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Environmental health aspects of lead

Die gesundheitlichen Aspekte der Umweltverschmutzung durch Blei

Les problèmes sanitaires posés par le plomb présent dans l'environnement

LEAD LEVELS IN INFANT FOOD SOLD ON THE ITALIAN MARKET

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SUMMARY

Measurement of stable lead have been carried out in about 60 samples of different types of infant food sold in Italy, including formula milk, strained food, infant flours, infant drinks.

From these results, correlated with the average food assumption, the daily intake of lead has been calculated from the fourth through the twelfth month of life.

Stable lead has been measured in bones (vertebrae) of still born or infants dead during the first month as well as in adult subjects.

Utilizing a mathematical model proposed by the Authors themselves in a previous work, some hypothesis are proposed concerning the retention of stable lead.

Among the elements which nowadays are considered contaminant of the environment, lead is doubtless one of the most important, mainly due to fact of its use, in an organic form, as additive in gasoline.

In spite of the fact that only 20% of the lead produced in the world in used as gasoline additive it has been estimated that more than 98% of atmosphere contamination comes from gasoline combustion. Therefore one can say that concentration of lead in the air is strictly related with the density of motor-vehicles traffic.

Lead, once introduced in the air, falls down increasing its concentration on the soil: it has been calculated that the soil receives, on the average 1 $\mu g/cm^2$/ yr because of rain and 0,2 $\mu g/cm^2$/ yr because of fallout (1).

As a consequence the contamination of food chain becomes one of the most important sources of human lead contamination.

Schröeder and Balassa (2) carried out many measurements of lead in food finding the following values (data are on fresh-weight basis):

- Condiments	1,2 µg/g	(range 0 - 1,5)
- Fish and seafood	0,5 µg/g	(" 0,2 - 2,5)
- Meat and eggs	0,2 µg/g	(" 0 - 0,37)
- Grains	0,4 µg/g	(" 0 - 1,39)
- Vegetables	0,2 µg/g	(" 0 - 1,30)

The presence of lead in fresh milk was under the limit of detection. A continous and sistematic monitoring from 1962 in U.S.A. drinkable waters has shown the lead content is not higher than the levels fixed by U.S.A. Public Health Service, i.e. 50 µg/litre; with these data and information from other sources some Authors calculated the lead intake with food (3) is about 300 ug daily.

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METHODS

The following infant food types, sold on the Italian market have been analysed as shown in table 1.

We have tried to cover, as far as possible, the different types of infant food, used during the first year of life, particulary during and after weaning.

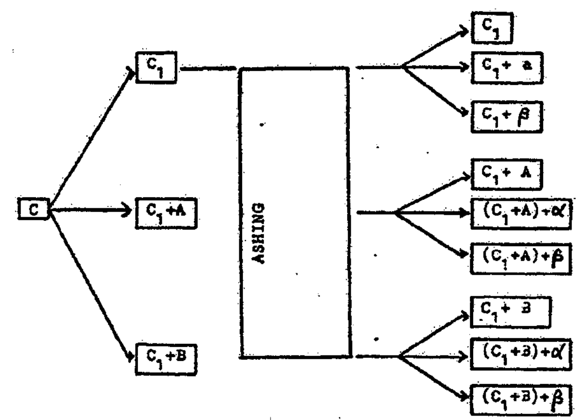
Therefore we chose the most widespread types so that the results might be as far as possible representatives. 15 Samples of milk powder coming from the archives of a Factory, produced in an area around Parma from june 1952 throung march 1966, were also examined as well as milk samples produced in the area around Pavia from 1964 trough 1971.

Eventually Lead has been measured in bone (vertebrae) ashes of human subjects and still born of the Milano area.

All the measurements were carried out by an atomic absorption Spectrophotometer (Atomsorb, Jarrell Ash.) with a Westinghouse hollow cathode lamp.

As for milk powder and flour 50g. were taken from their containers; for strained food and infant drinks all the content was taken. These amounts were ashed in a furnace at 450°C then dissolved in 5 ml. of concentrated HNO_3 and left in the furnace as far as ashes were completely white. Then 5 ml. of HCl 1:1 were added to the ashes which were heated, filtered and trasferred to a 25 ml volumetrie flask and diluted to the mark with distilled water.

Lead was determined on this solution by the addition method. In order to verify possible lead losses during ashing in the different groups of samples (milks, flours etc.) we operated as shown below:



C = Sample to be analysed
C_1 = Subquantities of sample
A = α = 2,5 ppm of Pb
B = β = 5,0 ppm of Pb

Supposing that during ashing there are no lead losses the following equations are expected to be obtained.

$$\boxed{C_1 + A} = \boxed{C_1 + \alpha}$$

$$\boxed{C_1 + B} = \boxed{C_1 + \beta} = \boxed{C_1 + A + \alpha}$$

$$\boxed{(C_1 + B) + \alpha} = \boxed{(C_1 + A) + \beta}$$

The results gave a confirmation to the above mentioned hypothesis.

RESULTATS AND DISCUSSION

The results are shown in table 2 - 3 - 4 and 5. The values are in the range referred by other Authors. As for infant formula milk the values are about four times higher than those produced in the Cincinnati (U.S.A.) area. On the basis of the average values of the examined different food types and of food consuption data in the 1st year of life, has been calculated the lead daily intake.

In the second half-year the average is of about 260 µg. a day i.g. about four times the daily intake calculated for adults by Morse and Welford.

