Late Industrial Development and Occupational Health in Southern Italy

GIORGIO ASSENNATO, MD, SCD, MPH, LUCIA BISCEGLIA, MD, GIGLIOLA DE NICHILO, MD, MARIA EMANUELA GRASSI, MD, ANTONIO LO IZZO, MD

The authors report the occupational medicine problems in the Apulia region, which are representative of those in Southern Italy. Late industrialization was associated with an early peak in injuries that was not associated with an increased workforce. Examples of operations adversely affecting worker and population health are presented. *Key words:* industrialization; steel industry; asbestos industry; Italy.

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It is easier to understand the evolution of occupational medicine in Southern Italy when one also knows the socioeconomic forces that have shaped the overall industrial development in the region. We primarily focus on the occupational medicine problems in the Apulia region, where we all work, which may represent a paradigm for the whole of Southern Italy.

SOCIOECONOMIC ANALYSIS

The late industrialization in Southern Italy was based on heavy financial investments in the 1960s that resulted in a widely perceived dualism between a private and profitable industrial system in Northern Italy and state-sponsored and unprofitable industrialization in Southern Italy. The striking geographical heterogeneity is reflected in the percentages of the total population of all non-agricultural workers in 1961: 30.2% in Northern Italy and 9.7% in Southern Italy, the latter showing an increase from 8.2% in 1951, which, however, was partly due to an increase in the numerator, partly due to a decrease in the denominator, linked to the massive emigration that occurred in the early 1960s.[1] In spite of significant investments in the industrial sector in Southern Italy, the total numbers of industrial workers increased from 6,040,000 in 1961 to 6,900,000 in 1975 in Northern Italy, but only from 1,750,000 to 2,600,000 in Southern Italy. The total industrial profits in the manufacturing sector in Southern Italy increased from 747 billion Lire in 1961 to 2,555 billion Lire in 1975, whereas in Northern Italy the figures were 5,580 billion and 11,645 billion Lire, respectively.[2] The political decision to invest in industrial development in Southern Italy resulted in the establishment of capital-intensive enterprises, often called "cathedrals in the desert." The process associated with their location in Southern Italy was described as "industrialization without development."[3]

There are several examples of giant firms located in the region. It was pointed out that several factors need to be considered in evaluating the impact of the new industrialization on the local structure[4]: some firms remain isolated from the local environment; in other situations the new firm is invaded by the local conditions; in others it is the territory that is penetrated by the giant firm, which was the case of Taranto, in Apulia, as described below.

TRENDS IN OCCUPATIONAL INJURIES

The differences in industrial development between Northern and Southern Italy and the different focuses on safety issues are shown by the trends of occupational injuries over 50 years.[5] The incidence rate of occupational injuries (computed per 1,000 workers/year) in Northern Italy increased from 173.19 in 1951 to 243.06 in 1963, while in Southern Italy it varied from 265.98 to 303.37 with a nonlinear trend, since the index was 306.22 in 1952 and the peak (325.42) was observed in 1955. The late introduction of mechanized technologies resulted in an early peak in Southern Italy that was not associated with an increased workforce. What is even more noteworthy is that the injury rate has been consistently higher in Southern Italy, in spite of the much lower level of industrialization (Figure 1).[6]

From the 1980s to the present, incorporation of computerized technology and the approval of laws on work health and safety have resulted in a further gap between Northern and Southern Italy, since compliance with the safety legislation has been slower in the south.[7–9] The numbers of public employees in the occupational health services in charge of controlling the work environments in the plants show striking differences between Northern and Southern Italy, resulting in differences in compliance with the law. For instance, in 2001 the employees in local occupational health

Received from the Occupational Medicine Division, Department of Internal Medicine and Public Health, University of Bari, Bari, Italy.

Address correspondence and reprint requests to: Giorgio Assennato, MD, Dipartimento di Medicina Interna e Medicina Pubblica, Piazza Giulio Cesare 11, 70124 Bari, Italy.

