

## LEAD EXPOSURE: ASSESSMENT OF THE RISK FOR THE GENERAL ITALIAN POPULATION

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**Summary.** - According to the regulations contained in the presidential decree DPR 496/82 certain Italian regions have carried out investigations - based on the blood lead level measurement - for the biological surveillance of the general population against the risk of saturnism. A work-group from the Istituto Superiore di Sanità (Italian National Institute of Health) coordinated the activity of the various centers and organized an appropriate quality control program to guarantee the quality of the analytical data collected. A total of 8635 subjects (4864 females and 3771 males) have been examined, 1968 of which (1058 females and 910 males) were under 14 years of age. The median values of the observed blood lead levels were, for the adults, 153  $\mu\text{g/l}$  in males and 100  $\mu\text{g/l}$  in females; and, for the children, 94  $\mu\text{g/l}$  in males and 86  $\mu\text{g/l}$  in females. The reference limit decreed by law for the 98th percentile is exceeded by the adult-males group, while both limits, at the 90th and 98th percentiles are exceeded by the population residing in the Portofino (CA) municipality. Our investigation confirms the correlation between blood lead levels, alcohol consumption, and cigarette smoking: in both sexes and in all age groups (except for females 15-25 years of age) a positive correlation of blood lead levels with alcohol consumption and cigarette smoking is clearly evident. The association of blood lead levels with alcohol seems to be stronger than that with cigarette smoking. The comparison with the results of previous investigations shows a 25% reduction of blood lead levels in the general Italian population during the 1979-1985 period.

**Riassunto** (Rischi da esposizione al piombo per la popolazione italiana). - In seguito alle disposizioni del DPR 496/82, in alcune regioni italiane sono state effettuate indagini per la sorveglianza biologica della popolazione contro il rischio di saturnismo, basate sulla misura del livello di piombo nel sangue. Un gruppo di lavoro dell'Istituto Superiore di Sanità ha coordinato le operazioni dei vari centri e organizzato un idoneo programma di controllo di qualità al fine di assicurare la qualità dei dati analitici raccolti. In totale sono stati esaminati 8635

soggetti (4864 femmine e 3771 maschi), dei quali 1968 di età inferiore ai 14 anni (1058 femmine e 910 maschi). I valori mediani della piombemia osservati erano, per gli adulti, di 153  $\mu\text{g/l}$  per i maschi e 100  $\mu\text{g/l}$  per le femmine; per i bambini di 94  $\mu\text{g/l}$  per i maschi e 86  $\mu\text{g/l}$  per le femmine. Il limite di riferimento fissato dalla normativa per il 98° percentile risulta tuttavia superato per il gruppo dei maschi adulti, mentre entrambi i limiti, per il 90° e per il 98° percentile, sono superati nel caso della popolazione residente nel comune di Portofino (CA). La correlazione tra valori di piombemia, consumo di alcool etilico e abitudine al fumo risulta confermata anche in questa indagine. In entrambi i sessi e in tutte le classi di età (tranne che per le femmine tra i 15 e i 25 anni) risulta evidente una correlazione positiva della piombemia sia con il consumo di alcool che con l'abitudine al fumo. L'associazione piombemia-alcool sembra essere più stretta di quella piombemia-fumo. Il confronto con i risultati di precedenti indagini indica una diminuzione dei livelli di piombemia per la popolazione italiana di circa il 25% nel periodo 1979-1985.

### Introduction

In the recent past, by voluntarily applying the guidelines from the European Community Council, two surveys have been performed, in different regions of the national territory on a limited number of subjects [1, 2], to assess the lead exposure level in the general Italian population in order to collect information to plan preventive measures.

According to the regulations contained in the Presidential Decree, DPR no. 496/82, a new investigation has been performed as a part of programs already planned by a certain number of regions (coordinated by a working group from the Istituto Superiore di Sanità): screening activities were carried out mainly during 1985 [3].

In this article, we will only outline a concise picture of the Italian situation concerning the blood lead levels and the main risk factors associated with them, as it results

from an exhaustive cumulative analysis of the data (already described in detail elsewhere [3]) obtained by the different regional collaborating centres.

## Methods

The population sampling procedures, chosen by the different collaborating centres, have been described elsewhere [3]. In all cases it was ascertained that the sample group was representative of the population from which it was selected.

Blood samples were collected in a standard way by all centres; the equipment used was free from lead contamination.

Blood tests to determine the blood lead levels were performed by different laboratories, chosen by the regions on the basis of their quality standards, resulting from the participation in the Interlaboratorial Quality Assurance Program (IQAP) promoted by the Istituto Superiore di Sanità [4, 5]. The participation of the laboratories in the quality control program continued through the whole screening phase, and also for a subsequent period.

For the blood lead level measurements, all laboratories have used atomic absorption spectrometry with electrothermal atomization.

Personal information for each subject and distinctive features for each population group and geographical area were collected by administering a standardized questionnaire (Appendix 1).

The participating regions, the residence areas of the population, the examined groups and the collaborating laboratories are listed in Table 1.

## Results

### *Regional distribution of the tested subjects*

The distribution of the tested subjects by region and by exposure category is shown in Table 2. Subjects were classified as "exposed", according to the classification adopted in previous studies, if they were (or had been) involved in an occupation at risk, or if - for this reason - they were (or had been) under medical control. These subjects are included only in Table 2: all the other tables, therefore, will include exclusively the subjects classified as "not exposed".

