# The Italian Surveillance System for Occupational Cancers: Characteristics, Initial Results, and Future Prospects

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**Background** *Occupational cancer monitoring is important for cancer prevention and public health protection. A surveillance system for identifying occupational cancer risks and cancer cases in Italy that are likely to be of occupational origin using information available in the Italian Social Security archives was created and assessed. Persons employed in the private sector, the employing company, its industrial sector, and years of employment are available in these archives.*
**Methods** *A method to find known occupational hazards was first tested using a case-control approach. Cases were from six Italian cancer registries (CRs) and controls were sampled from source populations and as "exposure" the economic sector of the employing company was used. The potential of using hospital discharge records as case sources was subsequently assessed: these cover larger populations and are available more quickly than CR case series.*
**Results** *In the CR-based study many known occupational cancer risks related to specific industrial sectors were identified. By using cases from hospital discharge records many industries at risk were identified, as well as cases of recent diagnosis likely to be of occupational origin. However, for some industrial sectors (e.g., the chemical industry) the approach was unable to detect any excess risk. Furthermore, information on employees in important areas like agriculture, self-employment, and the public sector is not available in the Social Security archives.*
**Conclusions** *This approach appears to be a promising low-cost method for occupational cancer surveillance, at least for some industries, and can be easily implemented in other countries.* Am. J. Ind. Med. 2006. *© 2006 Wiley-Liss, Inc.*

***KEY WORDS: occupational cancer; surveillance; record linkage; case-control***

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## INTRODUCTION

Research on occupational cancers is important for cancer prevention and the safety of the population as a whole [Tomatis, 2000]. The European Community recently urged member states to implement a reporting system for occupational diseases [Bosch, 2003]. Italian law mandates that cancer cases due to occupational exposure should be identified and referred for compensation. However, only a negligible fraction of occupational cancers are identified [Leigh and Robbins, 2004], not simply because of long disease latency and multiplicity of causes, but because occupational histories are almost never taken from cancer patients, even for cancers potentially of occupational origin (e.g., bladder or lung cancer), and treating physicians in general are not ''tuned in'' to the problem of occupational causes of cancer [Merler et al., 1999; Azaroff et al., 2002]. However, it has been estimated that, in the early 1990s, a substantial proportion of workers in the EU were exposed to carcinogens [Kauppinen et al., 2000].

The Italian Occupational Safety Act (legislative decree 626/94) provides for the establishment of a nation-wide occupational cancer registry, under the auspices of the National Institute for Occupational Health (ISPESL), which is entrusted with the tasks of identifying activities associated with cancer risk, and identifying cancer cases likely to be of occupational origin. With a view to setting-up such a system, the National Cancer Institute of Milan and ISPESL began collaborating in 2000 to evaluate the potential of using the electronic database of past employment, available since 1974 at the Italian National Institute for Social Security (INPS). For Italians employed in private companies, and for each year of a person's employment, the name of the employing firm and the industrial sector in which it operates are archived. Archived data for public sector employees and the self-employed are much less detailed.

There are several sources of population-based cancer cases in Italy: cancer registries (CRs), regional mortality archives, and regional hospital discharge records. Appropriate controls can be sampled from electronic population files, also available in many parts of Italy. Therefore, it is possible to carry out population-based case-control studies in order to estimate the risk of cancer by site in relation to industrial sector, by linking cases and controls to their employment histories.

The aim of this research is to assess the potential and limits of this approach. To do this: (a) an analysis of cancer risk by industrial sector using the most recently-available cancer incidence datasets from six Italian CRs is provided, and (b) the preliminary results of a similar analysis confined to the Region of Tuscany, using recent cancer cases identified from hospital discharge records are presented. In both cases occupational data were obtained from the Social Security electronic database of past employment.

## MATERIALS AND METHODS

### Cancer Cases From Cancer Registries

All cancer cases in the age range 35–69 years, incident in various periods from 1990 to 1998 in CRs covering the Veneto Region, the City of Genoa, the Friuli Region, the Province of Varese, the Umbria Region, the Province of Genoa (excluding the chief town), and the Province of Macerata were considered [Parkin et al., 2003]. Cases older than 69 years were not considered as only information on the most recent part of their employment history is retrievable (occupational data only available from 1974). Cases younger than 35 were also excluded because of their small numbers.