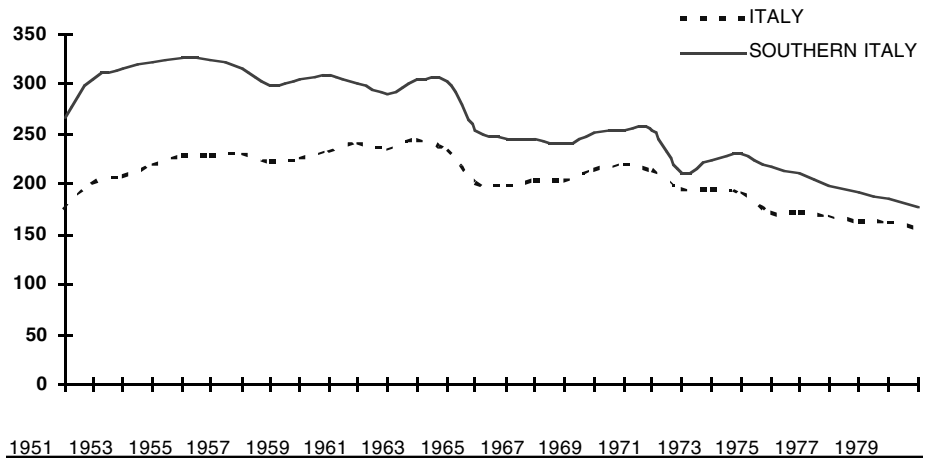


Figure 1—Trend of occupational injuries in industry 1951–1980 (frequency index per 1,000 workers/year), comparing Italy vs Southern Italy (not including islands—Sicily and Sardinia).

services (SPESAL) numbered 137 in Apulia, but many more in Northern regions, e.g., 319 in Veneto, 341 in Piedmont, and 435 in Emilia-Romagna. Such a gap is also explainable on the basis of the much stronger influence of unionized labor, which is a strong determinant of the quality of the practice of occupational medicine in Northern Italy (as recently stated by Howard Frumkin: "If organized labor sneezes, occupational medicine gets a cold."[10])

We present here the experience in Apulia, a region located in the Southeastern Italy (Figure 2), which can be considerated paradigmatic of the industrialization process in Southern Italy.

THE TARANTO STEEL PLANT

The steel center in Taranto represents the best example of a "cathedral in the desert," whose impact on both occupational health and environmental health has been dramatic over the years. The Taranto plant was built over a 15-year period (1960–1975). Direct employment increased from 6,000 to 20,000 workers in the early 1990s, before privatization resulted in a substantial reduction of the workforce. The original operation cost the Italian state around 200 million Lires for each job created. The Taranto plant is still an integrated steel making facility, where raw materials (iron ore, coal, and limestone) are processed to produce finished products (steel sheets, plates, rolls, bars, etc.). Several activities in the integrated steel-making cycle involve procedures provided by subcontractors, which are generally small companies. Within such small companies, a heavy toll of occupational accidents (sometimes fatal) has been paid over the years. Because of the extremely large size of the labor force needed, employment recruitment has extended to distant towns and villages, resulting in transportation problems and in seasonal absenteeism due to the farming activity typical of the new-blue collar workers hired in Taranto. Over the years, and especially after privatization, the relationship of the enterprise to the Taranto population and institutions deteriorated, because of heavy environmental pollution resulting in widespread exposure to polycyclic aromatic hydrocarbons (PAHs) released from the coke oven shops and epidemiologic data showing excesses of several cancers in the area.

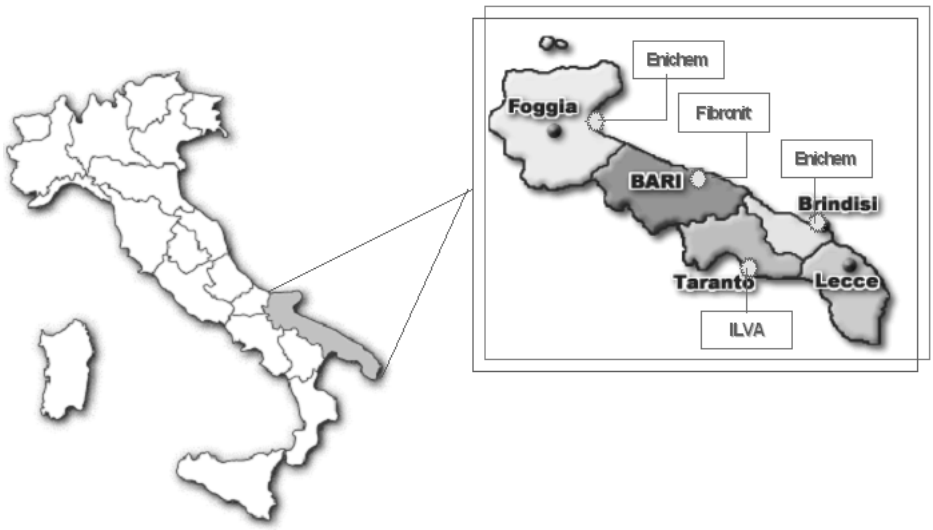
In 2002 a criminal law case was filed by the General Prosecutor in Taranto, accusing the management of the steel plant of criminal misbehavior in condoning inadequacy of industrial hygiene procedures with respect to the oldest batteries of the coke-oven plant. Some of us were appointed by the Taranto Prosecutor to assess occupational exposures to a wide range of volatile coal-tar pitch compounds. The study[11–13] concerned batteries indicated as 3–4 and 5–6, constructed, respectively, in 1964 and 1970. Each couple of batteries consists of 90 ovens. There were critical aspects in the functioning of these batteries, due to their age, characterized by frequent interruptions of production cycles and technical failures.

The survey was carried out with two-day campaigns of monitoring to evaluate external and internal exposures to PAH. Personal air samples from the workers were obtained during the morning shift. On the same days, spot urine samples before and after the shift were collected to determine 1-hydroxypyrene as an internal-dose biomarker. A questionnaire to evaluate potential confounding factors was administered by occupational physicians to collect information about smoking habits, consumption of grilled food, etc.

The results of area sampling on the charging car showed that in the areas near the ovens in coke plants the German technical guiding concentration (TRK) for benzo(a)pyrene of 5 $\mu g/m^3$ was exceeded in 11 of 16 samples. The PAH concentrations in breathing-zone air of coke-oven workers ranged from 20.40 mg/m^3 to 76.68 mg/m^3, with a median of 30,00 mg/m^3.

As for the biological monitoring, 105 workers were involved in the survey, 55 in battery 3–4 and 50 in battery 5–6. The concentrations of 1-OHP in the pre-shift samples ranged from 0.01 $\mu mol/mol_{creat}$ to 1.32 $\mu mol/mol_{creat}$, with a median of 0.33 $\mu mol/mol_{creat}$, and in

Figure 2—The Apulia region (Southern Italy).



post-shift samples ranged from 0.01 µmol/mol$_{creat}$ to 31.04 µmol/mol$_{creat}$, with a median of 2.41 µmol/mol$_{creat}$ (Table 1). Statistical significant differences were observed between hydroxypyrene concentrations of workers belonging to battery 3–4 vs battery 5–6, with battery 3–4 values being higher. Analysis by job title showed significantly higher values in top-side workers.

No statistically significant difference between smokers and non-smokers was found. No confounding role was ascertained for consumption of grilled meat or for having been off the job before the sample collection.

To categorize exposure levels, Jongeneelen and colleagues proposed a three-level benchmark guideline for urinary hydroxypyrene. The first level, 0.24 for non-smokers and 0.76 for smokers, represents the level of background exposure in general population. The second level, 1.4, corresponds to no biological effect. The third level, 2.3, is specific for coke-oven workers: it corresponds to the U.S. threshold limit value of 0.2 mg/m^3 in the benzene-soluble fraction and it is estimated to be associated with a relative risk of lung cancer of 1.3.

Applying these levels to our data, we observed that 34% of the workers in the battery 3–4 exceeded the third level, as did 15% in battery 5–6; 50% in battery 3–4 and 22% in battery 5–6 exceeded the second level; 94% and 70% of non-smokers workers exceeded the first level of 0.24 and 72% and 42% of smokers workers exceeded the level of 0.76. As a consequence of this survey, the management decided to shut down the batteries under study.

THE MANFREDONIA PETROCHEMICAL PLANT

Other examples of a "growth pole" development strategy are present in Apulia, as well as in the rest of Southern Italy. The impact of the new heavy industries on the poor underlying economy resulted in the failure of the so-called induced industrialization, depression of the traditional local firms, a heavy toll of waste sites, old plants to be demolished and cleaned up, and the labeling of areas of high environmental concern (Manfredonia, Brindisi, Taranto). The Enichem petrochemical plant, which produced fertilizers and caprolactam, was built at the end of the 1960s in Manfredonia and closed at the end of the 1980s.

A serious accident occurred in September 1976, when the scrubbing tower for the synthesis of ammonia gases blew up, releasing into the atmosphere several tons of potassium carbonate and bicarbonate solution containing arsenic trioxide. One hundred and fifty people were admitted to the local hospital for arsenic poisoning. The absolute and relative frequencies of subjective symptoms were greater among the inhabitants of Manfredonia than among the factory workers for most of the symptoms evaluated.[14]

The magnitude of the event induced the Institute of Occupational Health of Bari University to perform a survey on 1,188 of the 1,639 workers employed by ANIC, SCD, and their contracting firms at the time of the accident at the Manfredonia Petrochemical plant. The tests were performed during the 50 days immediately after the accident, with the aims preventing the onset of any organic lesions and of obtaining parameters to assess the exposure of the factory workers. There was a higher frequency of urinary arsenic values >1,000 µg/L (the value that was indicated as a biological limit for occupationally exposed subjects) among the workers living in Manfredonia compared with those living elsewhere, demonstrating that pollution had occurred in the town of Manfredonia. The simultaneous increase in transaminases demonstrated a real effect on the liver, albeit slight.[15,16]

In the fall of 1977, 2,253 land samples were taken in an area near the ANIC plant in Manfredonia in order to identify the ground arsenic contamination as a con-

TABLE 1 ILVA Coke Plant: Environmental and Biological Data According to Job Title

Job Title	PAH_t ($\mu g/m^3$)	Pyrene ($\mu g/m^3$)	1-OHP_{pre} ($\mu mol/mol_{creat}$)	1-OHP_{post} ($\mu mol/mol_{creat}$)
Standpipe operator	30.54	2.66	5.4	14.6
Top side worker	73.26	6.58	5.6	15.4
Coke guide operator	67.11	1.32	2.5	2.5
Door operator	56.25	5.19	2.4	3.8
Charging car operator	32.46	0.50	1.4	3.4

sequence of the accident. The results showed arsenic deposited irregularly over a wider area than expected, although the concentrations measured were not high enough to be considered dangerous.[17]

The findings of the survey were published in a monographic issue of *Medicina del Lavoro*[17]: from the point of view of the biological assessment, no association was found between urinary arsenic levels and the occupational exposure. A critical aspect was linked to the urgency of the situation in which the information was collected and to the selected marker of internal dose, which was not able to discriminate the amount of the arsenic excreted after occupational exposure from the amount derived from other sources, such as diet.[18]

In spite of repeated suggestions indicating the need for prolonged surveillance due to the carcinogenicity of arsenic, no subsequent investigation was conducted on the workers , unlike the Seveso experience. Late adverse health effects were highlighted in 1995 by a 47-year-old never-smoker worker affected by lung cancer, who promoted a search for cancer cases among the workers in collaboration with a medical association.[19] After a 30-year interval, a criminal law case was filed on the basis of 26 suspected occupational cancers among the exposed workers, and it is still going on. The worker who started the inquiry died in 1997. No epidemiologic study has been conducted on the general population living near the petrochemical plant.

THE BRINDISI PETROCHEMICAL PLANT

The petrochemical plant in Brindisi and the steel plant in Taranto are still operating, although with smaller workforces. In addition to the adverse health effects on workers, the impacts on the general populations living near the industrial sites and on the environment should be considered.

A case–control study was conducted by Belli at al.[20] to investigate the association between cancer mortality and residence in neighborhood of the Brindisi petrochemical plant. Cases (144) were all subjects resident in the town and in three neighboring municipalities who died in the study area in 1996–1997 from lung cancers, pleural neoplasms, bladder cancers, and lymphohematopoietic malignancies. Controls (176) were subjects resident in the same area who died in 1996–1997 from any other cause. Residence within 2 km from the center of the petrochemical plant was associated with moderate increases in risks for lung, bladder, and lymphohematopoietic neoplasms. These results were confirmed after adjusting for smoking habit, occupation, and education level.

THE ASBESTOS ISSUES

From the point of view of the health impact of industrial activities, the Fibronit experience in Bari is of paramount importance, combining severe effects on the workers' health with dramatic health and environmental problems among the general population living around the contaminated area. The asbestos-cement facility built in the late 1930s, operated until the late 1980s. In the early 1970s, after a protest from the workers' committee at the plant, a survey carried out by the local occupational medicine department showed a very high prevalence of asbestosis and other asbestos-related health effects.

A cause-specific mortality study has been conducted among these workers.[21] The cohort included 417 male subjects employed from February 1, 1972. Employment data were obtained from the personnel roster of the plant and case files. Vital status and cause of death on December 31, 1995 and on December 31, 2000, were ascertained for every cohort member. Workers' mortality was analysed using standardized mortality ratio (SMR). The mortality experience was compared with that of the population resident in Apulia by cause, sex, age, and calendar year. The confounding role of smoking habits was tested by the Axelson method. The Kaplan–Meier procedure was performed to illustrate cohort recruitment and temporal trends for all causes of mortality. For the first follow-up, a graphic representation of the SMR of lung cancer was obtained using the Cox model to shape nonparametrically the SMR on the temporal axis of latency and to explore its relationship with lung cancer.

At the end of the first follow-up period, in 1995, 105 deaths were observed; by December 31, 2000, 40 more workers had died. Using 95% confidence limits estimated by Poisson distribution, in the first follow-up period significantly increased mortality rates for all causes (SMR 118), pneumoconiosis (SMR 14,810), all types of cancer (SMR 139), lung cancer (SMR 190.7), and pleural (SMR 1,578.9) and peritoneal (SMR 1,666.7) malignant neoplasms were found. In the

TABLE 2 Fibronit Mortality Study: Results of Two Subsequent Follow-ups of 417 Male Subjects

	First Follow-up (1995)				Second Follow-up (2000)			
CAUSES	No. Deaths	E	SMR	95% CI	No. Deaths	E	SMR	95% CI
All causes	105	88.64	118.5	96.9–143.4	145	120.14	120.7	102–142
All tumors	40	28.74	139.2	99.5–189.5	58	39.26	147.7	114–191
All respiratory tumors	24	11.7	205.1	131.5–305.2	35	15.36	227.9	164–317
Lung cancer	20	10.49	192	116.5–294.4	25	13.71	182	116.6–259.6
Pleural mesothelioma	3	0.19	1,578.9	325.7–4613.3	10	0.34	2,963	1.594–5.507
Peritoneal mesothelioma	2	0.12	1,666.7	222.3–6018.1	2	0.17	1,165	291.4–4.658
Liver tumors	3	2.87	104.5	21.6–305.4	4	3.44	116.3	43.6–309.8
Colorectal cancer	2	2.41	83	10.1–299.7	2	1.76	113	28.4–454

second follow-up period, further increased mortality rates were observed for all causes (SMR 121.5), all cancers (SMR 149), respiratory cancer (SMR 229), pleural cancer (SMR 2,989), and pneumoconiosis (SMR 15,270) (Table 2). Relevant differences between observed and expected mortality were found 20 years after first exposure for lung cancer and 30 years after first exposure for all cancers and pleural and peritoneal cancers. The SMR of lung cancer investigated using the Cox model showed a curvilinear trend from first exposure, with a peak at 35 years. Our findings were consistent with literature data on asbestos-cement workers, reporting increased mortality from pneumoconiosis, lung cancer, and malign mesothelioma. Such increases could not be entirely explained by smoking. The long period of latency for pleural and peritoneal neoplasms was confirmed in both follow-up studies.[21]

By means of methods based on geographic analysis, the relationship between the presence of the asbestos-cement factory in the urban area of Bari and the spatial distribution of malignant mesothelioma deaths occurring between 1980 and 2001 among residents was analyzed. The data source for the 64 cases studied was the national registry of mesotheliomas (Renam), for the Apulia regional operating center (Cor-Puglia). Both individual data analysis and explorative geographic analysis indicated an increased risk of disease among people living near the asbestos-cement factory: within an area centered on the location of the plants and having a radius of 1 km, the estimated risk was 2.38 times above the reference level.[22]

PERSPECTIVES

As a result of the developmental model imposed to this region, the towns of Brindisi and Taranto have been labeled "areas at high environmental risk" by the Italian Ministry of Environment and have been investigated by the scientific committee WHO–ECEH (World Health Organization–European Center for Environment and Health).[23]

Among the projects for the clean-up of these areas, the Italian Ministry of Environment assigned grants to the Apulian Epidemiologic Observatory to perform the following epidemiologic studies on both workers and the general population:

- Prevalence study of biomarkers of genotoxicity among populations living at different distances from an Italian steel plant at Taranto[24]
- Medical surveillance and health risk assessment study of steel-plant workers
- Assessment of the Cancer Registry of the South Apulia (Provinces of Brindisi, Taranto, Lecce)
- Study of the short-term effects of air pollution on mortality and hospital admissions for respiratory diseases in Taranto
- Medical surveillance and health-risk assessment of petrochemical workers

These studies represent a great opportunity to assess the occupational and environmental health issues related to two typical "cathedrals in the desert." The Southern Italian experience of late industrialization and its consequent problems could provide some lessons for the developing countries that are considering de-localization of heavy industries.[25]

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