The distribution of the tested subjects by region and sex, and the sex ratio, is shown in Table 3.

Table 4 shows the cumulative distribution of the tested subjects by age and sex, and the sex ratio.

### *Cumulative distribution of the blood lead levels*

Median values, some percentiles of interest (90th, 98th, 97.5th, 2.5th), and blood lead levels range (minimum and maximum), for children (males and females) and adults

(males and females) respectively, are shown in Table 5 and 6. Blood lead levels by age group, in the adults, are shown in Table 7 (males) and Table 8 (females).

Fig. 1 through 12 show the charts in which the blood lead (PbB) levels are plotted for: male children; female children; all male adults; all female adults; males, 15-25 yrs; males, 16-39 yrs; males 40-55 yrs; males, > 55 yrs; females, 15-25 yrs; females, 26-39 yrs; females, 40-55 yrs; and females, > 55 yrs.

From the data available from Tables 5-8 and the charts of Figs 1-12, it is possible to point out immediately that:

- a) the blood lead level of the adult males, at the 98th percentile, exceeds the reference limit (350 µg/l) decreed by the DPR 496/82 as the maximum tolerable level for the general population;
- b) a marked increase in blood lead levels of males, as compared to that of females, is present for all adult age groups;
- c) the trend for higher blood lead levels in males can already be observed in children (0-14 age group);
- d) a sharp increase of blood lead levels occurs with age, both in males and females.

### *Distribution of blood lead levels by region*

Tables 9-12 show parameters of interest (median, percentiles, minimum, maximum) for the blood lead levels measured in the different regions in males ≤ 14 yrs; males > 14 yrs; females ≤ 14 yrs; and females > 14 yrs, respectively.

In Table 9, it can be easily observed how the blood lead levels measured in children, both males and females, in the Sardinia region, are distinctly higher than those measured in the other regions. It must be specified that the high reported values of Sardinia have been caused by the exceedingly high levels observed in the representative sample of children from Portoscuso (a town in the Cagliari province). These values, at the 98th percentile, are even higher than the reference limit for the general population, according to the Italian law.

In Table 10, it has to be pointed out that the blood lead levels for the adult males at the 98th percentile in Lombardy, Emilia-Romagna, Sardinia, and Latium (Rome) exceed the reference limit decreed by the Italian law. As far as Sardinia is concerned, the worrisome, extremely high values at the 90th and 98th percentile (412 µg/l vs the reference limit of 300 µg/l, and 608 µg/l vs 350 µg/l, respectively) are again caused by the values observed in the population sample of Portoscuso.

### *Variables positively correlated with blood lead levels: alcohol and cigarette smoke*

The data presented clearly demonstrate, as in previous investigation [1, 2] the strong correlation of blood lead levels with age and sex. Therefore, it was important to analyze the data to confirm and to better quantify also the possible correlation between blood lead levels, ethyl alcohol consumption and smoking habit.

Table 1. - *Participating regions, residence areas of the study population examined groups and collaborating laboratories*

Region	Area	Groups	Laboratories
Friuli-Venezia Giulia	Trieste	Adults	Toxicological lab., USL 1, Trieste
Trentino-Alto Adige	Bolzano	Adults	Provincial chemical lab., Bolzano
Lombardy	Milan, Pavia, Brescia, Gardone Val Trompia, Monza, Cinisello Balsamo, Vigevano	Adults + Children	PMIP USL 75, Milan; PMIP USL 77, Pavia; PMIP USL 41, Brescia
Liguria	Sanremo	Adults	LIP Chemical Section, USL 3, Imperia
Veneto	Belluno, Padua, Verona, Treviso, Cittadella, Costa Rovigo, Fumane, Mestre, Montebelluna, Montebelluna, Solzano	Adults + Children	PMIP, Chemical and Envi- ronmental Sec., Venice; PMIP, Chemical and Envi- ronmental Sec., Verona
Emilia-Romagna	Bologna, Casola Valsenio, Castel Bolognese, Faenza, Scandiano, Sassuolo	Adults + Children	PMIP USL 28, Bologna; PMIP USL 35, Ravenna; Toxicological lab., USL Scandiano and Sassuolo
Sardinia	Cagliari, Portofino, Settimo S. Pietro	Adults + Children	USL, Cagliari
Latium	Rome	Adults + Children	USL, Rome

USL = Unità Sanitaria Locale (Local health authority)

PMIP = Presidio Multizonale di Igiene e Prevenzione (Multi-district unit of hygiene and prevention)

LIP = Laboratorio di Igiene e Profilassi (Laboratory of hygiene and prophylaxis)

Table 2. - *Distribution by region and by exposure category of the study population*

Region	Study population		"Not exposed"		"Exposed" (*)
	n	%	n	%	n
Lombardy	2117	22.4	2099	24.3	18
Trentino-Alto Adige	204	2.2	174	2.0	30
Veneto	2663	28.1	2551	29.5	112
Friuli-Venezia Giulia	1194	12.6	1096	12.7	98
Liguria	153	1.6	149	1.7	4
Emilia-Romagna	1575	16.6	1436	16.6	139
Latium	1198	12.0	774	9.0	424
Sardinia	366	3.9	365	4.2	1
<b>Total</b>	<b>9470</b>	<b>100.0</b>	<b>8644</b>	<b>100.0</b>	<b>826</b>
<b>%</b>	<b>100.0</b>	<b>91.3</b>	<b>8.7</b>		