The Lead intake during infancy is the benning of the accumulation in the body described by the following equation:

$A = a + b\,(t - c)^{n}$

where:

A is the concentration of Po-210 in pCi/gCa

t is the age of cattle in months

a,b,c,n, are parametres whose values are 0,49;0,068;-5;0,37 respectively.

From this equation it appears that lead has an affinity for bone higher than that of calcium. Should this hypothesis be true for human bones at different ages should correspond to a similar curve, with, of curse, different values for the above said parametres depending on the different phisiological conditions between human and cattle and on the fact that the curve for cattle is referred to Pb-210 and for human subjects to stable lead.

Nevertheless a great similarity of the trend could be demonstrated even if the two curves had in common the parameter n only. Actually the ratio between lead concentration in infant and adult males bones seems to give a confirmation to such an hypothesis. We ought to point out, however, that due to the small number of the subjects examined, it was impossible to obtain a representative curve for cohorts.

On the other hand, the values published by Schroeder and Tipton (9) can't be used to draw a curve, even if they confirm the accumulation of lead according to the age, both for deficiencies in statistical elaboration of the results and the fact that the values themselvas refer to different population chatacterized by different food habits.

The different accumulation of Ca and Pb in human body brings to think that there is a different behaviour between elements which play physiological functions in the body and the ones for which the funcions are not known. The latters, like Pb and Sr, can't completely follow the homeostatic mechanisms and therefore accumulate in the organism (bone), while Ca is practically constant throughout life. This remark could be kept in mind as one of the fact which could explain the cellular process of ageing.

Table 1 - Infant food types analysed.

Food	n° prpducers	n° products
1 - milk powder	7	16
2 - infant flours	7	13
3 - strained meats	4	8
4 - strained fruits	5	9
5 - beverages	2	7

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Table 2 - Pb in infant foods.

Flours			strained meat			strained fruit			fruit juices		
n°	Pb µg/gr dry		n°	Pb µg/gr fresh		n°	Pb µg/gr fresh		n°	Pb µg/gr fresh	
1	1,4		1	0,75		1	0,2	(0,2)	1	0,1	
2	0,9		2	0,45		2	0,8	(0,8)	2	0,4	
3	1,2		3	0,65		3	<0,1	(<0,1)	3	<0,1	(<0,1)
4	1,5		4	0,75		4	<0,1		4	<0,1	(<0,1)
5	1,8		5	0,55		5	2,0		5	<0,1	
6	0,5		6	0,40	(0,40)	6	<0,1	(<0,1)	6	<0,1	
7	0,7		7	0,40	(0,35)	7	<0,1		7	<0,1	
8	1,0	(0,9)	8	0,40	(0,40)	8	<0,1				
9	0,9	(0,9)	average	0,54 ± 0,12		9	0,3				
10	1,5										
11	0,1	(0)									
12	2,4	(1,5)									
13	1,6										
average	1,2 ± 0,4										

(The values in brackets are refered to a second analysis)

Table 3 - Pb in infant formula milk.

1971			1952-1966		
n°	Pb µg/gr dry		n°	Pb µg/gr dry	Year
1	1,5	(1,5)	1	2,1	1952
2	2,3	(2,3)	2	2,1	1954
3	2		3	2,4	1955
4	1,5	(1,5)	4	2,1	1956
5	2,3		5	2,6	1957
6	1,3	(1,3)	6	2,6	1958
7	2		7	2,9	1959
8	1,8		8	2,6	1960
9	1,5	(1,5)	9	2,1	1963
10	1,2		10	2,1	1963
11	2	(1,9)	11	2,1	1964
12	2		12	1,6	1965
13	2,1		13	2,1	1965
14	1,8		14	1,6	1966
15	1,6		15	1,6	1966
16	2,4				
average	1,8 ± 0,4				

(The values in brackets are refered to a second analysis)

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Table 4 - Pb in milk produced in the area of Pavia (Italy). (The measures have been carried out in pools of about 50 samples collected during the single weeks of the year).

Year	µg/gr ash	µg/gr liter	µg/gr dry*
1964	27,8	200	1,6
1965	28,1	202	1,6
1966	35,0	255	2,1
1967	34,4	247	2,0
1968	34,4	247	2,0
1969	37,5	266	2,2
1970	34,4	278	2,3
1971	32	230	1,9

* A dry residue of 120 g/liter has been considered

Table 5 - Pb in human bone samples (area of Milano).

Adults			Infants		
Year	Age (years)	µg/gr ash	Year	Age (days)	µg/gr ash
1967	46 male	106,2	1967	<20 (4)	43,7
1967	62 "	125,0	1967	<20 (7)	43,7
1967	54 "	137,5	1968	<20 (11)	51,2
1969	31 female	56,2	1968	<20 (5)	52,5
1969	64 "	63,7	1969	<20 (7)	43,7
			1969	<20 (12)	50,0

(in brackets n° of samples of the pools analysed)

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Table 6 - Daily intake of lead from 4th to 12th month of life.

	Daily intake: Food (g.)	Daily intake: Pb (µg.)	
4° month			
milk	640	138	
rice flour	15	18	
strained meat	30	16	tot. 172
5° month			
milk	640	138	
infant flours	25	30	
strained milk	100	54	tot. 222
6° month			
milk	510	110	
infant flours	50	60	
strained meat	100	54	tot. 224
7°-8° months			
milk	600	130	
strained meat	100	54	
flours and biscuits	50	60	tot. 244
9°-12° months			
milk	650	140	
strained meat	120	65	
flours and biscuits	70	84	tot. 289

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