For each registry, a random sample of controls from the population resident in each CR area at the center of the incidence period included in the study was extracted from regional health service files. These files include almost all residents, since only people who register with the regional health service have access to a general practitioner.

For a given CR and sex, the same control set was used for all cancer sites. The number of controls was decided based on the most frequent cancer site in each age class (5 years wide): specifically two to four controls were chosen for each case of the most frequent cancer, in inverse relation to the number of cases. Thus there were proportionately more controls for CRs, sex, and age classes with fewer cases.

Only subjects with occupational information were included in the study. The study base [Miettinen, 1985] therefore consisted only of people who had worked in the private sector. Employment histories, consisting of names of companies worked for, their industrial sector codes, and periods of employment, were obtained by automatic linkage to the Social Security (INPS) files. The linkage datum was the Italian personal identification code, generated from the name, surname, sex, date, and place of birth of each individual in Italy. INPS uses a classification scheme (ATECO 91) to place companies in industrial sectors. This scheme is closely similar to that of Revision 1 of the European NACE classification [European Communities, 1990]. Both classify firms in terms of the products, goods, or services they sell, and not in terms of production processes used. However, the ATECO 91 classification is highly detailed, contains numerous categories with small numbers of individual firms allocated to each category. To produce more manageable categories, related industrial activities into larger categories (e.g., the textile industry) were grouped with the assistance of a specialist in occupational medicine.

An individual was considered as ''exposed'' to a given industrial sector if he/she worked for a company in that sector for at least a year. People employed in banks, shops, hotels and restaurants, insurance, education and social services were chosen as the reference category and were thus considered ''unexposed.'' Only the longest period of employment was considered when an individual was employed in different sectors for more than a year. Duration of employment, latency, and exposure time lags were not considered in the present analysis.

Cancer sites were those specified at the 3-digit level of the ninth revision of the International Classification of Diseases. However, the following sites were grouped: colon and rectum, all leukemias, and all non-Hodgkin's lymphomas; furthermore tongue, gum, mouth, oropharynx, hypopharynx, and other and ill-defined parts of the mouth were grouped as oral cavity.

Relative risks (RRs) by sex and cancer site associated with each industrial sector and their 90% confidence intervals (CI) were estimated by unconditional logistic regression, adjusting for age and CR [Breslow and Day, 1980].

To evaluate the ability of the method to detect established carcinogenic hazards, results were compared with evaluations carried out by the International Agency for Research on Cancer [IARC, 1987]. Substances, mixtures and exposure circumstances considered carcinogenic to humans by the IARC (i.e., IARC Group 1) were considered. As target organs those mentioned in a recent review [Tomatis, 2000] were considered and, for carcinogenic substances, industrial sectors where a definite exposure is reported in the IARC monographs. However, some of the instances of exposure classified by the IARC as carcinogenic (e.g., aluminum production) were not present in the dataset. Furthermore, information present in the Italian Social Security archives regarding a company's activity was often insufficient to determine whether or not exposure to a specific carcinogen was present, so that many carcinogenic agents were not investigated in this study.

Plausible excess risks not considered as such by IARC were also reported, where plausibility is indicated by frequent or consistent reports of associations in the existing literature. Incidental findings of excesses of cancer implausibly due to occupational exposure or apparently related to industrial exposure but rarely reported in the literature were not considered, since our primary aim was to assess the ability of the approach to identify established occupational carcinogenic hazards. Use of incidental findings for hypothesis generation is beyond the scope of this article.

### Cancer Cases From Hospital Discharge Records, Region of Tuscany

Population-based CRs are an important and unbiased source of cancer cases. However, CRs cover only about 20% of the Italian population, and cancer registry incidence data become available at least 2 years (and often more) after case occurrence. This delay means that emerging occupational hazards are not detected quickly enough to conduct in-depth investigations (e.g., interviews with cancer patients before they die) to verify working conditions and determine whether exposures continue.

Italian hospital discharge records are another source of cancer cases. In most Italian Regions these records are used as the basis for making payments (from Regional funds) to public and private hospitals for diagnosing and treating patients. Discharge records contain the patient identification code, municipality of residence, diagnostic codes, and date of discharge. They are archived in Regional databases and are available with only a 6-month delay. To explore the use of this information source for identifying occupational hazards, all hospital discharges in the Region of Tuscany from 1998 to 2001 with a diagnosis of lung, pleural, or bladder cancer in the age range 35–74 years were examined. Incident cases for the period 2000–2001 were defined as those discharged during that time with the cancer but with no previous diagnosis of the cancer in 1998–1999. As controls an age- and sex-stratified random sample of the population resident in Tuscany at January 31, 2000 extracted from regional health service files was used. The occupational history of each subject was then sought in the INPS files. The reference category was the same as that used by the CR analysis. RRs by sex and cancer site associated with each industrial sector and their 90% CI were estimated by unconditional logistic regression, adjusting for age [Breslow and Day, 1980].

## RESULTS

### Cancer Cases From Cancer Registries

Table I shows the incidence periods considered, the numbers of incident cases, and the numbers of controls sampled, for each participating CR. The last two columns of the table show the study base, that is, numbers of cases and controls with employment history, and which were therefore included in the analysis. Overall 36,379 cases and 29,572 controls were included in the analysis. The proportions of cases and controls included in the study, relative to total cases and controls, were almost identical: age-adjusted proportions were 0.49 for male cases, 0.49 for male controls, 0.25 for female cases and 0.26 for female controls.

Table II shows RRs of cancer at specific sites in relation to industrial sector with carcinogenic agent or exposure circumstances considered responsible according to the IARC. The cancer sites listed are those mentioned as target organs in a recent review on occupation cancers [Tomatis, 2000].

This case-control study uncovered almost all cancer-occupation associations considered definite by the IARC, and which the dataset was capable of revealing; although some associations were not statistically significant.

Cancer risks for other anatomic sites consistently reported in the literature as associated with the industries

**TABLE I.** Participating Italian Cancer Registries, With Numbers of Incident Cases and Controls

| Cancer registry | Incidence period | Number of cases[a] | Number of sampled controls | Cases included in analysis[b] | Controls included in analysis[b] |
|---|---|---|---|---|---|
| Veneto | 1990–1996 | 41,550 | 18,103 | 14,078 | 6,778 |
| Genoa City | 1986–1996 | 22,780 | 26,670 | 6,910 | 7,396 |
| Friuli | 1995–1998 | 12,281 | 10,200 | 5,519 | 4,434 |
| Varese | 1993–1997 | 10,687 | 10,125 | 5,143 | 4,993 |
| Umbria | 1994–1996 | 7,103 | 7,260 | 2,614 | 2,926 |
| Genoa Province excluding major town | 1993–1996 | 3,155 | 4,823 | 1,061 | 1,543 |
| Macerata | 1995–1997 | 2,616 | 3,660 | 1,054 | 1,502 |
| Totals | | 100,172 | 80,841 | 36,379 | 29,572 |

The last two columns show numbers of cases and controls with adequate occupational histories and who were included in the analysis.
[a]In age range 35–69 years.
[b]Those who worked in a given industrial sector for at least 1 year as reported by Social Security files.

listed in Table II were also found; these are reported here. Increased risk of pleural mesothelioma has been described in woodworking industries [Minder and Vader, 1988]. A considerably increased risk of pleural mesothelioma among men who had worked in such industries was found (RR 2.83; 90% CI 1.23–6.51 based on 7 exposed cases and 570 exposed controls). Increased risk of bladder cancer is frequently reported in men employed in the leather industry [IARC,

**TABLE II.** Relative risk (RR) of Cancer at Specific Sites in Relation to Industrial Sector, With Carcinogenic Agent Considered Responsible According to the IARC

| Industry sector | Agent or exposure circumstance | IARC monograph reference | Site | Sex | Numbers of cases and controls exposed (employed in sector) | RR (90% CI) |
|---|---|---|---|---|---|---|
| Shipyards | Asbestos | Vol. 14 and Suppl. 7 | Lung | M | 120/441 | 1.05 (0.87–1.28) |
| | | | Larynx | M | 40/441 | 1.66 (1.22–2.28) |
| | | | Pleura | M | 22/441 | 4.58 (2.89–7.27) |
| Rubber | Benzene | Vol. 29 and Suppl. 7 | Leukemia | M | 3/83 | 2.18 (0.78–6.08) |
| | | | Leukemia | F | 3/34 | 8.65 (2.88–25.96) |
| Leather and shoes | | | Leukemia | M | 10/300 | 1.48 (0.80–2.73) |
| | | | Leukemia | F | 6/522 | 0.90 (0.42–1.93) |
| Petrol refinery | | | Leukemia | M | 2/118 | 1.50 (0.44–5.17) |
| Metal plating | Chrome, nickel | Vol. 49 | Lung | M | 21/45 | 1.92 (1.21–3.06) |
| Wood industry | Wood dust[a] | Vol. 62 | Nose | M | 3/570 | 2.73 (0.84–8.94) |
| Leather and shoes | Leather industries: boot and shoes manufacture and repair | Vol. 25 and Suppl. 7 | Leukemia[b] | M | 10/300 | 1.48 (0.80–2.73) |
| | | | Leukemia[b] | F | 6/522 | 0.90 (0.42–1.93) |
| | | | Nose | M | 5/2019 | 4.68 (1.65–13.27) |
| | | | Nose | F | 1/1296 | 7.97 (0.76–83.89) |
| Iron and steel making | Iron and steel founding | Vol. 34 and Suppl. 7 | Lung | M | 369/1163 | 1.28 (1.13–1.45) |
| | | | Lung | F | 1/73 | 21.08 (2.73–162.92) |
| Rubber industry | Rubber industry | Vol. 28 and Suppl. 7 | Bladder | M | 10/83 | 1.31 (0.73–2.34) |
| | | | Bladder | F | 5/34 | 1.49 (0.67–3.31) |
| | | | Leukemia[b] | M | 3/83 | 2.18 (0.78–6.08) |
| | | | Leukemia[b] | F | 3/34 | 8.65 (2.88–25.96) |

Sex-specific associations with at least one exposed case are reported.
The cancer sites listed are those mentioned as target organs in a recent review of occupation cancers [Tomatis, 2000].
[a]Including furniture and cabinet-making (Vol 25 and Suppl. 7).
[b]Same figures as reported under benzene.

1987]. We found an indication of increased risk of bladder cancer among men in the leather industry (RR 1.24; 90% CI 0.90–1.70, based on 41 exposed cases and 300 exposed controls); there were only 5 exposed female cases in the leather industry.

It was also found that male employees in the iron and steel industry had an excess of bladder cancer (RR 1.20; 90% CI 1.00–1.44 based on 140 exposed cases and 1,163 exposed controls), again in agreement previous studies [Boffetta et al., 1997].

Excesses of pleural mesothelioma and lung cancer have been reported in rubber industry workers [Weiland et al., 1998]. A non-significant increased risk for lung cancer in men who had worked in this industry (RR 1.25; 90% CI 0.83–1.90 based on 23 exposed cases and 83 exposed controls) and a considerably increased risk of mesothelioma (RR 6.29; 90% CI 1.75–22.54 based on 2 exposed cases and 83 exposed controls).

Other industrial sectors with excess cancer risks by our data are shown in Table III. This table lists only industry-cancer associations supported by previous reports and plausible exposures. None of the industries in Table III are listed by the IARC as definitely associated with a carcinogenic risk to humans.

It is noteworthy that our CR-based study failed to detect cancer risks in the chemical, sheet metal-working, electrical, foodstuff, glass, and plastics industries. The complete study results are available at: www.occam.it.

## Cancer Cases From Hospital Discharge Records, Region of Tuscany

For lung, pleura, and bladder, 4,089 incident cancer cases of age 35–74 years from Tuscany hospital discharge records in 2000–2001 were identified. A random, age- and sex-stratified sample of 14,115 controls from the Regional Health Service file of people resident in Tuscany on December 31, 2000 was obtained. Table IV shows, by sex and cancer site, the numbers identified, and also the study base, that is, the number of people included in the study by virtue of having at least 1 year of occupational history according to the Social Security archive.

The proportions of cases and controls included in the study, relative to total cases and controls, were comparable. The high proportion of pleural cancer cases with an occupational history, relative to controls, is almost certainly due to the high occupational etiologic fraction for this cancer.

Table V shows associations of lung, bladder, and pleural cancer with working in given industries, identified by analysis of the Tuscany hospital discharge database 2000–2001. Only associations previously identified by the IARC or consistently reported in the literature are listed.

Overall increased risks for lung cancer (RR 1.69, 90% CI 1.14–2.49 based on 28 cases and 86 controls) and bladder cancer (RR 2.00, 90% CI 1.38–2.90, based on 30 cases and 86 controls) was found among male chemical industry employees. However, these associations are not reported in

**TABLE III.** Industrial Sectors With Excess Cancer Risk Uncovered by Our Analysis Supported by Previously Published Indications of an Association

| Industry sector | Presumed carcinogenic agent. IARC classification in brackets | Reference | Site | Sex | Numbers of exposed cases and controls | RR (90% CI) |
|---|---|---|---|---|---|---|
| Transport | Diesel (2A) and gasoline (2B) exhausts | Boffetta et al. [1997] | Lung | M | 349/904 | 1.40 (1.23–1.59) |
| | | | Lung | F | 4/92 | 4.71 (1.69–13.16) |
| | | Boffetta and Silverman [2001] | Bladder | M | 132/904 | 1.39 (1.15–1.68) |
| | | | Bladder | F | 1/92 | 4.63 (0.71–30.20) |
| | Benzene (1) | Blair et al. [2001] | Leukemia | M | 32/904 | 1.52 (1.06–2.18) |
| | | | Leukemia | F | 2/92 | 3.75 (1.07–13.14) |
| | Asbestos (1) | Malker et al. [1985] | Pleural mesothelioma | M | 34/904 | 3.24 (2.09–5.02) |
| Building[b] | Asbestos (1) | Dietz et al. [2004] | Larynx | M | 227/2593 | 1.44 (1.22–1.71) |
| | Asbestos (1) | Richiardi et al. [2004] | Lung | M | 961/2593 | 1.28 (1.17–1.41) |
| | | | Lung | F | 2/122 | 2.53 (0.72–8.88) |
| Printing | Azo dyes[a] | Kogevinas et al. [2003] | Bladder | M | 20/168 | 1.78 (1.15–2.73) |
| | | | Bladder | F | 1/91 | 5.02 (0.85–29.63) |
| Paper | Chromium (1) in welding and pipefitting | Teschke et al. [1997] | Nose | M | 2/148 | 9.18 (2.13–39.52) |

Sex-specific associations with at least one exposed case are reported.
[a]IARC evaluation not applicable.
[b]Exposure to many established or probable carcinogens, in addition to asbestos, occurs in the building industry.

**TABLE IV.** Total Cases of Lung, Pleural, and Bladder Cancer Identified as Incident in 2000–2001 From Tuscany Regional Hospital Discharge Records, Together With Numbers of Population Controls

| | Numbers identified | | Numbers included in analysis (percentage of total) | |
|---|---|---|---|---|
| | Men | Women | Men | Women |
| Lung cancer | 2,228 | 480 | 1,319 (59.20) | 182 (37.92) |
| Pleural cancer | 91 | 37 | 61 (67.03) | 19 (51.35) |
| Bladder cancer | 1,770 | 309 | 972 (54.91) | 117 (37.87) |
| Population controls | 10,200 | 3,915 | 5,662 (55.51) | 1,430 (36.53) |

Those included in the analysis had at least 1 year of occupational history.

Table V since they are not supported as such by the literature (risks associated with the chemical industry are reported in terms of exposure to individual chemicals, mixtures, or production processes).

## DISCUSSION

It is unlikely that CR-based findings are subject to major bias since cases were population-based, while controls were sampled from the population files of the source populations; furthermore information on occupation was gathered regardless of case/control status.

People employed in defined ''tertiary'' sectors was used as reference category. It is possible that people in these sectors were of higher socioeconomic status than average, and hence at lower risk of respiratory tract cancers. However, as noted by Kriebel et al. [2004], this is unlikely to have produced an important confounding effect. Furthermore several other industrial sectors (not associated with increased risk) had no increased risk of respiratory cancers using this reference category.

It is important to draw attention to an important limit of this approach. Only the name of the employing company, its main activity, and period the person was employed there are available in Italian Social Security archives; the occupation

**TABLE V.** Excess Risks of Lung, Bladder, and Pleural Cancer by Industry as Identified From the Tuscany Hospital Discharge Database for 2000–2001

| Industry sector, IARC classification in brackets | Presumed carcinogenic agent, IARC classification (in brackets) | Reference | Site | Sex | Relative risk (90% CI) | Numbers of exposed cases/controls |
|---|---|---|---|---|---|---|
| Iron and steel foundries (1) | | | Lung | M | 3.67 (2.62–5.15) | 46/68 |
| | | | Bladder | M | 2.27 (1.52–3.39) | 26/68 |
| Building materials | Asbestos (1) | | Lung | M | 1.81 (1.38–2.38) | 63/188 |
| | Asbestos (1) | | Pleura | M | 5.09 (1.90–13.60) | 5/188 |
| Sheet metal working | Asbestos (1) PAH[a] | | Lung | M | 1.50 (1.24–1.82) | 151/616 |
| | | | Lung | F | 1.56 (0.79–3.07) | 8/36 |
| | Asbestos (1) | | Pleura | M | 4.45 (2.07–9.59) | 14/616 |
| | | Kogevinas et al. [2003] | Bladder | M | 1.15 (0.93–1.42) | 109/616 |
| | | | Bladder | F | 0.94 (0.34–2.61) | 3/36 |
| Leather and shoes (1) | | Walker et al. [1993] | Lung | M | 1.84 (1.40–2.42) | 59/196 |
| | | IARC [1987] | Bladder | M | 1.12 (0.81–1.56) | 34/196 |
| | | | Bladder | F | 1.14 (0.66–1.98) | 13/124 |
| Foodstuffs | | Lagorio et al. [1995] | Lung | M | 1.66 (1.17–2.35) | 33/114 |
| Textiles (2B) | Asbestos (1) | Chiappino et al. [2003] | Pleura | M | 1.41 (0.34–5.88) | 2/165 |
| Rubber (1) | Asbestos (1) | | Pleura | M | 17.83 (4.52–70.31) | 2/21 |
| Building | Asbestos (1)[b] | | Lung | M | 1.67 (1.40–1.99) | 224/716 |
| | Asbestos (1) | | Pleura | M | 2.22 (0.96–5.15) | 9/716 |
| Transport | Diesel (2A) and gasoline (2B) exhausts | Boffetta et al. [1997] | Lung | M | 2.08 (1.62–2.67) | 79/239 |
| | | | Lung | F | 3.88 (0.91–16.53) | 2/4 |
| | Asbestos (1) | | Pleura | M | 4.12 (1.55–10.91) | 5/239 |
| | Diesel (2A) and gasoline (2B) exhausts | Boffetta and Silverman [2001] | Bladder | M | 1.45 (1.09–1.93) | 52/239 |
| Mineral extraction | Radon (1), crystalline silica (1) | Lagorio et al. [1995] | Lung | M | 1.87 (1.24–2.83) | 25/67 |
| Glass (2A, 3) | Asbestos (1), PAH[a] (2A-3) | Bartoli et al. [1998] | Lung | M | 2.18 (1.44–3.29) | 25/62 |
| | Asbestos (1) | | Pleura | M | 11.77 (4.03–34.38) | 4/62 |

Figures with at least one exposed case are reported.
[a]Polycyclic aromatic hydrocarbons.
[b]Exposure to many established or probable carcinogens, in addition to asbestos, occurs in the building industry.

or job description of the employee is unavailable. This results in all individuals in a given industry being considered as ‘‘exposed,’’ irrespective of whether they are, for example, sales representatives, administrative staff or directly concerned with production. Clearly too, individuals exposed to different hazards within a given industry (e.g., mechanics in the textile industry) are not identified. However, such individuals are likely to constitute a small proportion of the whole workforce, and bias due to this source is likely to have had little impact on our estimates.

The above limitation is the consequence of a more general limitation of this approach: that it used information collected for administrative purposes as an indicator of occupational exposure. Such information is extremely limited in its ability to pinpoint exposure to specific hazards. For example, within the chemical industry, cancer hazards are linked to the production of specific chemicals (e.g., vinyl chloride) or types of chemicals, but the actual substances produced by individual companies are not available in the archives; the consequent dilution of risk is almost certainly the main reason for finding of no increase in cancer in certain industries known from other studies to be associated with excess cancers.

Another limitation of the use of Italian Social Security archives is that in Italy industrial sector information is archived only for private sector employees. For other employment categories (agriculture workers and the self-employed—mainly artisans and shopkeepers) only the number of years of employment is recorded; while for public sector employees, only minimal employment information (name of employing body) is archived. These categories of workers are therefore excluded from our approach and risk for these activities would need to be addressed in some other way.

Hospital discharge records are a less accurate case source than CRs. In this part of the study, incident cases were considered as those with no previous diagnosis of the same disease over the previous 2 years. This can result in inclusion of cases with an erroneous diagnosis and inclusion of already prevalent cases not admitted to hospital in the 2 previous years. To estimate the magnitudes of these potential sources of error, these data were compared with estimates obtained by applying incidence rates from the Province of Florence CR for the years 1993–1997, and extrapolating them to the entire population of the Region of Tuscany, of which Florence is the major city. For lung cancer 2,228 male and 480 female incident cases were identified from hospital discharge records, while for the period 2000–2001, 2,294.1 male and 554.9 female cases were estimated. For pleural mesothelioma 91 male cases and 37 female cases were identified compared with 31.6 male and 14.6 female cases estimated. Similarly, for bladder cancer 1,770 male and 309 female cases were found compared with estimates of 2,014.4 and 354.4, respectively. Since coding accuracy is systematically monitored by the Regional health authority, and the numbers of cases detected are close to the numbers expected, it is likely that most cases were correctly diagnosed. However, there were considerably more cases of pleural cancer than expected, in both sexes. This is probably due to the erroneous use of the pleural cancer code for both lung cancers and pleural metastases due to other cancer. Nonetheless, our results for mesothelioma are in agreement with the existing literature, although they do suggest that cases identified should be checked prior to more in-depth investigations.

The role of occupation in the etiology of diseases has been investigated from routinely collected information since the end of nineteenth century [Farr, 1864]. Recently, some northern European countries and Switzerland have started occupational surveillance systems based on data from CRs, with occupations recorded at censuses to estimate occupational cancer risk [Andersen et al., 1999; Bouchardy et al., 2002]. Other systems are based on death certificates [Sala et al., 1998; Aronson et al., 1999]. An important difference between these approaches and the approach presented here is that the Italian Social Security archive potentially provides information on a person’s entire working history, whereas in all the above studies the information on occupation was available for one or two points in time. On the other hand job title was almost always available in these studies, but is never available in Italian Social Security files.

In all the above-mentioned surveillance systems, the aim is to uncover the existence of occupational hazards. However, as far as we are aware, the information gathered has never been used to determine whether the hazards uncovered are still present in the employing firm(s); neither has it been used to identify victims of occupational cancers. In this approach, the name of the employing company and period of employment are available. This makes it possible to investigate in detail for past occupational exposures and determine whether exposure continues. Such information is also likely to be useful for case referral for compensation. Italian legislation mandates that all suspected cases of occupation disease should be referred for examination with a view assigning compensation. As hospital discharge records are available soon after diagnosis they provide a fast-track method of identifying new potential occupational cancer cases to be followed-up by further investigation.

## CONCLUSIONS

This method of case-control analysis using routinely available data has proven able to detect known occupational hazards, using incident cases both from population-based CRs and from hospital discharge records. It is, therefore, useful for detecting past occupational hazards, in particular those that may still be present or newly emerging in a given area, and for identifying recently diagnosed cancer cases that might qualify for compensation under Italian law. The method can be applied over much of Italy, since hospital discharge records are available in almost all regions. It can probably also be applied to other countries with CRs or where hospital discharge records are available and where limited occupational information is routinely available.

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