(\*) Subjects have been classified as "exposed" if they were (or had been) involved in an occupation at risk, or if they were (or had been) under medical control for risk of saturnism. These subjects are included only in Table 2: all the other tables, therefore, will include exclusively the subjects classified as "not exposed"

Table 3. - *Distribution by region, by sex and sex ratio of the tested subjects*

Region	Tested subjects		Males		Females		M/F
	n	%	n	%	n	%	
Lombardy	2099	24.3	844	22.4	1255	25.8	0.673
Trentino-Alto Adige	174	2.0	141	3.7	33	0.7	4.273
Veneto	2551	29.5	1108	29.4	1443	29.6	0.768
Friuli-Venezia Giulia	1096	12.7	441	11.7	655	13.4	0.673
Liguria	149	1.7	70	1.8	79	1.6	0.886
Emilia-Romagna	1436	16.6	560	14.8	876	18.0	0.639
Latium	774	9.0	438	11.6	336	6.9	1.304
Sardinia	365	4.2	172	4.6	193	4.0	0.891
<b>Total</b>	<b>8644</b>	<b>100.0</b>	<b>3774</b>	<b>100.0</b>	<b>4870</b>	<b>100.0</b>	<b>0.775</b>

Table 4. - Distribution by age, by sex and sex ratio of the tested subjects

Age group (yrs)	Tested subjects		Males		Females		M/F
	n	%	n	%	n	%	
0-14	1970	22.8	911	24.1	1059	21.7	0.860
15-25	957	11.1	385	10.2	572	11.7	0.673
26-39	2108	24.4	794	21.0	1314	27.0	0.604
40-55	2029	23.5	919	24.4	1110	22.8	0.828
> 55	1580	18.3	765	20.3	815	16.7	0.939
Total	8644	100.0	3774	100.0	4870	100.0	0.775

Table 5. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in children (0-14 yrs), by sex

Sex	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
Males	910	94	139	206	51	197	360	20
Females	1058	86	125	180	45	173	371	8

Table 6. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in adults (>14 yrs), by sex

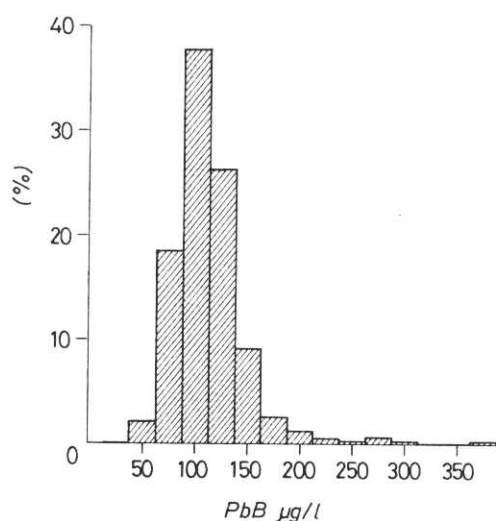
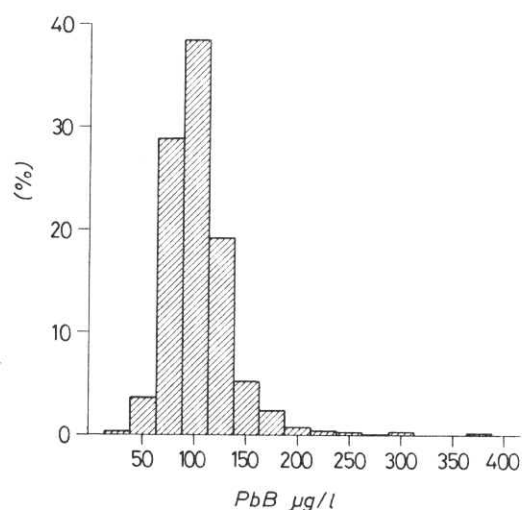
Sex	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
Males	2861	153	268	373	71	360	729	28
Females	3806	100	168	245	48	234	550	25

Table 7. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in male adults, by age group

Age group (yrs)	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
15-25	385	124	193	280	60	265	484	47
26-39	793	143	244	365	71	360	729	28
40-55	919	166	281	394	79	374	631	45
> 55	764	170	289	394	79	371	608	50

Table 8. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in female adults, by age group

Age group (yrs)	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
15-25	571	86	138	180	44	179	232	32
26-39	1314	91	150	216	46	200	548	25
40-55	1107	103	180	279	52	264	450	30
> 55	814	119	198	285	56	265	550	31

Fig. 1. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) in male children.Fig. 2. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) in female children.

