

## Research on the health state of the Sicilian population living in areas at environmental or natural risk: the experience of the Regional Department of Epidemiology

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### Abstract

**Background:** In Sicily, people live near areas characterized by the presence of environmental polluting substances derived from urbanization and industrialization. In the areas of Augusta-Priolo (SR), Gela (CL) and Milazzo (ME), the increase of number of pathologies could be linked with environmental pollution. The aim of this paper is to present an overview of the available data and studies to underline the importance of these sources to conduct epidemiological survey in Sicily, besides to the analysis of mortality and morbidity.

**Methods:** An evaluation of the health status of the residential population was done comparing the mortality and morbidity of the local population with the mortality and morbidity of a reference population. Data was obtained from the Italian national office of statistics and Hospital Discharge Records. Standardized Mortality Ratios and Standardized Hospitalization Ratios were calculated.

**Results:** In the area of Augusta-Priolo we observed, in for men, a significant increase in mortality and hospital admissions for colon-rectal, trachea, bronchus, lung and pleura cancers. In Biancavilla, we observed an increase in mortality for pleura cancer in men and women and an increase in morbidity in women only. In Gela, a significant increase in mortality in males and females was observed only for tumoral diseases. In Milazzo, we only found a significant increase in the incidence of larynx cancer and cardiovascular disease for men and in women of pulmonary disease for women.

**Conclusions:** This first review allowed us to update previous analyses of mortality data conducted in the same areas. The results, even taking into account the differences between the areas,, highlights changes in health status related to some diagnostic groups. These could be linked with pollution. Now that the available health data has been revised and updated new studies must be conducted.

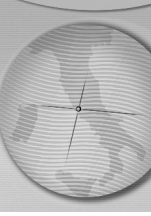
*Key words: health state, environmental, pollution, Sicily*

### Introduction

Currently in Sicily, as in other Italian regions, people live near areas characterized by the presence of environmental polluting substances derived from urbanization and industrialization. In Sicily, the factories tended to be built in areas where people resided. In light of this, the evolving concepts of environment and social justice are determining both the need for studies to characterise and evaluate the risk and the reclamation of polluted areas.

Frequently, in Sicily, when there are discussions regarding environmental pollution, attention is given only to industrial areas, such as Augusta-

Priolo (SR), Gela (CL) and Milazzo (ME), however, we must keep in mind that there are also areas where the causes of pollution are of natural origin, for example, Biancavilla (CT). In these areas, the increase in the number of pathologies may be linked with potential environmental health risks. This potential association has also been noted by the residents, who have, along with the press, have voiced their concerns to environment organizations and public health institutions. In response to this, new policies of inspection, surveillance, intervention and the communication of health risks must be derived from sound multidisciplinary studies.



In the areas of Augusta-Priolo, Gela and Milazzo petrochemical industries are present and these are defined as "Areas with high environmental risk"; moreover the same areas (Augusta-Priolo, Gela and Milazzo) and the area of Biancavilla, where there is diffuse contamination of natural amphybolic, asbestos-like, fibres (fluoro-edenite), are defined as "National interest for reclamation sites".

The health surveillance in these areas is of great importance primarily to safeguard public health but also to assess sites for reclamation. In the '90s, in some of these areas, epidemiological surveys were conducted however mortality was the only health indicator used (1-8). In recent years data from the Hospital Discharge Cards (SDO) has become available, and so it is now possible to conduct more detailed studies on the inhabitants of Augusta-Priolo, Gela, Milazzo e Biancavilla.

This report aims to: a) review the available epidemiological studies, conducted in partnership with the Epidemiological Observatory Department of Sicily, to analyse the health state of people living in environmental risk areas; b) highlight the importance of the flow of health information, the collection and use for epidemiological analysis, while still providing a brief description of the results.

#### ***Geographical studies: use of informative sources concerning mortality and hospital admissions***

During 2005, the Regional Department of Epidemiology conducted a study in collaboration with the Epidemiological Department of the local health unit RM/E. This was made possible due to the contributions of the Ministry of Economy and Finance and the Operative Project of Ministry of Health. The study provided an analysis of mortality and hospital admissions: two alternative and independent information data sources (9). With these sources it was possible to undertake a complete health data analysis. With this study, besides to the analysis of mortality and morbidity for the inhabitants of Augusta-Priolo, Biancavilla, Gela and Milazzo, we want underline the importance of availability and use of data coming from a regional level.

