

## **The Urban Area Adjacent to Vercelli City: An Epidemiological Study about the Health Effect of the South Industrial District - Death Causes Analysis in the Cohort from 1985 to 2014**

### **Il distretto industriale di Vercelli-sud e il suo impatto sulla salute umana: studio di coorte (1985-2014)**

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**Keywords:** Pulsed-xenon ultraviolet device; Environmental contamination; Operating rooms; Disinfection

**Parole chiave:** Luce UV pulsata allo Xenon; Contaminazione ambientale; Sale operatorie; Disinfezione

#### **Abstract**

The linkage between environmental pollution and human health problems is well-known. The aim of this study is to reveal how the presence of industrial activities, especially waste disposal activities, in the neighborhood of the residential area of the city could affect human health. Moreover, we want to define if there are preferential target organs/systems for pollutant derived from various industrial activities, and research a possible safe distance from the plant, from which an individual is quite safe.

A mortality study in the cohort from 1985 to 2014 of Vercelli residents has been carried out. The pollutants dispersion model highlighted two areas with different exposure: a residential area recipient of pollutant deposition (RPD) and an Historical City Center (HCC) apparently free from the environmental contamination. SMR analysis together with Relative Risk analysis were carried on and compared with Piemonte region rates.

This study highlights numerous excesses for the exposed population. A significant increases for total cancer, + 62% for lung cancer in men and a four-fold excess for brain cancer in men is reported. In women cohort there are more than doubled excesses for leukemia and lymphoma, and for liver and ovarian cancers.

This study confirms that environmental pollution caused by various industrial activities badly affects human health, causing cancer among other diseases. Living in the neighborhood of plants determine a great exposition to pollutants, that surely represent a chronic exposition to toxic; the residence factor is very important if considered time people usually spent at home specially with young children.

Overall, the analysis has highlighted several and relevant excesses in the exposed area that certainly deserve to be investigated with improved characterization of occupational and demographic factors (such as income). Finally, this study suggests the importance of living in a healthy environment such a quickly strategy to avoid contaminated site and so to maintain good health.

## **Riassunto**

L'associazione tra inquinamento ambientale e problemi di salute è ormai ben nota. Lo scopo di questo studio è quello di valutare come la presenza di attività industriali, in particolare quelle di smaltimento dei rifiuti, nei pressi delle zone residenziali delle città possa influire sullo stato di salute dell'uomo. In aggiunta cerchiamo di definire i possibili organi/sistemi bersaglio degli inquinanti delle attività industriali, e una possibile distanza dalle fabbriche alla quale un individuo è più protetto.

Abbiamo condotto uno studio di coorte che si estende dal 1985 al 2015 sulla popolazione residente nella provincia di Vercelli. Il modello di dispersione degli inquinanti ha evidenziato due area a diverso livello di inquinamento: un'area residenziale che è il principale destinatario degli inquinanti dispersi a causa della vicinanza con l'area industriale, e un centro storico apparentemente non contaminato. Sono state condotte analisi dell'SMR e del Rischio Relativo, e i dati paragonati con i tassi di mortalità della regione Piemonte.

Questo lavoro ha evidenziato numerosi incrementi di malattia nella popolazione esposta: un significativo aumento è stato registrato per i casi totali di tumore, +62% per il cancro al polmone negli uomini, e un aumento di 4 volte per quanto riguarda il cancro al cervello per l'uomo. Per le donne sono stati invece registrati più del doppio degli incrementi attesi per leucemia e linfoma, oltre che per tumori al fegato e alle ovaie.

Questo studio ha confermato che l'inquinamento ambientale dovuto alle attività industriali influisce negativamente sulla salute umana, determinando varie patologie tra cui cancro. Vivere nei pressi delle aree industriali rappresenta un fattore di rischio a causa dell'esposizione agli inquinanti che può certamente essere considerata un'esposizione cronica al tossico; il fattore residenziale è molto importante se consideriamo il tempo che le persone trascorrono presso la propria abitazione specialmente insieme con i bambini.

In aggiunta questo studio ha evidenziato numerosi e rilevanti aumenti di malattie nell'area esposta, che dovrebbero essere approfondite considerando tra l'altro anche il fattore occupazionale e quello demografico.

In conclusione questo studio vuole dare un suggerimento nella scelta della propria abitazione; la scelta dell'ambiente di vita, così come altri fattori, può e dovrebbe essere un fattore da considerare come strategia di prevenzione nel mantenimento di uno stato di salute ottimale.

Keywords: cohort study, human health, cancer, environmental pollution, waste disposal, residential area.