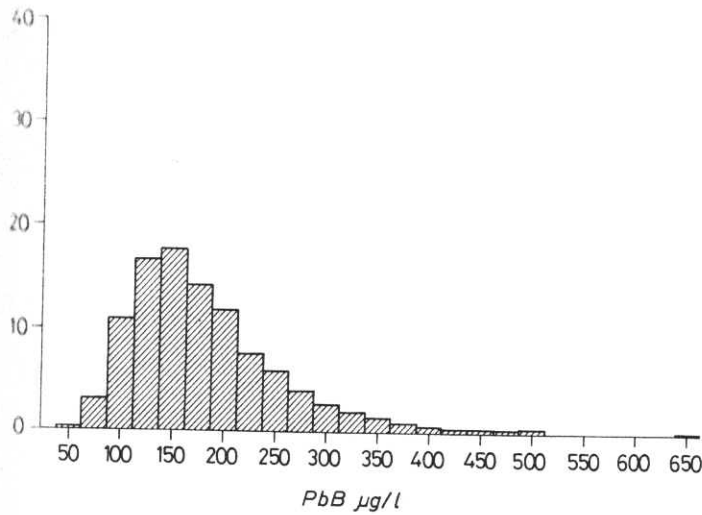


Fig. 3. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) in male adults.

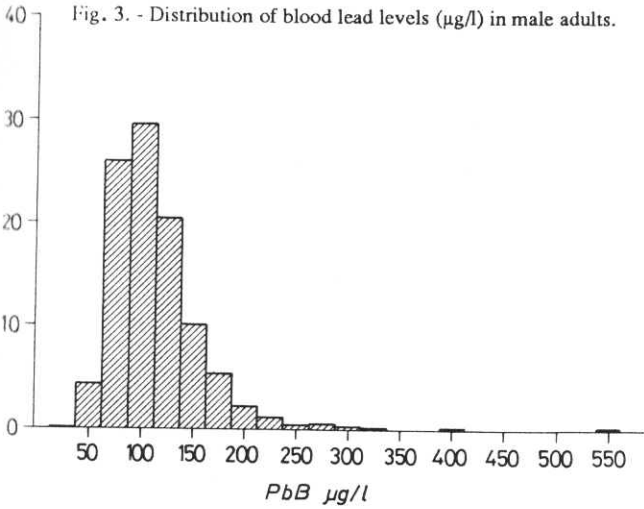


Fig. 4. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) in female adults.

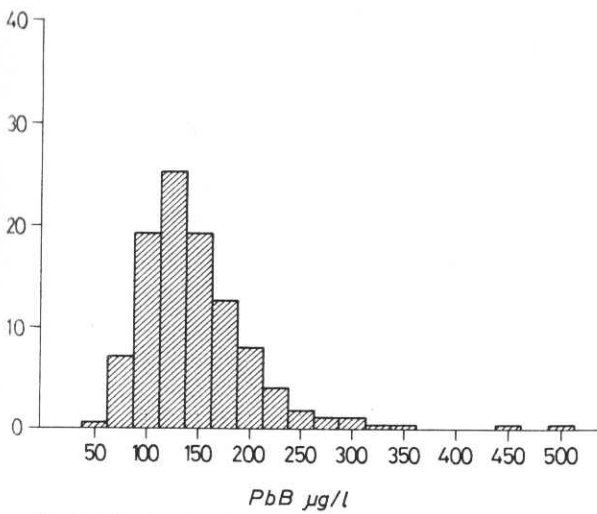


Fig. 5. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: males, 15-25 yrs.

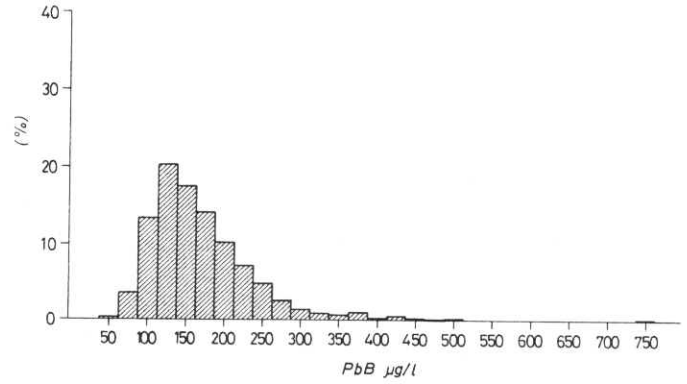


Fig. 6. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: males, 26-39 yrs.

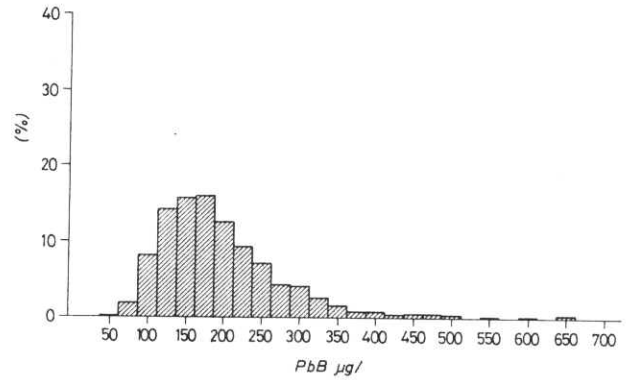


Fig. 7. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: males, 40-55 yrs.

