 10.10-17.82) and 12.19 µg/day (IQR 8.97-17.36) in men and women, respectively.

	Lead Intake (µg/day)			
Food category	50th	(IQR)	95th	% Contr.
Total	12.943	(9.355 - 17.509)	30.456	100.00
Cereals	1.849	(1.240 - 2.736)	4.386	13.83
Meat	0.895	(0.579 - 1.340)	2.464	6.92
Milk & dairy products	0.376	(0.240 - 0.559)	1.062	2.94
Eggs	0.006	(0.003 - 0.009)	0.015	0.05
Fish & seafood	0.294	(0.133 - 0.574)	1.305	2.86
Vegetables	2.697	(1.776 - 4.092)	6.459	20.35
Legumes	0.104	(0.048 - 0.193)	0.408	0.94
Potatoes	0.073	(0.043 - 0.130)	0.284	0.65
Fresh fruits	0.660	(0.419 - 0.908)	1.489	4.63
Dry fruits	0.004	(0.001 - 0.013)	0.095	0.12
Sweets	0.473	(0.232 - 0.817)	1.753	4.19
Oils and fats	0.031	(0.023 - 0.042)	0.070	0.22
Beverages	3.625	(1.524 - 7.795)	20.976	42.29

Table 2. Estimates of dietary lead intake for total population according to main food categories and percentage of contribution of each category to total intake.

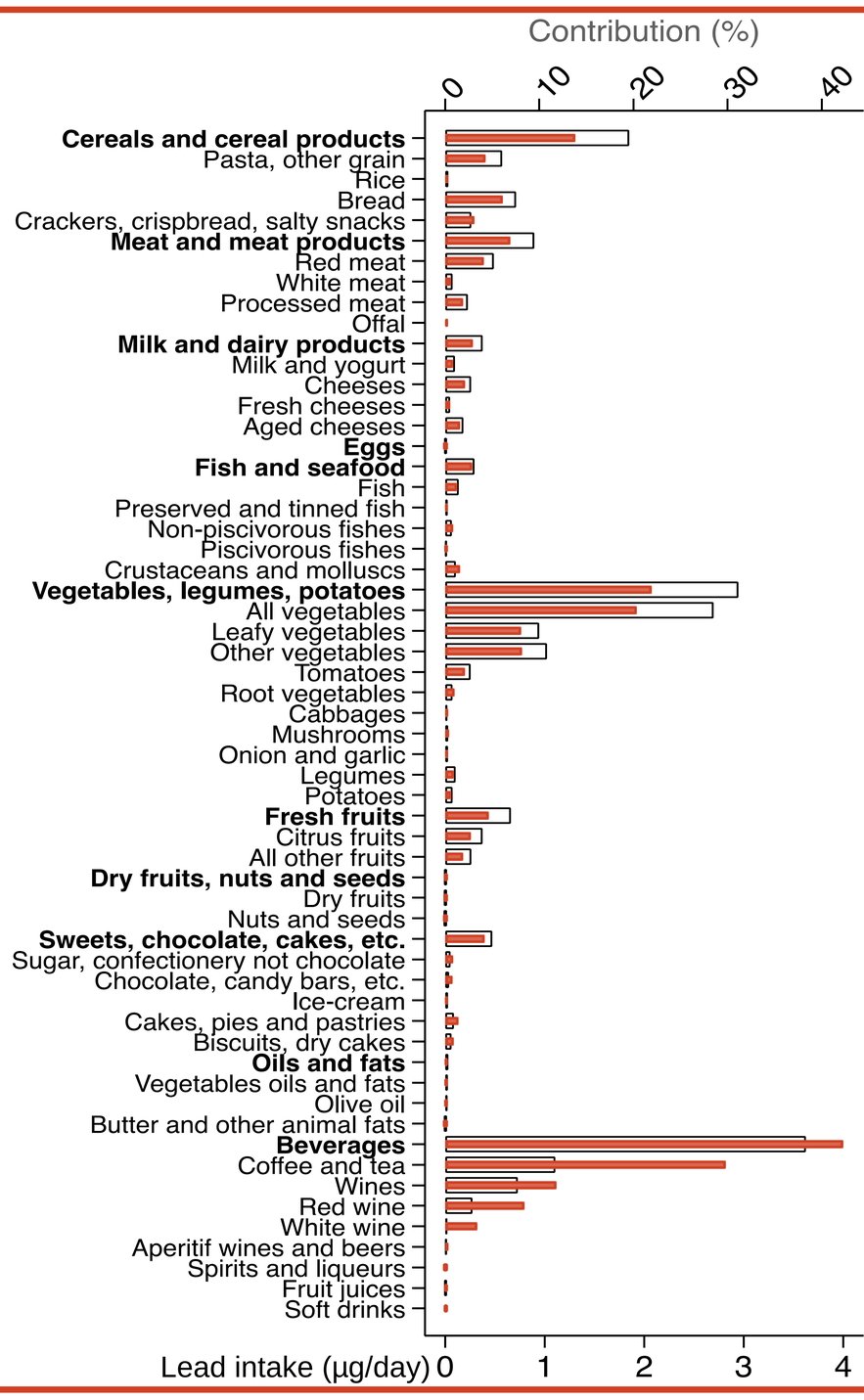

Figure 1. Levels of lead intake (red columns) and contribution of food categories to its intake (white columns).

Conclusions

Our study provides an updated assessment of lead exposure through diet in a Northern Italian community. Although environmental lead contamination and exposure has markedly decreased in the last decades, recent findings pointed out that a safety threshold value could not be established for prevention of adverse effects due to lead exposure. In our community, despite the generally low levels of intake compared with other European populations, the levels of lead intake are at still at risk for chronic renal disease and hypertension.

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