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Mortality due to tumours of the digestive system in towns lying in the vicinity of metal production and processing installations

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ABSTRACT

Background: Releases to the environment of pollutants from industrial metal production and processing installations can pose a health problem to humans, owing to the toxic substances that such emissions contain.
Objectives: To investigate whether there might be excess mortality due to tumours of the digestive system among the population residing near Spanish metal production and processing installations included in the European Pollutant Emission Register.
Methods: Ecological study designed to examine mortality due to malignant tumours of the digestive system (oral cavity and pharynx, oesophagus, stomach, pancreas, liver, gallbladder, and colon–rectum) at the municipal level, over the period 1994–2003. Population exposure to pollution was estimated on the basis of distance from town of residence to the pollution source. Using mixed Poisson regression models, we analysed: risk of dying from cancer in a 5-kilometre zone around installations by year of commencement of operations; effect of pollution discharge route (air or water) and type of industrial activity; and risk gradient within a 50-kilometre radius of such installations.
Results: Excess mortality (relative risk, 95% confidence interval) was detected in the vicinity of pre-1990 installations for colorectal cancer (1.05, 1.02–1.08 in men; 1.04, 1.00–1.07 in women) and liver cancer (1.06, 1.00–1.12 in men), with this risk being concentrated in installations that released pollution to air. On stratifying by type of industrial activity, statistically significant associations were also observed between the remaining tumours and certain metal production and processing activities. There was also a gradient effect in the proximity to a number of installations.
Conclusions: The results support the existence of an association between risk of dying due to some tumours of the digestive system and residential proximity to the Spanish metal production and processing installations studied.

1. Introduction

Residential proximity to industrial point sources of air and water pollution is a potential source of exposure to known or suspected carcinogens. Metal production and processing installations constitute an industrial sector that warrants special attention by reason of its pollutant emissions. Human exposure to metals is common, due to their wide use in industry and long-term environmental persistence. Historically, the heaviest metal exposures occurred in the workplace or in environmental settings situated close to industrial sources (Hayes, 1997). These types of industries, which include non-ferrous and ferrous metal smelters, emit inorganic arsenic and other metals, such as chromium, cadmium, lead and nickel, regarded as known or possible carcinogens. Furthermore, fumes in the iron and steel foundry industry are known to emit other carcinogenic substances, such as polycyclic aromatic hydrocarbons (PAHs) (Humfrey et al., 1996), while chemical exposures in the primary aluminium industry are known to include numerous toxic substances (Benke et al., 1998). In addition, metalworking fluids (MWFs) –a group of chemical substances which epidemiological evidence has shown to be carcinogenic in humans (Savitz, 2003)– are used in installations for surface treatment of metals and plastic materials, as well as to cool and lubricate metalworking processes. It would thus seem altogether appropriate to assess the possible relationship between such installations and the frequency of cancer in their environs. Among the tumours that have been associated with carcinogens emitted by these industries are those of the digestive system (oral cavity and

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pharynx, oesophagus, stomach, pancreas, liver, gallbladder and colon–rectum) (Clapp et al., 2005; Siemiatycki et al., 2004).

In Spain, tumours of the digestive system represented one third of cancer-related deaths in 2007, with colorectal cancer being the second most frequent site with 13,516 deaths. This same year there were 5747 deaths due to stomach cancer, 4976 due to pancreatic cancer, 4544 due to liver cancer, 2204 due to oral and pharyngeal cancer, 1777 due to oesophageal cancer and 1305 due to gallbladder cancer, in both sexes (Instituto Nacional de Estadística, 2010). These tumour sites share common risk factors, such as tobacco, alcohol (colon–rectum, oral cavity and pharynx, oesophagus, liver and pancreas), ionising radiation (colon–rectum, oesophagus, stomach, liver and pancreas) and type of diet (colon–rectum, oral cavity and pharynx, stomach and pancreas) (Blot et al., 2006; Clapp et al., 2005; Crew and Neugut, 2006; Giovannucci and Wu, 2006; Hsing et al., 2006; London and McGlynn, 2006; Lowenfels and Maisonneuve, 2006; Mucci and Adami, 2002). Insofar as occupational exposure is concerned, some studies have detected an increased risk of tumours of oesophagus, colon–rectum, stomach and pancreas among workers exposed to MWFs and mineral oils, and particularly among workers involved in grinding operations (Calvert et al., 1998; Mirer, 2003; Tolbert, 1997). There are also studies that have associated: exposure to heavy metals with tumours of stomach, pancreas and liver; exposure to organic solvents with tumours of rectum, oesophagus, stomach, liver and pancreas; and exposure to reactive chemicals with tumours of oral cavity and pharynx, liver and pancreas (Blair and Kazerouni, 1997; Clapp et al., 2005; Landrigan et al., 2000; Lynge et al., 1997; Siemiatycki et al., 2004).

The European Pollutant Emission Register (EPER) (EPER, 2009), a public inventory of industries set up by the European Commission under the terms of Directive 96/61/EC, is a valuable resource for monitoring industrial pollution, and enables the possible association between residential proximity to these pollutant installations and risk of cancer mortality to be studied (Garcia-Perez et al., 2009; Monge-Corella et al., 2008; Ramis et al., 2009). One of the EPER's industrial groups encompasses metal production and processing installations, with data on the pollutants released and the geographical coordinates of each installation.

This paper sought to ascertain whether there was excess mortality due to tumours of the digestive system among the population residing in the vicinity of Spanish metal production and processing installations which report their emissions to the EPER.

2. Materials and methods

An ecological study was designed to examine mortality due to tumours of the digestive system at a municipal level (8073 Spanish towns), over the period 1994–2003. Separate analyses were performed for the overall population and for each sex.

Observed municipal mortality data were drawn from the records of the National Statistics Institute for the study period, and corresponded to deaths coded as: malignant neoplasm of lip, oral cavity, and pharynx — codes 140–149 (International Classification of Diseases/ICD-9) and C00–C14 (ICD-10); malignant neoplasm of oesophagus — codes 150 (ICD-9) and C15 (ICD-10); malignant neoplasm of stomach — codes 151 (ICD-9) and C16 (ICD-10);

Table 1
Relative risk of death due to tumours of the digestive system in towns lying at a distance of less than 5 km from metal production and processing installations, estimated using Poisson mixed regression models.

	Metal (all) installations			Pre-1990 installations			Pre-1990 installations					
							Air			Only water		
	Obs[a]	RR	95%CI	Obs[a]	RR	95%CI	Obs[a]	RR	95%CI	Obs[a]	RR	95%CI
Oral and pharyngeal cancer												
Total	4823	0.96	0.92–1.01	4551	0.98	0.94–1.03	2781	0.97	0.92–1.03	1770	0.99	0.93–1.05
Men	4061	0.96	0.91–1.01	3833	0.99	0.94–1.04	2360	0.98	0.92–1.04	1473	0.99	0.92–1.06
Women	762	1.02	0.92–1.12	718	1.01	0.92–1.12	421	1.05	0.93–1.18	297	0.98	0.86–1.11
Oesophageal cancer												
Total	3868	0.95	0.90–1.00	3655	0.97	0.92–1.02	2251	0.98	0.92–1.05	1404	0.96	0.89–1.03
Men	3403	0.93	0.88–0.98	3210	0.96	0.91–1.01	1978	0.97	0.90–1.04	1232	0.94	0.88–1.02
Women	465	1.05	0.91–1.21	445	1.08	0.94–1.24	273	1.11	0.94–1.32	172	1.03	0.85–1.26
Stomach cancer												
Total	12,397	1.00	0.97–1.03	11,672	1.00	0.97–1.03	6893	1.00	0.97–1.04	4779	0.99	0.95–1.03
Men	7602	0.99	0.96–1.03	7191	1.00	0.96–1.04	4252	0.99	0.95–1.04	2939	1.01	0.96–1.06
Women	4795	1.02	0.97–1.06	4481	1.00	0.95–1.05	2641	1.03	0.97–1.09	1840	0.97	0.91–1.03
Pancreatic cancer												
Total	7719	0.98	0.94–1.01	7284	0.99	0.95–1.02	4203	1.00	0.96–1.05	3081	0.97	0.92–1.02
Men	4122	1.00	0.95–1.05	3899	1.01	0.96–1.06	2238	1.02	0.96–1.08	1661	1.00	0.94–1.07
Women	3597	0.96	0.91–1.01	3385	0.96	0.91–1.01	1965	0.99	0.92–1.05	1420	0.93	0.87–1.00
Liver cancer												
Total	5154	1.05	1.00–1.10	4875	1.06	1.01–1.11	2676	1.11	1.04–1.18	2199	1.01	0.95–1.07
Men	3768	1.05	1.00–1.11	3551	1.06	1.00–1.12	1963	1.10	1.02–1.17	1588	1.02	0.96–1.10
Women	1386	1.05	0.96–1.14	1324	1.05	0.96–1.14	713	1.14	1.01–1.27	611	0.98	0.87–1.09
Gallbladder cancer												
Total	2652	1.00	0.94–1.06	2514	0.99	0.93–1.05	1390	0.96	0.89–1.04	1124	1.01	0.94–1.10
Men	895	1.02	0.93–1.12	852	1.03	0.93–1.13	461	0.96	0.85–1.09	391	1.10	0.97–1.25
Women	1757	1.01	0.94–1.09	1662	0.99	0.92–1.06	929	1.00	0.91–1.09	733	0.98	0.89–1.08
Colorectal cancer												
Total	23,217	1.04	1.02–1.07	21,883	1.04	1.02–1.07	12,514	1.06	1.03–1.09	9369	1.02	1.00–1.05
Men	13,057	1.05	1.03–1.08	12,256	1.05	1.02–1.08	7088	1.06	1.02–1.09	5168	1.04	1.00–1.08
Women	10,160	1.03	1.00–1.06	9627	1.04	1.00–1.07	5426	1.06	1.02–1.11	4201	1.01	0.96–1.05

[a] Observed.