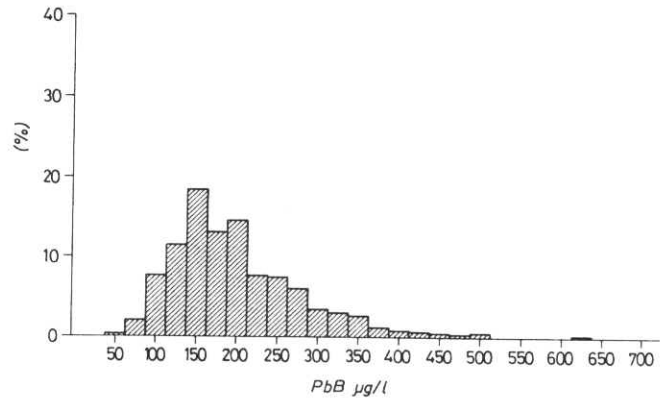


Fig. 8. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: males, > 55 yrs.

Table 9. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in male children (0-14 yrs), by region

Region	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
Lombardy	277	99	136	179	56	179	329	41
Trentino-Alto Adige	-	-	-	-	-	-	-	-
Veneto	571	91	130	157	49	154	228	20
Friuli-Venezia Giulia	-	-	-	-	-	-	-	-
Liguria	-	-	-	-	-	-	-	-
Emilia-Romagna	-	-	-	-	-	-	-	-
Latium	7	80	115	115	60	115	115	60
Sardinia	55	140	275	360	65	360	360	54

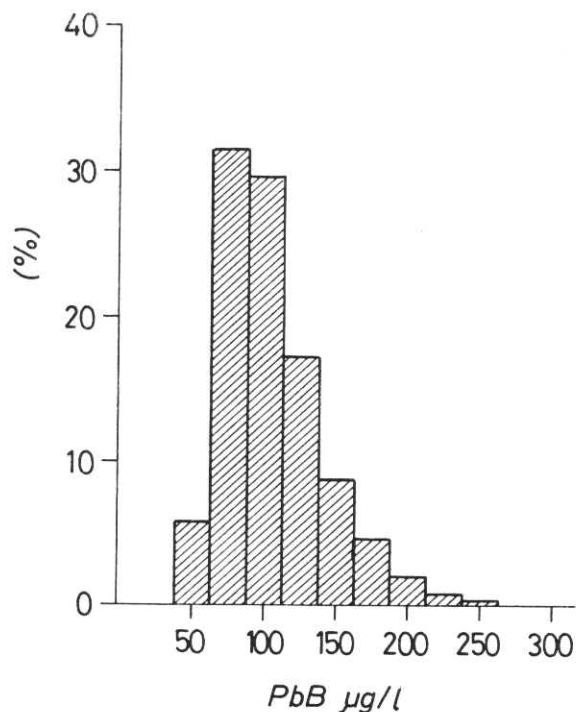


Fig. 9. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: females, 15-25 yrs.

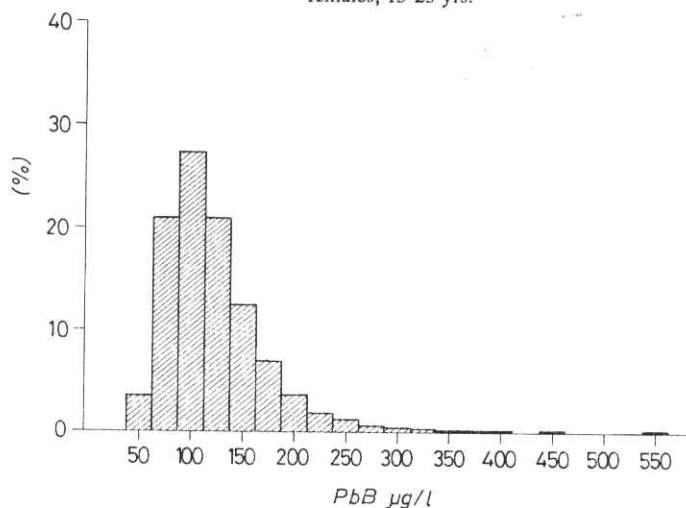


Fig. 10. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: females, 26-39 yrs.

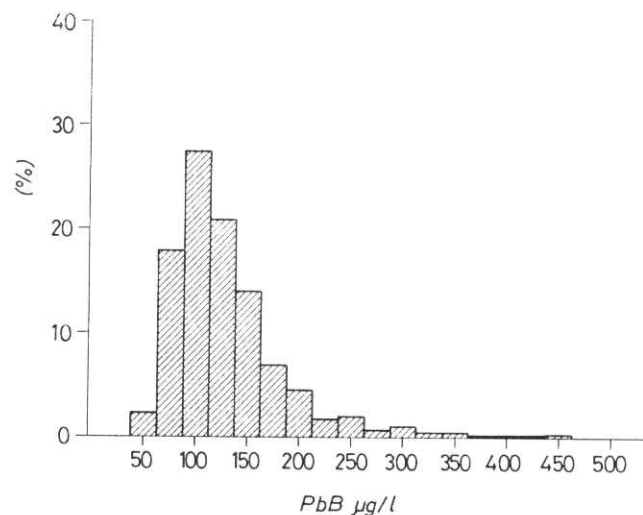


Fig. 11. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: females, 40-55 yrs.