It is necessary to estimate the spatial and temporal trend of the health status of people living in areas in which the attention of the public health operators, administrators and citizenship today is growing.

#### **Methods**

In Sicily, the areas at environmental risk fundamentally differ in dimension, location and

source of environmental polluting substances. The evaluation of the health status of the residential population was done by comparing the mortality and morbidity of the local population with the mortality and morbidity of a reference population. The definition of the areas under investigation, and the respective areas of reference, was based on criteria of distance from the source of the pollution. This definition was taken from previous studies with in these areas (figure 1) (9-11).

The hypothesis for the choice of the reference area (neighbouring countries, regions and provinces) was: the area must have similar demographic, geographical and social characteristics (12) and for the available medical offer.

The data source for mortality (1995-2000) was the Italian National Office of Statistics (ISTAT). While for morbidity (2001-2003), the Hospital Discharge Cards (SDO), directly managed from the Regional Department of Epidemiology, were used.

For each of the four areas in study, residents' data concerning their deaths and hospital admissions for specific causes were collected. Causes were identified using the International Classification of Diseases Ninth Revision (ICD-IX) codes and of the International Classification of Diseases Ninth Revision, Clinical Modification (ICD-IX-CM).

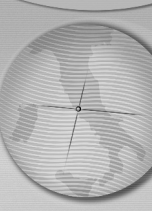
For the statistical analysis, we used the indirect standardization system. We calculated, separately for men and women, Standardized Mortality Ratio (SMR) and Standardized Hospitalization Ratio (SHR) with the Confident Interval at 95% (IC 95%). To calculate SHR we considered only the ordinary hospital admissions excluding admission to day hospital, for rehabilitation and in long term care. We analyzed hospital admissions excluding, through a procedure of "record linkage", repeated admissions of the same patient for the same causes.

#### **Outcome**

Table 1 shows a summary of the outcomes. The excesses of mortality or morbidity, in terms of the number of patients admitted to hospital, were reported. In a previous report of July 2005, published by the Sicilian Regional Department of Epidemiology, full descriptions of the outcomes were printed (9-11).

#### ***Augusta-Priolo***

In respect to the neighbouring areas, in Augusta-Priolo we observed a significative increment of mortality and hospital admission for colon-rectum, trachea, bronchus, lung and pleura cancer for men.



In the non-tumoral causes we found a significant excess only in hospital admissions for chronic pulmonary diseases and for illness of the kidneys. We found both for men and women significant excesses of mortality and morbidity only for acute pulmonary diseases, and for hospital admission for ischemic and pulmonary diseases.

#### *Biancavilla*

In the area of Biancavilla, we observed an increase in mortality for pleura cancer in men and women and for women only an increase in morbidity. For non-tumoral diseases, we observed, in both genders, excesses of mortality and morbidity for respiratory and cardiovascular diseases.

#### *Gela*

In the area of Gela, the outcomes showed significant increases of mortality in males and females for tumoral diseases only (men: stomach, larynx, bronchus and lung; women: colon-rectal, trachea, bronchus and lung). In terms of morbidity, significant excesses were founded in both genders for bladder cancer, cardiovascular disease and pulmonary disease (acute, chronic and asthma). While, for men only, we found a higher incidence of larynx cancer and pneumoconiosis and, for women only, we found a higher incidence of colo-rectal cancer, non-Hodgkin lymphoma and kidney disease.

#### *Milazzo*

In Milazzo, we only found a significant increase in the incidence of cancer of the larynx and for cardiovascular diseases in men while in women increases were noted for pulmonary disease. For hospital admissions, we noted an increase in the incidence of cardiovascular disease (in particular ischemic illnesses) in men; while, for both men and women, we found an increase in the number of admissions for acute pulmonary disease.

#### **Discussion**

This work allowed us to update the previous analysis of mortality conducted in these areas. For the first time, the health status of the population was described in terms of morbidity. The results, even taking into consideration the differences within the areas, highlights changes in the health status related to some diagnostic groups.