Parole chiave: studio di coorte, salute umana, cancro, inquinamento ambientale, smaltimento di rifiuti, area residenziale.

## Introduction

The evaluation of human exposure to pollutants in the environment represents one of the main critical elements of epidemiology and risk assessment, with significant implications in planning prevention and rehabilitation interventions [1-4]. Exposure is defined as 'contact between an agent present in any environmental matrix and human body'; furthermore, exposure analysis is the process which estimates or measures the amount, the frequency and the duration of exposure contact, together with the number and the characteristics of the exposed population [5,6]. Exposure can be long or short term and may concern the work context (occupational exposure) or extra-working environment (referred as 'Environmental'); the source, the exposure's routes, the metabolic path and other important factors in the exposure evaluation are described. In the working context, where the presence of specific substances is linked to the production processes, the exposure time and the possibility of grouping the exposed subjects on the basis of their job, make the exposure estimation process relatively feasible and accurate; instead the various forms of environmental pollution are characterized by multiple exposures, at low concentrations, with high dispersal and space-time variability [7-9]. In most cases, since it is extremely expensive to calculate individual exposure measurements, indirect methods are used, such as environmental pollution and / or surrogate variables of actual exposure measures and estimates, using questionnaires or qualitative/quantitative information concerning the impact of the polluting source [1,2,6,10].

## Aim of the study

The aim of the present study is to evaluate the exposure effect on health conditions of inhabitants living near the south industrial district of Vercelli where an incinerator for USW (Urban Solid Waste) and a chemical manufacturing site are present. Specifically, we want to define short and long term exposure effects on inhabitants living near the site health. [1,2,4,7,8,11-15]

## Environmental Pressing Principles

The exposed southern residential area of Vercelli city is at environmental risk both due to pollutants released (ARPA-2015 model) from the MSW incinerator, and to the presence of an adjacent chemical production site for which it is necessary to consider a potential exposure to chemical for residents for a correct evaluation, although we do not have aerial dispersion models. [6].

Finally, even if not considered in detail in this report, within the RPD area there is a contaminated industrial site (chrome-plating and silver tool production) where several investigations have identified the presence (only partly attributable to the active production) of trichloroethylene [10,17-20]. This industrial complex ceased its activity in 2001 when it was transferred far from Vercelli city.

### **Brief Overview and Critical Environmental Issues of the Former USW Incinerator (1977-2014)**

Until 1992, for over 15 years, tons of waste have been accumulated within the incinerator area, in particular bottom ash, deriving from the emptying ovens, probably rich in toxic metals such as lead and cadmium, which should have been disposed in landfills for special waste.

Chemical and physical analysis show the nature of chemical substances released by the incinerator in the environment that include various toxic and carcinogenic compounds. Most substances as organic chlorine (dioxins, furans, PCBs - Polychlorinated Biphenyls), isopropyl alcohol (polycyclic aromatic hydrocarbons), VOC (volatile organic compounds), heavy metals in trace amounts (lead, cadmium and mercury), hydrochloric acid, nitrogen oxides, sulfur oxides and carbon oxides that are defined as 'certain noxious' according the WHO; many of these compounds are dispersed into the air together with the dust, but they also accumulate in the bottom ashes [2,6-8,14-16].

### **Brief Overview and Critical Environmental Local Chemical Site (Active Since 1980, Still in Production)**

The chemical company (photo 2) was founded in 1980, while the production activity started in Vercelli plant in 1982 with the production of various compounds, such as: trimethylolpropane and sodium formate, neopentylglycol, pentaerythritol, formic acid, sodium sulfate, formaldehyde, trimethylolpropane diallylether, and maleic anhydride; in 2006 also biodiesel production started. Following the acquisition of Idrosol S.P.A., an important sodium formate user, the production of formic acid and sodium sulphate was suspended; formic acid is purchased for resale. In 2004 the society suspended the direct production of maleic anhydride which is purchased outside for scaling and packaging. In 2005 the transformation of pentaeritrite production process using lime instead of soda began, with simultaneous calcium formate production as a by-product.

The production processes still active are:

- dimethyl ester
- glycol mixtures.

Various environmental investigations carried out by the company on the site, relating to the production activities, identified the pollution in both the superficial unsaturated soil and the superficial groundwater; as for the soil concerning asbestos.

In the groundwater there was excess for iron, manganese, nickel, arsenic, benzo (a) pyrene and total hydrocarbons [2,7,17,21]. In addition, the company has performed determinations for specific compounds such as formaldehyde, acetaldehyde, butanone 2,2 oxyethanol, ethylene glycol, cyclohexane and pentaerythritol, detecting in the soil asbestos and the ubiquitous presence of formaldehyde and significant levels in the groundwater of formaldehyde, acetaldehyde and pentaerythritol.