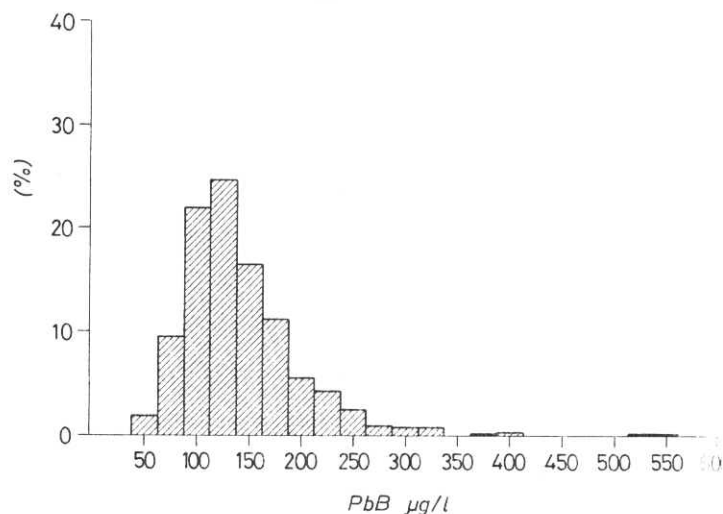


Fig. 12. - Distribution of blood lead levels ( $\mu\text{g/l}$ ) by sex and by age group: females, > 55 yrs.

Table 10. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in male adults (>14 yrs), by region

Region	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
Lombardy	566	176	293	377	87	367	594	56
Trentino-Alto Adige	141	125	200	280	60	280	300	50
Veneto	536	143	250	337	67	330	627	53
Friuli-Venezia Giulia	441	143	247	343	68	339	460	49
Liguria	69	145	247	276	45	276	311	28
Emilia-Romagna	560	164	272	371	70	358	500	50
Latium	431	143	245	380	75	372	500	59
Sardinia	117	177	412	608	92	608	729	86

Table 11. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in female children (0-14 yrs), by region

Region	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
Lombardy	425	93	130	175	54	174	247	8
Trentino-Alto Adige	-	-	-	-	-	-	-	-
Veneto	565	78	113	131	44	131	289	20
Friuli-Venezia Giulia	-	-	-	-	-	-	-	-
Liguria	-	-	-	-	-	-	-	-
Emilia-Romagna	-	-	-	-	-	-	-	-
Latium	5	90	110	110	70	110	110	70
Sardinia	63	108	206	369	55	360	371	49

Table 12. - Blood lead levels ( $\mu\text{g/l}$ ): median values, percentiles of interest and range in females adults (>14 yrs), by region

Region	Tested subjects	Median	90.0	98.0	2.5	97.5	max.	min.
Lombardy	830	121	197	285	56	265	550	38
Trentino-Alto Adige	33	65	125	220	40	220	220	40
Veneto	877	89	143	230	48	217	390	32
Friuli-Venezia Giulia	652	92	140	217	47	206	341	31
Liguria	78	111	171	286	30	286	375	25
Emilia-Romagna	876	96	163	231	46	224	434	31
Latium	330	100	158	243	52	226	295	38
Sardinia	130	127	212	327	50	242	548	40

Table 13. - Adults (&gt;14 yrs): distribution by smoking habit

Smoking habit (no. cigarettes/day)	Tested subjects		Males		Females	
	n	%	n	%	n	%
Non smokers	4446	66.6	1718	60.0	2728	71.6
< 6	492	7.4	179	6.3	313	8.2
6-10	454	6.8	190	6.6	264	6.9
11-20	850	12.7	459	16.0	391	10.3
> 20	432	6.5	317	11.1	115	3.0

Table 14. - Adult males (&gt;14 yrs): distribution by smoking habit and by age group

Smoking habit (no. cigarettes/day)	Age group (yrs)							
	15-25		26-39		40-55		> 55	
	n	%	n	%	n	%	n	%
Non smokers	237	61.6	444	55.9	535	58.2	502	65.6
< 6	33	8.6	48	6.1	60	6.5	38	5.0
6-10	24	6.2	55	6.9	56	6.1	55	7.2
11-20	75	19.5	135	17.0	144	15.7	105	13.7
> 20	16	4.2	112	14.1	124	13.5	65	8.5
Total	385		794		919		765	

Table 13 presents the distribution by smoking habit in the subjects of age > 14 yrs, while Tables 14 and 15 present the smoking habit distributions by age group in males and females, respectively. Tables 16 and 17 show the alcohol consumption distributions by age group in males and females, respectively. Subjects who report a daily consumption of ethyl alcohol < 50 g are classified as "moderate drinkers".

Tables 18 and 19 show the blood lead levels by age group, smoking habit, and alcohol consumption in males and females, respectively.

A positive correlation of blood lead levels is evident, both with alcohol consumption and with smoking habit, for both sexes and for all age groups (except for females 15-25 yrs). The association between blood lead levels and alcohol seems to be stronger than that between blood lead levels and smoke.