The epidemiological survey, conducted by integrating the different data sources available, produced results which were almost concordant for both tumoral illnesses and kidney diseases.

However, from the analysis of cardiovascular and respiratory problems we note discordance between mortality and admission to hospital. These results may be due to the characteristics of the illnesses and their context: use of temporal interval for the study of mortality and morbidity, latency between exposure and event, different type of codification, admission procedures and perception of the risk.

The geographic study, conducted using aggregate data, had some limits as it was impossible to manage confounders which originate from different life styles. Despite this the study did not find strong causal connections between environmental exposures and health effects. It can only find possible hypotheses for future studies to investigate. It's now important to underline that the process of definition of causal connection hasn't a dichotomous result but a continuous gradient of connection is present. From this point of view, a study, whose results do not produce strong results can still provide a significant contribution to the evaluation of causality (13). Therefore we can affirm that an aetiological hypothesis, to be used for a decision making process, needs to come from the integration of different studies.

#### *Use of assistance birth certificates (CeDAP)*

Afterwards, to better understand the health status of the residential population in the areas at risk in Sicily, an analysis of the information flows for births, for the period 1984-1998, using ISTAT data was performed. Some health reproduction indicators were analyzed: sex ratio (male/female at birth), still-birth rate (stillborn/total born), birth weight, gestational age and SGA (Small for Gestational Age: birth weight under 2500g and a gestational age  $\geq 37$  weeks). The results of the survey didn't show particular anomalies in the health reproduction state of women residing in the areas under study (14) with respect to the mean for Sicily. In particular, the sex ratio did not significantly differ from regional values. Only in the areas of Augusta-Priolo and Milazzo was slightly higher but this was not significant, furthermore the rate for still-births did not differ from the regional values. Only for the area of Gela was there a significant decrease in the rate low birth rate, those born with a birth weight under 2500g. The rate of births with a gestational age  $< 37$  weeks showed a significant decrement in the areas under study, except for the area of Milazzo. In this area, it highlighted a significant increase with respect to the regional value. For the areas of Augusta-Priolo and Gela, there was a

significant decrement in SGA with respect to the regional value.

This type of data source (birth certificates), recently reorganized at regional level, may face issues in terms of completeness and accuracy. Good quality of this source could allow specific studies, still analytic, on the reproduction health and the incidence of congenital malformations in the areas at environmental risk and to direct specific surveillance systems.

#### *Use of hospital admissions flow to evaluate costs*

Another study, quite innovative in our region, allowed for the evaluation of the additional costs provided by the health regional service for hospital assistance of people living in the areas near factories. For the cost analysis, results of morbidity, coming from a report on the health state of population living in the industrial areas, was used (9). Only the pathologies showing a significant increase in hospital admissions and with clear evidence of a causal connection with the environmental exposure were studied (15).

The source of economic data came from the hospital discharges (SDO). For the analysis DRGs (Diagnosis Related Group) were used. DRGs is a system in which you can classify hospital cases into one group i.e. a DRG includes cases with similar hospital resource use, as part of the prospective payment system.

It's important to underline that the greater part of the expense for the care of people living in the industrialized areas was used for diagnosis and the care of cardiovascular disease, respiratory disease and, in third place, cancer.

This is the first time this methodological approach has been used in Sicily in order to

undertake an economic evaluation of the health cost related to the provision of assistance to those people living in the areas near factories. Other studies, to evaluate the indirect costs, are necessary.