## Materials and Methods

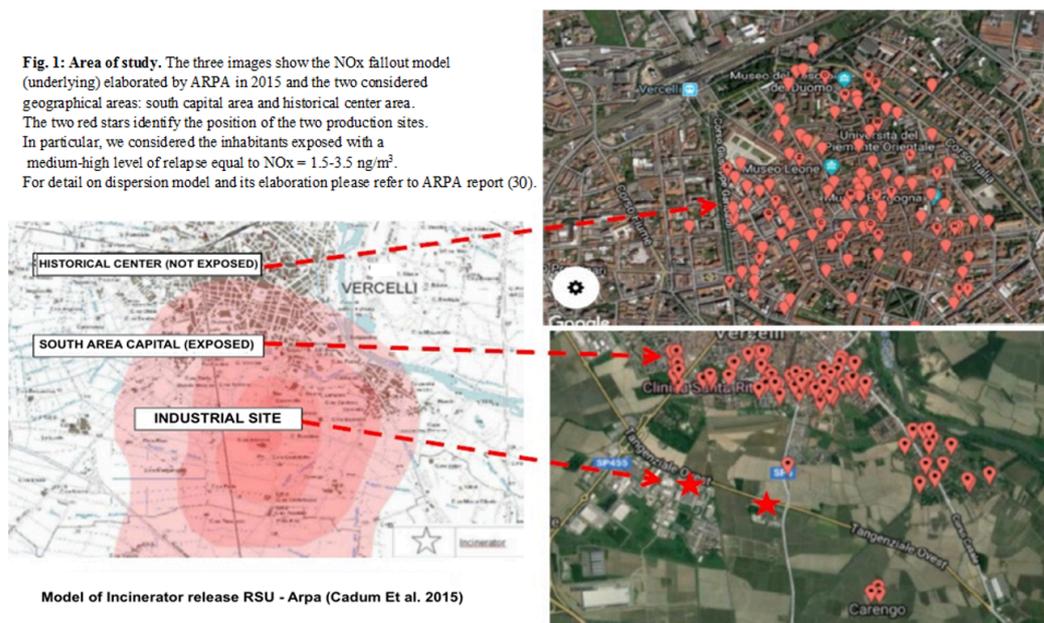
Figure 1 represents to see the area of study.

Pollutants exposure for the residential area was calculated using release patterns [6,11,14] estimated by ARPA (Regional Agency for Protecting Environment) in 2015 [16]: in particular, in order to detail accurate data in this survey, the most densely populated areas that were those exposed to the fallout from the incineration plant were identified.

We consider with great attention the mortality rate from 1985 to 2014, period during which the incinerator was built and worked

Vercelli ASL-SISP (Department of Sanitary and Hygiene - Local Sanitary Agency) data were used for years since 2000; while ISTAT (Italian Institute for Statistic) mortality data were used over the period between 2000-2014. These database provide death causes with the original death certificate codified in ICD VIII (valid at that time) [13].

Data from 1985 to 2014 concerning residents, immigrants, emigrants and deceased provided by registry office of Vercelli city were used in order to build cohort group. [6,13,22]



The Standardized Mortality Rates (SMRs) were calculated, while the expected value was calculated using Piemonte rates; the statistical significance was carried out according to the 90% Byar Method. Finally, a relative risk was calculated (exposed vs not exposed) from the SMR rates with appropriate elaboration of the relative confidence intervals at 90%.

## Results

### *Study Population*

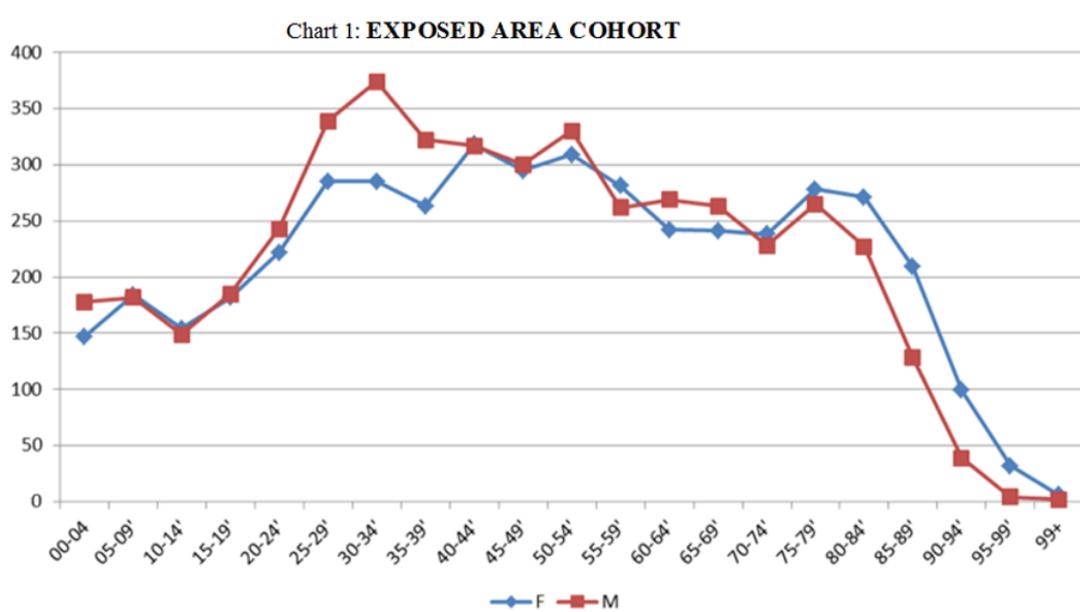
The following Table 1 and Table 2 (and Chart 1 and Chart 2) represent the two cohorts (exposed (RPD) and not exposed (HCC)) stratified by age and gender. The exposed area is composed by 9147 residents (49.6% women and 50.4% men) while the historic center is composed by 14817 individuals (54% women and 46% men).

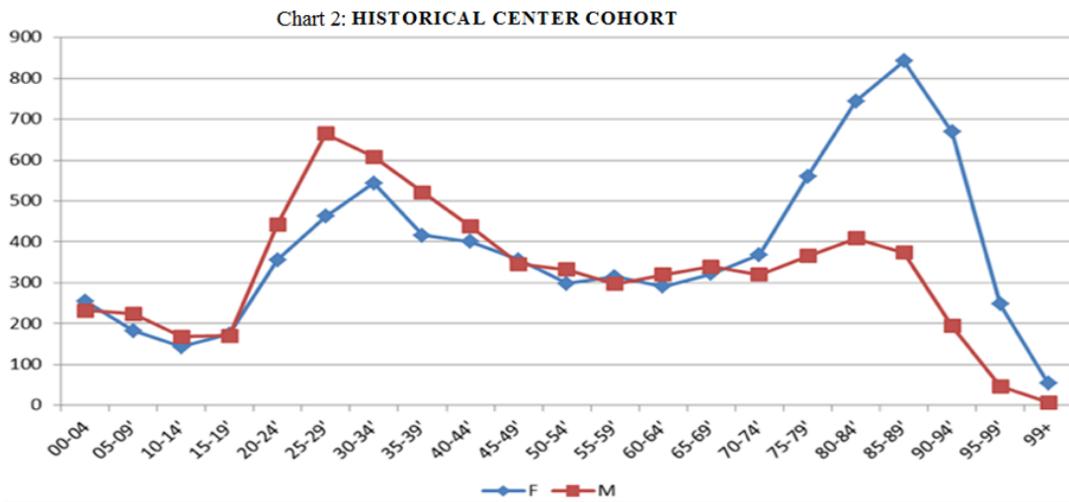
AGE	F	M	Total
00-04	147	178	325
05-09'	184	182	366
10-14'	154	149	303
15-19'	182	185	367
20-24'	222	243	465
25-29'	285	339	624
30-34'	285	374	659
35-39'	263	322	585
40-44'	318	317	635
45-49'	295	300	595
50-54'	309	330	639
55-59'	281	262	543
60-64'	242	269	511
65-69'	241	263	504
70-74'	238	228	466
75-79'	278	265	543
80-84'	271	227	498
85-89'	209	128	337
90-94'	99	39	138
95-99'	32	4	36
99	6	2	8
<b>Total</b>	<b>4541</b>	<b>4606</b>	<b>9147</b>

**Table 1:** 1985-2014 cohort group of exposed area residents stratified by age and gender.

AGE	F	M	Total
00-04	255	232	487
05-09'	183	224	407
10-14'	143	168	311
15-19'	174	170	344
20-24'	356	443	799
25-29'	462	665	1127
30-34'	544	608	1152
35-39'	416	521	937
40-44'	400	437	837
45-49'	356	346	702
50-54'	298	332	630
55-59'	315	297	612
60-64'	291	320	611
65-69'	322	339	661
70-74'	368	320	688
75-79'	560	365	925
80-84'	744	409	1153
85-89'	842	374	1216
90-94'	669	194	863
95-99'	248	46	294
99	54	7	61
<b>Total</b>	<b>8000</b>	<b>6817</b>	<b>14817</b>

Table 2: 1985-2014 cohort of historical center residents stratified by age and gender.





*Absolute Death Frequencies by Cause, Gender and Study Areas*

In Table 3, specific death causes of the two cohorts stratified by gender are reported.

The most frequent death cause is represented by cardiovascular system injury followed by the respiratory system disease; concerning cancer, the most frequent event is represented by lung cancer and then colon-rectum cancer.

	City center			Historical center		
	F	M	Total	F	M	Total
DIGESTIVE SYSTEM	74	75	149	19	32	51
URINARY SYSTEM	36	28	64	12	6	18
RESPIRATORY SYSTEM	203	177	380	28	49	77
UNKNOW CAUSE/NOT FOUND	43	41	84	9	14	23
CARDIOVASCULAR	1425	771	2196	268	278	546
PSYCHIC DISORDERS	37	14	51	7	8	15
ENDOCRINE	102	45	147	25	18	43
ACCIDENT / INJURIES	64	66	130	16	35	51
INFECTIVE	17	20	37	8	9	17
LEUKEMIA	11	9	20	11	11	22
LYMPHOMA	8	8	16	11	8	19
NOT DEFINED	64	16	80	15	9	24
CONGENITAL MALFORMATION	4	7	11	1	2	3
MELANOMA	5	4	9	1	2	3
MESOTHELIOMA	4	8	12	2	3	5
MYELOMA	6	4	10	2	3	5
DIGESTIVE SYSTEM NEOPLASM	8	5	13	1	3	4
ORAL CAVITY NEOPLASM	6	9	15	2	8	10
COLON-RECTUM CANCER	73	50	123	37	33	70
SKIN CANCER (NO MELANOMA)	3	1	4	1	1	2
ESOPHAGUS CANCER	2	6	8	1	6	7
LIVER/BILIARY TRACT CANCER	32	19	51	17	17	34
SMALL INTESTINE CANCER	2	1	3	2		2
LARYNX CANCER	4	10	14		4	4
NOT DEFINED CANCER	17	11	28	5	5	10
BREAST CANCER	69	2	71	27		27
SPLEEN CANCER (SARCOMA)	1		1			
BONE CANCER	3	2	5	2	1	3
OVARY CANCER	17		17	11		11
PANCREAS CANCER	19	15	34	10	13	23
PENIS CANCER					1	1

PERITONEUM CANCER	6	3	9	3	2	5
NERVOUS SYSTEM CANCER	7	6	13	4	14	18
LUNG CANCER	38	104	142	16	95	111
PROSTATE CANCER		48	48		14	14
KIDNEY CANCER	3	6	9	3	7	10
GASTRIC CANCER	23	23	46	7	16	23
TESTICLE CANCER		1	1			
THYME CANCER	1		1			
THYROID CANCER	2	1	3		1	1
UTERUS CANCER	24		24	9		9
VAGINA CANCER	2		2	3		3
BLADDER CANCER	11	24	35	3	10	13
MUSCULOSKELETAL	14	3	17	7	2	9
SKIN	8	3	11	1	1	2
NERVOUS SYSTEM	97	52	149	16	19	35
BLOOD	24	11	35	4	3	7
SARCOMA	3	2	5	2		2
<b>TOTAL CAUSE</b>	<b>2628</b>	<b>1710</b>	<b>4338</b>	<b>629</b>	<b>759</b>	<b>1388</b>

Considering exposed male risks assessment (Table 4), considering the SMR, we can observe statistically significant excesses for total cancers, in particular for colon-rectum, brain and lung while no particular problems for HCC residents are observed; considering the RR, the greatest excess is for lung cancer followed by the total oncological (leukemia, myeloma and lymphoma) and nervous system.

The Relative Risk analysis shows 23 death events due to environmental exposures with regard to the male gender.

DEATH CAUSES	ICD X	EXPOSED AREA				NOT EXPOSED AREA				RR	IC90 %	Exposure attributable cases
		OBS	EXP	SMR	IC90 %	OBS	EXP	SMR	IC90 %			
TOTAL CANCERS	C00-C97	273	<b>225,7</b>	<b>1,20</b>	<b>1,05</b> - <b>1,35</b>	380	421,9	0,90		1,33	1,26 - 1,40	90
GASTRIC CANCER	C16	16	16,1	0,99		23	31,1	0,73		1,35	1,02 - 1,67	5
COLON RECTUM CANCER	C18, 19-21	33	<b>24,7</b>	<b>1,33</b>	<b>1,01</b> - <b>1,66</b>	50	48,4	1,03		1,29	1,07 - 1,51	9
LIVER/BILIARY TRACT CANCER	C22-24	17	15,4	1,10		19	27,1	0,70		1,57	1,24 - 1,90	9

PANCREAS CANCER	C25	13	9,36	1,38	0,84 - 1,91	15	16,4	0,91		1,51	1,14 - 1,88	6
LUNG CANCER	C33- 34	95	<b>58,3</b>	<b>1,62</b>	<b>1,40</b> - <b>1,83</b>	104	95,5	1,08	0,91 - 1,24	1,50	1,36 - 1,64	47
KIDNEY CANCER	C64- 66,6 8	7	5,16	1,37	0,65 - 2,09	6	9,1	0,65		2,10	1,55 - 2,65	4
BLADDER CANCER	C67	10	12,8	0,78		24	27,2	0,88		0,88	---	---
LEUKEMIA	C91- 95	11	7,16	1,53	0,92 - 2,14	9	14,2	0,63		2,42	1,96 - 2,87	4
LYMPHOMA	C82- 85,9 6,81	8	7,68	1,04		8	15,2	0,52		2,00	1,75 - 2,25	4
MYELOMA	C90	3	3,27	0,92		4	6,0	0,66		1,46	---	
CENTRAL NERVOUS SYSTEM CANCERS	C71	14	3,31	<b>4,22</b>	<b>3,31</b> - <b>5,12</b>	6	4,91	1,21	0,47 - 1,94	3,48	2,71 - 3,60	12
HEMATOLO GICAL	---	22	18,1	1,21	0,82 - 1,59	21	35,4	0,59		2,08	1,78 - 2,38	10
CARDIOVAS CULAR	I00- I99	278	354,1	0,78		771	904,2	0,85		0,91	---	
RESPIRATOR Y SYSTEM	J00- J99	49	75,3	0,65		177	199,1	0,88		0,73	---	
PSYCHIC DISORDER	F03- 73	8	10,7	0,74		14	27,3	0,51		1,45	1,01 - 1,89	3
CONGENTIA L MALFORMA TION	P00- Q99	2	7,88	0,25		7	10,6	0,68		0,36	---	
<b>TOTAL CAUSE</b>	<b>A00- T98</b>	<b>759</b>	<b>840,9</b>	<b>0,90</b>		<b>1710</b>	<b>1960, 8</b>	<b>0,87</b>		<b>1,03</b>	<b>0,99</b> - <b>1,08</b>	<b>23</b>

Table 4: Mortality data, SMR and RR in men.

Concerning women (Table 5), the difference between exposed population and not exposed one are even more pronounced than for men. Highly statistically significant excesses are represented by colon rectum, liver and ovary cancers, leukemia, lymphoma and total hematological; concerning the historical center cohort we can observe intestine and lung cancers excesses. Considering the relative risks, the greater burden of deaths due to the exposure factor concerns the colorectal and hematological cancers as a whole. Relative Risk analysis shows 31 cases due to pollutants in the exposed area.

DEATH CAUSES	ICD X	EXPOSED AREA				NOT EXPOSED AREA				RR	IC90 %	Exposure attributable cases
		OBS	EXP	SMR	IC90 %	OBS	EXP	SMR	IC90 %			
TOTAL CANCER	C00-C97	190	146,2	1,29	1,16 - 1,42	411	444,6	0,92		1,40	1,32 - 1,48	76
GASTRIC CANCER	C16	7	10,8	0,64		23	37,1	0,61		1,05	---	
COLON RECTUM CANCER	C18, 19-21	37	19,1	1,93	1,55 - 2,30	73	63	1,15	0,95 - 1,35	1,67	1,47 - 1,87	24
LUNG CANCER	C33-34	16	12	1,33	0,86 - 1,80	38	31,4	1,21	0,91 - 1,50	1,09	---	
KIDNEY CANCER	C64-66,68	3	2,31	1,29	0,22 - 2,29	3	6,67	0,44		2,93	2,12 - 3,74	3
BILIAR TRACTS/LIVER CANCERS	C22-24	17	11,3	1,50	1,02 - 1,98	32	34,6	0,92		1,63	1,33 - 1,94	10
PANCREAS CANCER	C25	10	8,85	1,12	0,57 - 1,66	19	26,9	0,70		1,60	1,21 - 2,01	6
OVARY CANCER	C56, 570-574	11	6,19	1,77	1,12 - 2,42	17	14,9	1,14	0,71 - 1,56	1,55	1,17 - 1,93	6
BREAST CANCER	C50	27	24,9	1,08	0,76 - 1,40	69	70,2	0,98		1,10	---	
UTERUS CANCER	C53-55	9	6,83	1,31	0,67 - 1,93	24	18,9	1,26	0,88 - 1,63	1,04	---	
LEUKEMIA	C91-95	11	4,87	2,25	1,50 - 2,99	11	15,1	0,72		3,12	2,70 - 3,54	7
LYMPHOMA	C82-85,96,81	11	4,49	2,44	1,67 - 3,21	8	12,5	0,64		3,81	3,35 - 4,26	8
MYELOMA	C90	2	2,79	0,71		6	8,02	0,74		0,95	---	
CENTRAL NERVOUS SYSTEM CANCERS	C71	4	2,71	1,47	0,48 - 2,46	7	4,97	1,40	0,66 - 2,13	1,05	---	
ONCOHAEMATOLOGICAL	---	24	12,1	1,98	1,50 -	25	35,6	0,70		2,82	2,54 -	15
<b>TOTAL</b>					2,45						3,11	
CARDIOVASCULAR	J00-J99	268	427,1	0,62		1425	2023	0,70		0,88	---	
RESPIRATORY SYSTEM	F03-73	28	51,5	0,54		203	248,1	0,81		0,66	---	
PSYCHIC DISORDERS	P00-Q99	7	16,2	0,43		37	77,1	0,47		0,91	---	
<b>TOTAL CAUSES</b>	<b>A00-T98</b>	<b>629</b>	<b>831,4</b>	<b>0,75</b>		<b>2628</b>	<b>3627</b>	<b>0,72</b>		<b>1,05</b>	<b>1,01</b> - <b>1,09</b>	<b>31</b>

Table 5: Mortality data, SMR and RR in women.

Total genders situation (Table 6) is comparable to the one recorded separately for men and women: excesses are confirmed for total cancers, intestine, lung, central nervous system cancers and the hematological compartment both in leukemia and lymphoma. Relative Risk results show 45 deaths for lung cancer and 26 for the hematologic total; in all cases, the relative risk shows a significant value with over 100 deaths induced by the pressures in the exposed area, about 3-4 cases per year since 1985.

DEATH CAUSES	EXPOSED AREA				NOT EXPOSED AREA				RR	IC90%	Exposure attributable cases
	OBS	EXP	SMR	IC90%	OBS	EXP	SMR	IC90%			
TOTAL CANCER	463	371,9	1,24	1,16-1,32	791	866,5	0,91		1,36	1,31-1,42	166
GASTRIC CANCER	23	26,9	0,85		46	68,2	0,67		1,26	1,01-1,51	6
COLON CANCER	70	43,8	1,59	1,34-1,83	123	111,4	1,10	0,95-1,25	1,44	1,29-1,59	31
LUNG CANCER	111	70,3	1,57	1,37-1,76	142	126,9	1,11	0,97-1,25	1,41	1,29-1,53	45
KIDNEY CANCER	10	7,47	1,33	0,73-1,92	9	15,7	0,57		2,33	1,88-2,78	5
BILIAR TRACTS/LIVER CANCERS	34	27,4	1,24	0,92-1,55	51	61,7	0,82		1,51	1,29-1,73	17
PANCREAS CANCER	23	18,2	1,26	0,87-1,64	34	43,3	0,78		1,61	1,34-1,88	14
LEUKEMIA	22	12	1,83	1,35-2,30	20	29,3	0,68		2,69	2,39-2,99	14
LYMPHOMA	19	12,2	1,55	1,09-2,01	16	27,7	0,57		2,72	2,39-3,05	12
MYELOMA	5	6,06	0,82		10	14	0,71		1,15	---	
ONCOHAEMATOLOGICAL TOTAL	46	30,2	1,52	1,22-1,81	46	71	0,64		2,37	2,17-2,57	26
CENTRAL NERVOUS SYSTEM CANCER	18	6,02	2,99	1,99-3,31	13	9,88	1,31	0,78-1,83	2,28	1,79-2,51	8
CARDIOVASCULAR	546	781,2	0,69		2196	2297,2	0,95		0,72	---	
RESPIRATORY SYSTEM	77	126,8	0,60		380	447,1	0,85		0,70	---	
PSYCHIC DISORDER	15	26,9	0,55		51	104,4	0,48		1,14	---	
<b>TOTAL CAUSES</b>	<b>1388</b>	<b>1672,3</b>	<b>0,83</b>		<b>4338</b>	<b>5587,8</b>	<b>0,77</b>		<b>1,08</b>	<b>1,06-1,10</b>	<b>111</b>

Table 6: Mortality data, SMR and RR in total gender.

## Conclusions

Our research highlighted a great environmental contamination in the exposed area due to industrial plant; cancers incidence is enhanced in geographical areas close to different plants, especially to old incinerators [5,6,9,11,13,14,21,22].

Numerous excesses for total cancer, lung cancers, colorectal cancer, leukemia for the exposed population are reported. In addition, ovarian and hematological cancers (leukemia, myeloma and total lymphoma) excess are notable in female population.

Assessing the relative risks and the load in terms of attributable cases to the display factor, lung, colorectal and total hematologic cancers affect more than all; concerning total cancers in men and women, 166 deaths are estimated linked to the exposure (about 5 deaths per year); it should be noted that total cases also show a RR with over 100 deaths related to the exhibiting factor, about 3-4 annual deaths since 1985.

Our results show a more dangerous situation for women: this outcome could be explained, considering the greater time spent in residence for this group of inhabitants compared to men [5,14].

Excess for hepatic cancer [6,9,12-14,21,22] only in the female gender among the exposed population implies an environmental risk, given to the lower propensity of women to alcohol abuse; to establish a valid causal link, it would be advisable to investigate possible occupational risks, the presence of pre-carcinogenic liver diseases (hepatitis / cirrhosis) and exposure to environmental pollutants such as the aforementioned trichlorethylene / trichlorethylene.

A brief comment need to be reserved for kidney cancer (age group 21-30) (men) with a totally different trend; in addition to the assessment of individual risk factors (alcohol abuse, tobacco consumption) and occupational factors, it would be desirable to investigate and assess possible local exposures to trichlorethylene and trichlorethylene; ARPA several and numerous analysis have highlighted an environmental contamination deriving from former plant [10,17-20].

Concerning HCC residents there are excesses (on average 10%) close to significance for total genders for colorectal and lung cancers.

Excess is recorded for brain cancer (age group 8-18) both for the male gender and for the total: in this case the connection with having worked and / or lived near unhealthy plants like cement plants, foundries and petrochemicals have to be considered.

In order to assess an historical trend of such a long period, it is necessary to consider the possible etiological explanations, the undoubted improvements of medical therapies (especially in the oncological field) and the ever greater adherence to prevention campaigns (colorectal screening, uterus, breast, etc ...). For example, concerning liver cancer it seems clear that the hepatitis vaccination introduction in the early 1980s and the better therapies for such infections and the related subsequent cirrhosis, has significantly improved liver cancer prognosis and reduced the relative mortality.

This survey suffers from the lack of information for some confounders useful for an optimal control of exposure such as occupational, the voluntary such as the consumption of smoke and / or alcohol [3,5,10,16-18,21,23].

In our research we did not proceed with a correction of the deprivation index because, as already in the ARPA study, this control proved little or even nothing between the two groups.

It is important to note that the geographical area has a high environmental complexity [16], both due to atmospheric pollution (the Po valley shows the highest values of air pollution in Italy and one of the highest in Europe) and for other intrinsic environmental pressures in the exposed area due to the presence of a former production site (chromium plating) contaminated with trichlorethylene and trichlorethylene [10,18,20] not entirely attributable to it with an unknown source upstream to today.

Do not forget the exposure to pesticides [2,8,10,24-26] that certainly has a great importance for the exposed group and in a more marginal way for the historical center residents.

In this study the main exposure was defined as due to the pollution produced by the incineration plant / chemical site, but it is necessary to keep in mind that many pollutants from other sources have a high persistence with accumulation in the environment and require a long period for complete degradation [9,15].

Our study confirms, limited to the same causes investigated, the critical issues already reported by the ARPA study [16] with excesses for total cancers, colorectal cancer, lymphoma and lung; for non-cancer causes confirmation is not obtained, but this may be due to different details due to specific causes, periods of non-overlapping analysis and different statistical analysis.

Also in this research, as in the ARPA's one, we observe an excess as relative risk for psychiatric and suicidal disorders [11,25,27,28] in male gender with an increase of 45%; ARPA researchers hypothesize a possible association with possible exposures to pesticides.

This survey confirms the compromised health condition of the exposed population; the research, moreover, highlights some significant problems for the historical center inhabitants. Our data largely overlap with those of the ARPA-2015 study.

The study presented here should be extended with more information on occupational factors and, given the excesses for cancers in digestive tract, understanding / investigating the possible consumption of vegetables and vegetables in the exposed area [2,7,11,14,21]; we recall that the risk for this type of exposure does not derive only from the local emissions from neighboring plants but also due to pollutants present in the land / water table / wells generated in part by the former production site located in the area [5,6,9,12,14,21,22,29-31].

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