Table 15. - *Adult females (>14 yrs): distribution by smoking habit and by age group*

Smoking habit (no. cigarettes/day)	Age group (yrs)							
	15-25		26-39		40-55		> 55	
	n	%	n	%	n	%	n	%
Non smokers	396	69.2	806	61.3	834	75.1	692	84.9
< 6	56	9.8	138	10.5	71	6.4	48	5.9
6-10	56	9.8	104	7.9	71	6.4	33	4.1
11-20	54	9.4	206	15.7	100	9.0	31	3.8
> 20	10	1.8	60	4.6	34	3.1	11	1.4
<b>Total</b>	<b>572</b>		<b>1314</b>		<b>1110</b>		<b>815</b>	

Table 16. - *Adult males (>14 yrs): distribution by alcohol consumption and by age group*

Alcohol consumption	Age group (yrs)							
	15-25		26-39		40-55		> 55	
	n	%	n	%	n	%	n	%
Non-drinkers	200	51.9	199	5.1	192	20.9	164	21.4
Moderate drinkers (*)	132	34.3	296	37.3	324	35.3	284	37.1
Drinkers	53	13.8	299	37.7	403	43.9	317	41.4
<b>Total</b>	<b>385</b>		<b>794</b>		<b>919</b>		<b>765</b>	

(\*) Subjects who report a daily consumption of ethyl alcohol < 50 g are classified as "moderate drinkers"

Table 17. - *Adult females (>14 yrs): distribution by alcohol consumption and by age group*

Alcohol consumption	Age groups (yrs.)							
	15-25		26-39		40-55		> 55	
	n	%	n	%	n	%	n	%
Non-drinkers	390	68.2	589	44.8	492	44.3	336	41.2
Moderate drinkers (*)	176	30.8	639	48.6	524	47.2	421	51.7
Drinkers	6	1.0	86	6.5	94	8.5	58	7.1
<b>Total</b>	<b>572</b>		<b>1314</b>		<b>1110</b>		<b>815</b>	

(\*) Subjects who report a daily consumption of ethyl alcohol < 50 g are classified as "moderate drinkers"

Table 18. - *Geometric means of the blood lead levels, in the adult males; distribution by smoking habit and by alcohol consumption*

Smoking habit (no. cigarettes/day)	Non-drinkers		Alcohol consumption Moderate drinkers		Drinkers	
	PbB µg/l	n	PbB µg/l	n	PbB µg/l	n
<b>Age group: 15-25 yrs</b>						
Non-smokers	113.8	147	118.6	71	156.3	19
< 6	112.5	11	143.2	19	148.3	3
6-10	115.3	10	138.7	8	137.4	6
11-20	124.7	27	140.3	27	149.3	21
> 20	152.8	5	163.3	7	175.8	4
<b>Age group: 26-39 yrs</b>						
Non-smokers	111.9	110	132.1	170	162.2	163
< 6	115.6	7	149.3	24	177.0	17
6-10	132.1	15	123.9	21	175.0	19
11-20	132.7	35	150.7	49	181.6	51
> 20	141.6	31	159.2	32	203.9	49

Table 18. - (continued)

Smoking habit (no. cigarettes/day)	Non-drinkers		Alcohol consumption Moderate drinkers		Drinkers	
	PbB µg/l	n	PbB µg/l	n	PbB µg/l	n
Age group: 40-55 yrs						
Non-smokers	132.7	107	148.3	202	177.4	226
< 6	146.2	11	178.6	26	199.5	23
6-10	143.5	10	149.6	18	191.0	28
11-20	152.1	30	175.4	47	221.3	67
>20	153.1	34	167.1	31	216.3	59
Age group: >55 yrs						
Non-smokers	138.7	101	156.3	204	197.7	197
< 6	165.6	7	149.6	14	160.7	16
6-10	121.1	14	172.6	22	195.9	19
11-20	145.9	26	180.7	27	200.4	52
>20	144.2	15	184.5	17	231.7	33

n = number of subjects

PbB = blood level

Table 19. - Geometric means of the blood lead levels, µg/l, in the adult females; distribution by smoking habit and by alcohol consumption

Smoking habit (no. cigarettes/day)	Non-drinkers		Alcohol consumption Moderate drink		Drinkers	
	PbB µg/l	n	PbB µg/l	n	PbB µg/l	n
Age group: 15-25 yrs						
Non-smokers	83.4	286	91.8	108	77.3	2
< 6	103.5	32	93.8	23	47.0	1
6-10	78.9	36	78.9	20	-	0
11-20	87.9	31	98.2	21	171.4	2
>20	91.6	5	67.9	3	191.0	1
Age group: 26-39 yrs						
Non-smokers	80.5	366	93.1	393	116.1	47
< 6	88.7	54	100.9	72	117.8	12
6-10	87.5	48	103.5	52	119.1	4
11-20	88.5	91	109.6	99	146.2	16
>20	91.6	30	110.4	23	161.8	7
Age group: 40-55 yrs						
Non-smokers	93.8	369	108.9	395	124.2	67
< 6	101.2	27	113.0	39	184.1	5
6-10	101.9	33	112.7	33	129.4	5
11-20	97.5	45	128.5	44	164.4	11
>20	104.7	17	140.6	12	195.0	5
Age group: >55 yrs						
Non-smokers	104.7	286	125.0	355	157.0	50
< 6	102.8	18	131.2	28	104.7	2
6-10	98.6	17	138.4	14	110.4	2
11-20	109.4	12	141.6	16	123.6	3
>20	161.8	3	175.8	7	314.8	1

n = number of subjects

PbB = blood lead

Table 20. - Blood lead levels ( $\mu\text{g/l}$ ) observed in the present study compared with those observed in the 1979 and 1981 studies

Group	Sex	1979		1981		1985	
		PbB	n	PbB	n	PbB	n
All the national territory	M	200	683			153	2861
	F	140	1029			100	3806
Rome	M			190	111	143	431
	F			140	124	100	330
Milan	M			174	59	154	180
	F			123	118	108	220
Bologna	M			214	47	183	288
	F			114	51	117	370
Sassuolo	M			180	58	208	45
	F			150	49	133	60

n = number of subjects

PbB = blood lead

## Conclusions

A few points of this report, from which important suggestions for future action can be drawn, need to be more thoroughly examined.