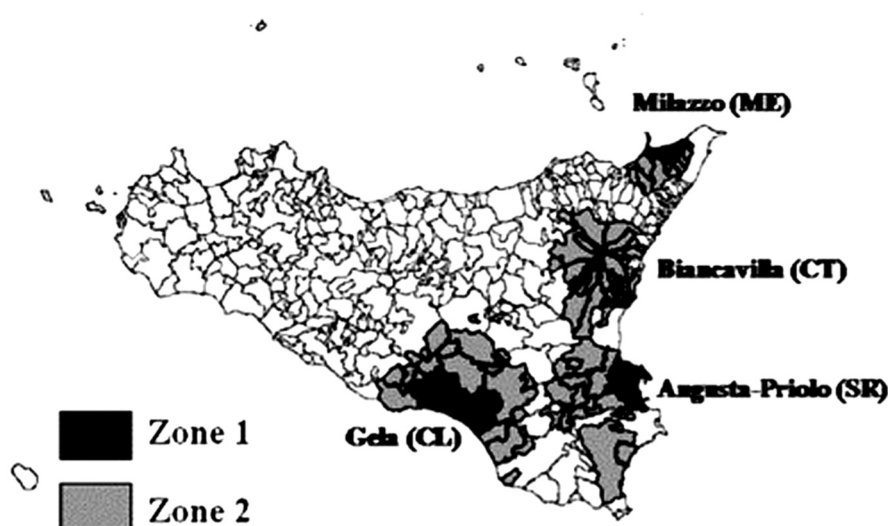
#### *Analytic studies: integration of surveillance systems with informative flows*

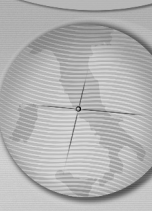
To support the connection between the exposition at environmental polluting substances and health state, analytic studies were conducted on the residential population of these areas. The analysis started during a collaboration between the National Institute of Health, the Epidemiological Regional Department, the local health units of Sicily and the mesothelioma regional register.

In the people living in Biancavilla, through a retrospective study, the incidence of pleural mesothelioma, during the period 1998-2004, was described (16). Elevate rates was found in this area as in other Italian population exposed to the asbestos fibre. For this population was so confirmed a high risk of incidence of mesothelioma and the possible of an other future increment of the incidence for the long period of latency between exposition and illness.

For the area of Milazzo, a retrospective study, on the health state of an occupational cohort from an amianthus-cement ex-factory was undertaken. In order to reconstruct the cohort, and to collect data, we received assistance from the local committee of the exposed ex-workers. The preliminary results showed a higher number of pleural mesothelioma in workers employed in the production of cement and an increase in mortality and morbidity, evaluated through the

Figure 1. Areas at environmental risk of Sicily - Zone 1: In study; Zone 2: Reference.





analysis of data coming respectively from the nominative register of death causes (ReNCaM) and of hospital admission (SDO) for asbestos correlate pathologies (17).

**Surveys ad hoc**

In collaboration with the unit of epidemiology of clinic physiology of the National Research Council of Pisa, the prevalence of congenital malformations in the area of Gela was described (18). The study showed a higher prevalence (the double respect Sicily and Italy) of congenital malformations in children of women living in industrialized area. There was a significant increase in the incidence of hypospadias. This data was similar to that found in other areas of Sicily (Augusta-Priolo) where the presence of teratogenic contaminants and mutagens has caused a significant increase in congenital malformations of the male genitals.

**Conclusions**

Since the first report on Health and Environment was produced by the World Health Organization (WHO) ten years ago, for which only mortality as used to describe the health state of the Italian population living in areas at risk, progress has been made. In Sicily, during this period, experiences and methods for ecological surveys were conducted. Now, besides the register of mortality, we dispose of hospital admissions flows and assistance birth

certificates. These other data sources allow the statistical description of morbidity and of reproductive health state. The results underlined, in particular in the areas of Augusta-Priolo and Gela, excesses in mortality or morbidity for the examined tumoral or non-diseases. This was less evident in the area of Milazzo which has a lower number of factories in respect to the other two. When a diffuse contamination of fluoro-edenitic fibres (i.e. Biancavilla) was present, we observed an excess of mortality and morbidity for asbestos related diseases. The evidence demonstrates a possible link between health status and environmental exposure but it didn't allowed for the controlling of confounders, for example, socio-Economic level, smoking, physical activity, food alimentation etc. Furthermore, the quality of the data or of method of data collection could have influenced the association. An ecological study could therefore only generate a hypothesis to confirm or not confirm results of other more specific studies.

For these reasons, stronger instruments for surveillance of health status are required. This surveillance must be based on the monitoring of the available information flows and on pathology registers to precede illness and highlight the presence of pathology clusters in populations at risk.

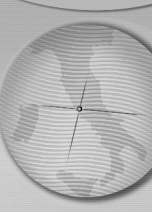
Analyzing just the studies, and their objectives which are currently available for the areas at risk of Sicily, shows that only a small number of cases

**Table 2. Mortality (ICD-IX) and Morbidity (ICD-IX-CM) in the areas at risk in Sicily. These causes showed a significative\* increment of Standardized Mortality Ratio (SMR) and Standardized Hospitalization Ratio\*\* (SHR) in the areas under study (Zone 1) with respect to the reference area (Zone 2).**

Causes (ICD-IX and ICD-IX-CM)	Augusta-Priolo		Biancavilla		Gela		Milazzo	
	Mortality Morbidity		Mortality Morbidity		Mortality Morbidity		Mortality Morbidity	
	M	F	M	F	M	F	M	F
<b>Cancer (140-239)</b>	■	■	■	■	■	■	■	■
Stomach (151)					■			
Colon-rectum (153-154)	■	■				■		
Larynx (161)					■	■		■
Trachea, bronchus and lung (162)	■	■			■	■		
Pleura (163)	■	■	■	■				
Bladder (188)						■	■	
Non-Hodgkin lymphoma (200, 202)								■
<b>Cardiovascular diseases (390-459)</b>		■	■	■	■	■	■	■
Ischemic illness (410-414)		■	■	■	■	■		■
<b>Pulmonary diseases (460-519)</b>	■	■	■	■	■	■	■	■
Acute pulmonary diseases (460-466; 480-487)	■	■	■	■	■	■		■
Chronic pulmonary diseases (490-496)		■	■	■		■		
Asthma (493)						■	■	
Asthma 0-14 (493)						■	■	
Pneumoconiosis (500-505)						■	■	
<b>Kidney illness (580-589)</b>		■				■		

\* p value < 0.05

\*\* Morbidity for hospitalized patients



in the type of environmental pollution known. We often have only evaluation, no preventive analysis of the expected cases to use for good quality statistical. Therefore studies to estimate mortality and morbidity and to confirm the existence of causal relationships between environmental exposures and health effects, with possible environment monitoring, are necessary. Epidemiological studies, used to describe health status, often use adjusted results. Still in Sicily sometimes the outcomes are adjusted, for example for socio-economics status. Stronger studies of association between environmental exposure and health risk must be conducted in Sicily, this may also require the updating and revision of available sources of evidence.

In the end, besides methodological problems, there are problems in the identification of ethological determinants and so of risk assessment, management and communication to population. We must identify the right way to communicate health and risk information to the population, minimizing the problem of misunderstanding caused by the gap between the languages used by the medical fraternity and the general population.

## References

- 1) Ramistella EM, Bellia M, Di Mare S, Rotiroti G, Duscio D. Environmental pollution, derived from industrialization, and cancer mortality. Review of the state of Augusta and Priolo. *Boll Acc Gioenia Sci Nat* 1990;23 (336): 437-62.
- 2) Madeddu A, Contrino L, Tisano F, Sciacca S. The Health of Aretusa and the time master. Atlas of cancer mortality and degenerative chronic diseases in the area of Siracusa during the years 1995-99. *Arti Grafiche Fratantonio Ed. Siracusa*, 2001.
- 3) Madeddu A, Contrino L, Tisano F, Sciacca S. The plague, the plague-spreader and the imaginary. Atlas of cancer mortality and degenerative chronic diseases in the area of Siracusa from the year 1995. II volume, updating three-year period 2000-2002. *Arti Grafiche Fratantonio Ed. Siracusa*, 2003.
- 4) Di Paola M, Mastrantonio M, Carboni M, Belli S, Grignoli M, Comba P, Nesti M. The mortality in Italy for pleura cancer during the years 1988-1992. Rome: Istituto Superiore di Sanità (Report ISTISAN 96/40), 1996
- 5) Mastrantonio M, Belli S, Binazzi A, Carboni M, Comba P, et al., 2002. The mortality in Italy for pleura cancer during the years 1988-1992. Rome: Istituto Superiore di Sanità (Report ISTISAN 02/12), 2002.
- 6) Pasetto R, Bruni B, Bruno C, D'Antona C, De Nardo P, Di Maria G, Di Stefano R, Fiorentini C, Gianfagna A, Marconi A, Paoletti L, Putzu MG, Soffritti M, Comba. Sanitary problems of Biancavilla for amianthus: epidemiological, clinical and experimental aspects. *Not Ist Super Sanità* 2003;17(1): 8-12.
- 7) Basile R, Mollica Nardo G. Epidemiological survey about mortality in the area of Milazzo during the years 1996-99. *O.E. Not Regione Sicilia Assessorato Sanità*, 2003.
- 8) World Health Organization. Environment and Health in Italy. In: Bertollini R, Faberi M, Di Tanno N.(Ed.). Rome: Il Pensiero Scientifico ed.; 1997. p. 451-64.
- 9) Fano V, Cernigliaro A, Scondotto S, Pollina Addario S. The health state of people living in areas at high environmental risk and in the areas of national interest of Sicily: analysis of mortality (1995-2000) and admissions to hospital (2001-2003). *Notiziario O.E. Dip Osservatorio Epidemiologico, Assessorato Sanità, Regione Siciliana. Roma: Casa Editrice Rirea*, 2005.
- 10) Valeria Fano, Achille Cernigliaro, Salvatore Scondotto, Sebastiano Pollina Addario, Sebastiana Caruso, Antonio Mira, Francesco Forestiere, Carlo A. Perucci. Analysis of mortality (1995-2000) and hospital admissions (2001-2003) in the industrial area of Gela. *Epidemiolol Prev* 2006; 30(1): 27-32.
- 11) Achille Cernigliaro, Valeria Fano, Sebastiano pollina Addario, Sebastiana Caruso, Placido Pennisi, Francesco Forestiere, Carlo A. Perucci, Pietro Comba, Salvatore Scondotto. Mortality and hospital admissions in the population of Biancavilla with chronic exposition to natural fibres. *Epidemiol Prev* 2006; 30(4-5): 227-31.
- 12) Cadum E, Costa G, Biggeri A, Martuzzi M. Deprivation and mortality: an index of deprivation for the analysis of geographical inequalities. *Epidemiol Prev* 1999;23(3):175-87.
- 13) Pietro Comba, Lucia Fazzo - Epidemiological study design for pollution areas: validity and feasibility. In F. Bianchi, P. Comba. *Epidemiological survey in polluting areas: the basis for research, methodological and managerial procedures, equity prospective. Rapporto ISTISAN 06/19*, pag. 200.
- 14) Elisa Tavormina, Valeria Fano, Achille Cernigliaro, Salvatore Scondotto. Reproductive health in Sicilian areas at high environmental risk: 1984-1998. 30th AIE Congress - Terrasini (Palermo), pag. 25.
- 15) Sebastiano Pollina Addario, Achille Cernigliaro, Valeria Fano, Gabriella Dardanoni, Francesco Forastiere. Cost evaluation for hospital admission in the Sicilian industrialised areas with an high environmental risk. 30th AIE Congress - 4-6 October 2006 (Palermo), pag. 154.
- 16) Bruno Caterina, Belli Stefano, Cernigliaro Achille, Cossari Pierluigi, Pennisi Placido, Scondotto Salvatore, Tumino Rosario, Nicita Carmela, Zona Amerigo, Comba Pietro. Incidence rate of pleura cancer in Biancavilla during the years 1998-2004. *Spring AIE Congress - Roma 15-16 May 2006*; 31.
- 17) Lucia Fazzo, Achille Cernigliaro, Carmela Nicita, Amerigo Zona, Caterina Bruno, Giovanna Fiumanò, Caterina Villari, Giovanni Pugliesi, Rosario Tumino, Alessandro Marinaccio, Pietro Comba. Epidemiological cohort study of the amianthus-cement workers of Mela San Filippo (Messina). 30th AIE Congress 4-6 october 2006 ;Terrasini (Palermo).
- 18) Fabrizio Bianchi, Sebastiana Bianca, Gabriella Dardanoni, Nunzia Linzalone, Anna Pierini. Congenital malformation in new born in Gela (Sicily, Italy). *Epidemiol Prev* 2006; 30(1): 19-26.