First of all, the results of our investigation have confirmed that the most important variables associated with blood lead levels - a good index of exposure to lead - are: sex, age, alcohol consumption and smoking habit.

The 1981 study reported a 13% average decrease of blood lead levels, when compared with the 1979 study: the data collected in our present study are consistent with an estimated 25% decrease of blood lead levels in the general Italian population during the 1979-1985 period (Table 20).

These findings are comparable to those of similar investigations carried out in the United States of America [6, 7] and in Sweden [8], and can be explained mainly by the decreased use of lead as an additive for gasoline.

The higher average blood lead levels observed for the adult males in Lombardy, Emilia-Romagna and Sardinia - sometimes even exceeding the upper reference limits decreed by the Italian law - should be imputed to the pollution caused by industrial settlements.

Particularly important is the finding that the population  $\leq 14$  yrs of a town in Sardinia has blood lead levels, at the 98th percentile that exceed the upper reference limits of the Italian law. It must also be added that the international health organizations agree that these limits are not sufficiently protective for the children. Blood lead levels for children should be significantly lower: 150  $\mu\text{g/l}$  at the 50th percentile; 200-250  $\mu\text{g/l}$  at the 90th percentile; and 250-300  $\mu\text{g/l}$  at the 98th percentile.

Considering that the detrimental effects of lead, as recently reported [9-11], can take place even for exposures corresponding to very low blood lead levels both in the central nervous system (learning trouble during childhood) and in the cardiovascular apparatus, our data clearly show that the exposure to lead for the general Italian population is still a very relevant (and sometimes alarming) health problem.

Therefore, adequate attention and constant control by health care workers and by health authorities is still needed.

Review submitted on invitation by the Editorial Board of the *Annali*.  
Accepted for publication: 26 April 1989.

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## Appendix 1. - Standardized questionnaire administered to each subject

**PERSONAL INFORMATION**

(Confidential)

DATA QUESTIONNAIRE COMPLETED

<input type="text"/>	<input type="text"/>	<input type="text"/>
d	m	y

**SUBJECT EXAMINED:**Surname  First name Residential address  Postal code Home telephone  Workplace telephone Number  Number **TYPE OF WORK:**Present  Previous Transmission of results: NO ☐ To the subject ☐To the general practitioner ☐ Only if elevated PbB ☐**GENERAL PRACTITIONER:**Surname  First name Address  Telephone number **BACKGROUND DATA**1-2 District  3-4 Area code  5-7 Type of survey 8-11 Personal number of subject  12 Sex M ☐ F ☐ 13-14 Data of birth (year) 

	PRESENT	PREVIOUS
Occupation (code according to list annex)	15-16 <input type="text"/>	17-18 <input type="text"/>
Number of years in the occupation	19-20 <input type="text"/>	21-22 <input type="text"/>
Medical surveillance for occupational lead exposure	23 YES <input type="checkbox"/> NO <input type="checkbox"/>	24 YES <input type="checkbox"/> NO <input type="checkbox"/>

**SMOKING HABITS**

	≤ 5	6-10	11-20	>20
25 (cigarettes/day)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**TINNED FOOD HABITS**

	≤ 1	1+2	>2
26 (tins/week)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### PREDOMINANT DRINKING HABITS

27 Tap water	<input type="checkbox"/>	28 Spring water	<input type="checkbox"/>	29 Mineral water	<input type="checkbox"/>	30 Milk	<input type="checkbox"/>
31 Alcoholic aperitif	<input type="checkbox"/>	32 Bitter	<input type="checkbox"/>	33 Cognac	<input type="checkbox"/>	34 Whisky	<input type="checkbox"/>
35 Brandy	<input type="checkbox"/>	36 Other spirits	<input type="checkbox"/>				
37 Beer	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
38 Wine	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>

## BLOOD SAMPLING

39 Capillary 1 Venous 2

## ANTICOAGULANT

40	EDTA	1	Heparin	2
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## RESULTS OF BLOOD ANALYSIS

41-46 Date of analysis 

d	

m	

y	

 47-49 Code number of laboratory 

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50-52 Blood lead results. 

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Results of internal quality control  
sample on the same day

53-55 A 

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 56-58 B 

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## RESULTS OF BLOOD CADMIUM ANALYSIS

59-64 Date of analysis    

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 d    

--	--

 m    

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 y    65-67 Code number of laboratory    

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68-69 Blood cadmium results 

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Results of internal quality control  
sample on the same day

70-71 A 

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 72-73 B 

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## REMARKS: