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Mortality of filling station attendants

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OBJECTIVES — Gasoline contains established human carcinogens, such as benzene. The health impact of exposure to this fuel, however, has not been fully elucidated. We report on the mortality of a cohort of 2665 filling station managers from the Latium region (Italy).

METHODS — This is the first workplace-based cohort of gas station attendants. However, only self-employed individuals were available for study (about 50% of the whole work force). The follow-up period extended from 1981 through 1992. The mortality experience of the cohort was compared with that of the regional population.

RESULTS — The overall analysis for standardized mortality ratios (SMR) showed a significantly decreased mortality from all causes, mainly due to a deficit of cardiovascular diseases and malignant neoplasms. Nonsignificantly increased risks for esophageal cancer [SMR 241, 90% confidence interval (90% CI) 82-551], brain cancer (SMR 195, 90% CI 77-401) and non-Hodgkin's lymphoma (SMR 173, 90% CI 47-448) were found for the men; mortality due to lung cancer and leukemia was lower than expected, and no kidney cancer death was recorded. Among the attendants of small stations (characterized by a small number of employees and high sales of gasoline per full-time employee), the SMR values for esophageal cancer (for men SMR 351, 90% CI 120-803) and brain cancer (for men and women SMR 266, 90% CI 105-559) showed increased values.

CONCLUSIONS — Filling station attendants are exposed to gasoline vapors and seem at risk of cancer of various sites. Due to the power limitations of this study, however, a precise estimate of the risk for many causes of death was not achievable. Further cohort studies of greater size are warranted.

KEY TERMS — benzene, cohort, gasoline exhausts, gasoline vapors, occupational cancer.

Gasoline is a complex and highly variable mixture of aliphatic and aromatic hydrocarbons, mainly of low molecular weight (1). Exposures to gasoline fuel and to exhausts from engines operating on gasoline are considered by the International Agency for Research on Cancer as possibly carcinogenic to humans (2-3).

So far, however, the health impact of exposure to petroleum fuels has not been fully elucidated (4). In particular, the hazard posed by exposure to benzene via gasoline vapors and exhausts is of major concern, due to the great number of workers employed in petroleum distribution trades and to the relevant contribution of such sources to the pollution burden in urban environments (5, 6).

While in the United States and northern Europe self-service stations dominate, Italy and other southern European countries still employ large numbers of workers in gasoline retail trades. In this paper we

describe the mortality experience of a cohort of filling station attendants from a region of central Italy.

Subjects and methods

Cohort design

A nationwide survey of service stations was carried out in Italy in 1980. Information on several characteristics of the stations and their managers was collected during the survey, such as the name, date of birth and length of employment of the manager, the number of attendants, the quantity of fuel sold in the previous four years, and the number of fuel deliveries to the station per year. Detailed data for the Latium region (central Italy) were obtained, and managers who were clearly identifiable as individuals (as opposed to commercial houses) and who were still alive on 1 January 1981 were considered eligible for the study [2665 stations and managers out of 3272 original records (81.4%)].

The cohort consisted of 2665 service station managers (2308 men and 357 women). At entry into the study their age averaged 46 years, their mean length of employment was 14 years, and most of them (91%) were full-time employees (table 1). At the end of the study, 2236 subjects were still alive (84%), 270 had died (10%), and 159 had not been traced

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Table 1. Distribution of filling station attendants by gender according to age and length of employment at entry, worktime, vital status at the end of the follow-up, and person-years of observation.

	Men		Women		Total	
	N	%	N	%	N	%
Age at entry (years)						
19–24	67	2.9	11	3.1	78	2.9
25–34	334	14.5	62	17.4	396	14.9
35–44	632	27.4	90	25.2	722	27.1
45–54	704	30.5	102	28.6	806	30.2
≥55	571	24.7	92	25.8	663	24.9
Total	2308	100.0	357	100.0	2665	100.0
Length of employment at entry (years)						
1–10	863	39.2	210	63.8	1073	42.4
11–20	897	40.8	85	25.8	982	38.8
≥21	439	20.0	34	10.3	473	18.7
Worktime						
Full-time	1941	92.5	228	81.1	2169	91.2
Part-time	157	7.5	53	18.9	210	8.8
Vital status						
Alive	1922	83.3	314	88.0	2236	83.9
Deceased	250	10.8	20	5.6	270	10.1
Lost to follow-up	136	5.9	23	6.4	159	6.0
Person-years by age						
≤29	785	3.3	113	2.9	898	3.2
30–39	3487	14.5	622	16.1	4109	14.7
40–49	6617	27.5	1020	26.4	7637	27.4
50–59	7228	30.1	1113	28.8	8341	30.0
60–69	4252	17.7	706	18.3	4958	17.8
≥70	1664	6.9	291	7.5	1954	7.0
Total	24033	100.0	3864	100.0	27897	100.0

Table 2. Characteristics of the 2665 stations whose managers were enrolled in the cohort study, by station size.

Station size	Yearly gasoline sales		Capacity of underground gasoline tank		Number of employees		Yearly gasoline sales per full-time employee	
	Number of stations	Mean number of liters	Number of stations	Mean capacity (m ³)	Number of stations	Mean number of employees	Number of stations	Mean number of liters
Small	1720	409 605	1738	9.64	1683	1.87	1659	264 213
Large	911	544 099	918	16.08	898	2.95	889	218 573

(6%). No information on the cause of death was available for 12 deceased persons (4%).

Some characteristics of the 2665 service stations in 1980 are described in table 2 by station size. Large stations, as expected, had higher sales of gasoline, underground tanks of greater capacity, and a greater number of employees than the small stations. The latter, however, were characterized by significantly higher sales of gasoline per full-time employee.

Each subject was considered from 1 January 1981 through 31 July 1991 if resident in Rome at the time of entry into the study, or through 30 June 1992 if resident in any other municipality within the Latium region. Vital status was ascertained through the registry of the last municipality of residence. The code for the underlying cause of death in the International Classification of Diseases (ICD), IX revision, was

retrieved by means of various methods, as described in detail elsewhere (7): first, through record linkage with the National Mortality File for deaths occurring before 1986; second, through record linkage with the Regional Death Index for deaths occurring during the period 1986–1992; third, from the registry of the municipality where the death occurred for those cases for which linkage procedures were unproductive. In the last case [75 out of 270 deceased individuals (28%)], the underlying cause of death was coded by an expert nosologist.

For the calculation of person-years at risk of dying, each subject was considered from 1 January 1981 until the end of the study period or the date of death. Those lost to follow-up were considered alive at the end of the study period. Standardized mortality ratios (SMR) and their 90% confidence intervals (90%

CI) were used to compare the mortality experience of the cohort with that of the regional population. The expected number of deaths was calculated with the use of gender-, age- and period-specific regional mortality rates. The statistical package OCMAP (8) was used for the analysis.

Exposure assessment

Information on duration of employment at entry, along with a series of indicators of work load, were available for all cohort members from the 1980 survey. No vapor recovery system has been enforced in Italy, and the relative quantity of fuel sold has remained relatively stable. Unleaded gasoline, in fact, still accounts for less than 5% of the total amount of marketed fuel. Due to the characteristics of Italian service stations, the yearly average quantity of gasoline sold per full-time employee can be considered an indicator of the average intensity of exposure experienced by the manager at refuelling.

Exposure to aromatic hydrocarbons among currently employed filling station workers was estimated by means of an environmental survey taken in 1992 (9). Measured concentrations of benzene, toluene, and xylenes [8-h time-weighted averages (TWA)] averaged 0.55, 0.71, and 0.32 mg · m⁻³, respectively. The number of vehicles filled, the daily sales of super premium gasoline and motor-bike fuel, and the winter season were all significant predictors of the logarithmic concentration of benzene (8-h TWA) in the simple regression analyses. The size of the station acted as an exposure modifier. While no single variable was able to predict the benzene level in large stations, for small stations an increase of 0.0579 and 0.0418 in the log benzene concentration per unit of increase in super premium gasoline (100 l) and in motor-bike fuel (10 l), respectively, was estimated. The overall variance explained by the multivariate

model was, however, only 12.3%. Therefore, a clearly defined categorization of the subjects into groups with internally homogeneous and significantly different exposure levels was not feasible. As regards the exposure assessment of the cohort, it seems that workers in small-size stations with higher sales of super premium gasoline may experience higher levels of exposure. We decided, consequently, to examine in detail this group of workers.

Results

All-cause mortality was significantly decreased, mainly due to a deficit in cardiovascular diseases and malignant neoplasms. The risk of blood disease (among both the men and the women) and injuries (only among the men) was increased, but the excess was not statistically significant (table 3).

Although cancer mortality was lower than expected, nonsignificantly increased risks were found for non-Hodgkin's lymphoma and for esophageal and nervous system cancers among the men (table 4). One case of soft-tissue sarcoma and one case of melanoma were observed versus 0.2 and 0.7 expected, respectively. The risk of colon and bladder cancers was slightly elevated, while mortality due to lung cancer and leukemia was lower than expected. No kidney cancer death was recorded, whereas two cases were expected. The number of deaths recorded among the women was very small (20 deaths, 5 cancers). Excess risks were found for pancreatic, uterine, and brain cancer, but each excess was based on one observed case (table 4).

Among the attendants of small stations, the SMR values for esophageal and brain cancer showed increased values when compared with the overall findings, reaching statistical significance among the men and in the whole subcohort. Moreover, the ex-

Table 3. Mortality of the service station attendants from the Latium region (1981–1992) by broad groups of causes of death. (O = observed deaths, E = expected deaths, SMR = standardized mortality ratio, 90% CI = 90% confidence interval)

Cause of death ^a	Men				Women				Total			
	O	E	SMR	90% CI	O	E	SMR	90% CI	O	E	SMR	90% CI
Infectious diseases (001–009)	—	1.8	·	·	1	0.1	769	39–3649	1	1.9	52	3–247
Malignant neoplasms (140–208)	78	99.6	78	64–95	5	8.9	56	22–119	83	108.5	77	63–92
Benign and unspecified neoplasms (210–239)	1	1.3	77	4–365	—	0.1	·	·	1	1.4	69	4–329
Diabetes mellitus (250)	7	9.6	73	34–138	1	1.5	67	3–316	8	11.1	72	36–131
Blood (280–289)	1	0.8	127	6–601	1	0.1	1111	57–5271	2	0.9	227	40–715
Nervous system (320–359)	4	4.4	92	31–210	—	0.5	·	·	4	4.8	83	28–190
Circulatory system (390–459)	97	114.7	85	71–210	6	9.6	62	27–123	103	124.3	83	70–98
Respiratory system (460–519)	14	19.4	72	44–113	—	1.0	·	·	14	20.4	69	41–107
Digestive system (520–579)	15	22.0	68	42–105	3	1.5	200	55–517	18	23.5	76	49–113
Genitourinary system (580–629)	2	4.1	49	9–153	—	0.3	·	·	2	4.4	45	8–142
Accidents and violence (800–999)	21	14.7	143	96–205	1	1.0	96	5–456	22	15.8	140	94–199
Ill-defined conditions (780–799)	10	·	·	·	2	·	·	·	12	·	·	·
All causes (001–999)	250	297.6	84	76–93	20	25.3	79	52–115	270	322.9	84	76–92

^a Code of the International Classification of Diseases, IX revision, in parentheses.

Table 4. Cancer mortality of the service station attendants from the Latium region (1981–1992). (O = observed deaths, E = expected deaths, SMR = standardized mortality ratio, 90% CI = 90% confidence interval)

Cause of death ^a	Men				Women				Total			
	O	E	SMR	90% CI	O	E	SMR	90% CI	O	E	SMR	90% CI
Oral cavity and pharynx (140–9)	1	2.7	38	2–179	—	0.1	·	·	1	2.7	37	2–174
Digestive organs (150–9)	22	31.9	69	47–98	1	3.0	33	2–157	23	34.9	66	45–93
Esophagus (150)	4	1.7	241	82–551	—	0.1	·	·	4	1.7	234	80–535
Stomach (151)	6	9.3	64	28–127	—	0.7	·	·	6	10.0	60	26–118
Colon (153)	6	5.3	113	49–224	—	0.6	·	·	6	5.9	102	44–201
Liver (155)	3	5.8	52	14–135	—	0.5	·	·	3	6.2	48	13–125
Pancreas (157)	2	3.6	55	10–173	1	0.3	303	15–1438	3	4.0	76	21–195
Respiratory organs (160–5)	33	37.0	89	65–119	—	0.9	·	·	33	37.9	87	64–117
Larynx (161)	3	2.9	105	29–272	—	0.0	·	·	3	2.9	105	29–270
Lung (162)	29	32.3	87	64–123	—	0.8	·	·	29	34.1	85	61–116
Connective tissue (171)	1	0.2	588	30–2791	—	0.0	·	·	1	0.2	526	27–2497
Melanoma (172)	1	0.7	137	7–650	—	0.1	·	·	1	0.8	123	6–586
Breast (174–5)	—	0.0	·	·	2	1.9	104	18–328	2	2.0	102	18–321
Uterus (179–80, 182)	·	·	·	·	1	0.7	154	8–730	1	0.7	154	8–730
Prostate (185)	2	5.3	38	7–119	·	·	·	·	2	5.3	38	7–119
Bladder (188)	6	4.9	122	53–242	—	0.1	·	·	6	5.0	120	52–236
Kidney (189)	—	2.3	·	·	—	0.1	·	·	—	2.4	·	·
Nervous system (190–2)	5	2.6	195	77–411	1	0.3	400	20–1898	6	2.8	214	93–421
Site unspecified (195–9)	2	3.7	54	10–169	—	0.4	·	·	2	4.1	48	9–152
Lymphohematopoietic (200–8)	5	6.7	75	29–157	—	0.7	·	·	5	7.3	68	27–143
Non-Hodgkin's lymphoma (200, 202)	3	1.7	173	47–448	—	0.2	·	·	3	1.9	158	43–408
Leukemia (204–8)	2	3.3	61	11–192	—	0.3	·	·	2	3.6	56	10–175

^a Code of the International Classification of Diseases, IX revision, in parentheses.**Table 5.** Mortality of the attendants of small service stations from the Latium region (1981–1992) by selected causes of death. (O = observed deaths, E = expected deaths, SMR = standardized mortality ratio, 90% CI = 90% confidence interval).

Cause of death ^a	Men				Women				Total			
	O	E	SMR	90% CI	O	E	SMR	90% CI	O	E	SMR	90% CI
Malignant neoplasms (140–208)	60	68.6	87	70–108	3	5.99	51	14–133	63	74.4	85	68–104
Esophagus (150)	4	1.1	351	120–803	—	0.0	·	·	4	1.2	342	117–782
Colon (153)	5	3.7	136	54–286	—	0.4	·	·	5	4.1	123	48–258
Pancreas (157)	2	2.5	80	14–252	1	0.2	476	24–2259	3	2.7	111	30–286
Larynx (161)	3	2.0	153	42–396	—	0.0	·	·	3	2.0	152	42–394
Lung (162)	22	22.7	97	63–138	—	0.5	·	·	22	23.3	95	64–135
Connective tissue (171)	1	0.1	833	43–3953	—	0.0	·	·	1	0.1	769	39–3649
Melanoma (172)	1	0.5	204	10–968	—	0.0	·	·	1	0.6	182	9–863
Bladder (188)	4	3.5	116	40–265	—	0.1	·	·	4	3.5	113	39–259
Kidney (189)	—	1.6	·	·	—	0.1	·	·	—	1.6	·	·
Nervous system (190–2)	4	1.7	233	79–532	1	0.2	625	32–2965	5	1.9	266	105–559
Lymphohematopoietic (200–8)	2	4.6	44	8–138	—	0.4	·	·	2	5.0	40	7–126
Non-Hodgkin's lymphoma (200, 202)	2	1.2	171	30–538	—	0.1	·	·	2	1.3	156	28–492
Leukemia (204–8)	—	2.3	·	·	—	0.2	·	·	—	2.5	·	·
Blood (280–289)	1	0.6	182	9–863	1	0.1	1667	85–7907	2	0.6	323	57–1015
Nervous system (320–359)	1	3.1	33	2–155	—	0.3	·	·	1	3.4	30	2–140
Circulatory system (390–459)	70	80.7	87	70–106	2	6.5	31	5–97	72	87.2	83	67–100
Respiratory system (460–519)	7	13.9	50	24–95	—	0.7	·	·	7	14.6	48	23–90
Accidents and violence (800–999)	13	9.9	132	78–209	—	0.7	·	·	13	10.6	123	73–195
All causes (001–999)	178	207.2	86	76–97	13	16.9	77	45–122	191	224.2	85	75–96

^a Code of the International Classification of Diseases, IX revision, in parentheses.

cesses of blood diseases, soft tissue sarcoma, and melanoma were concentrated into this subcohort (table 5). For these workers, furthermore, an increased risk of laryngeal cancer was recorded. The excess risk of non-Hodgkin's lymphoma was, however, almost equally distributed among the two subcohorts (tables 5 and 6). Attendants of large service stations, on the other hand, showed increased risks of bladder cancer, leukemia, and nervous system diseases (table 6).

Discussion

This study represents the first workplace-based cohort of filling station attendants. In fact, epidemiologic investigations of this occupational group are particularly difficult to carry out because managers, although directly involved in refueling, are self-employed workers, attendants are scattered among a large number of very small stations, and neither of these groups are generally subject to any form of centralized personnel record-keeping requirements.

Table 6. Mortality of the attendants of large service stations from the Latium region (1981–1992) by selected causes of death. (O = observed deaths, E = expected deaths, SMR = standardized mortality ratio, 90% CI = 90% confidence interval).

Cause of death ^a	Men				Women				Total			
	O	E	SMR	90% CI	O	E	SMR	90% CI	O	E	SMR	90% CI
Malignant neoplasms (140–208)	18	31.0	58	37–86	2	3.0	67	12–211	20	34.0	59	39–85
Esophagus (150)	—	0.5	—	—	—	0.0	—	—	—	0.5	—	—
Colon (153)	1	1.6	62	3–293	—	0.2	—	—	1	1.8	55	3–261
Pancreas (157)	—	1.1	—	—	—	0.1	—	—	—	1.3	—	—
Larynx (161)	—	0.9	—	—	—	0.0	—	—	—	0.9	—	—
Lung (162)	7	10.5	67	31–125	—	0.3	—	—	7	10.8	65	30–122
Connective tissue (171)	—	0.1	—	—	—	0.0	—	—	—	0.1	—	—
Melanoma (172)	—	0.3	—	—	—	0.0	—	—	—	0.3	—	—
Bladder (188)	2	1.4	139	25–437	—	0.1	—	—	2	1.5	134	24–423
Kidney (189)	—	0.7	—	—	—	0.1	—	—	—	0.8	—	—
Nervous system (190–2)	1	0.9	116	6–552	—	0.1	—	—	1	0.9	106	5–505
Lymphohematopoietic (200–8)	3	2.1	142	39–366	—	0.2	—	—	3	2.3	128	35–331
Non-Hodgkin's lymphoma (200, 202)	1	0.6	179	9–847	—	0.1	—	—	1	0.6	161	8–765
Leukemia (204–8)	2	1.0	196	35–617	—	0.1	—	—	2	1.1	177	31–557
Blood (280–289)	—	0.3	—	—	—	0.0	—	—	—	0.3	—	—
Nervous system (320–359)	3	1.3	231	63–596	—	0.2	—	—	3	1.5	204	56–527
Circulatory system (390–459)	27	34.0	80	56–110	4	3.1	129	44–296	31	37.1	84	61–113
Respiratory system (460–519)	7	5.5	127	59–238	—	0.3	—	—	7	5.9	120	56–225
Accidents and violence (800–999)	8	4.9	165	82–297	1	0.3	294	15–1395	9	5.2	173	90–302
All causes (001–999)	72	90.4	80	65–97	7	8.3	84	39–158	79	98.8	80	66–94

^a Code of the International Classification of Diseases, IX revision, in parentheses.

The following three issues are worth discussing: (i) the completeness of the cohort in relation to available sources which catalogue workers employed in this trade, (ii) a comparison of our findings with results from available relevant studies, (iii) and, finally, the major shortcomings of this study.

In the 1981 Italian census, the economic sector “retail sales of fuels and lubricants” listed 32 034 local units and 60 869 workers. More than 50% of the work force consisted of self-employed workers ($N = 32\,606$), 20% were employed family members ($N = 12\,439$), 4% were salaried clerks ($N = 2\,470$), and 22% were workmen ($N = 13\,354$) (10). Within the Latium region, according to the census (11), there were 3077 service stations, employing 5784 workers. Of these, 3018 were self-employed workers (54%), 1040 were employed family members (18%), 172 were salaried clerks (3%), and 1464 were workmen (25%). The cohort data source recorded a higher number of service stations ($N = 3272$) one year earlier, a finding compatible with normal market fluctuations.

We studied, therefore, about half of the whole work force employed in gasoline service stations in the region, namely, the self-employed managers, excluding family and salaried workers. The mortality experience of these populations might be different from that of the one under study. However, as most of the cohort members declared full-time employment [2169 out of 2379 with available information (91.2%)] and the majority of their stations employed one or two workers [1827 out of 2581 with available information (70.8%)], we deemed that our “filling station attendants” were directly involved in refueling.

We found excess risks, although not statistically significant, for blood diseases, esophageal cancer,

nervous system cancer, and non-Hodgkin's lymphoma in the whole cohort. Moreover, an increase in the SMR values for these causes of death was found for the managers of small stations, along with an excess risk for laryngeal cancer. Managers of large stations, on the other hand, showed increased risks for bladder cancer, leukemia, and nervous system diseases. The exposure profile of small station workers can be the most easily characterized in terms of gasoline vapors and exhausts, while attendants in large stations were involved in other tasks besides refueling, such as mechanical, electrical, and tire repairing jobs. This difference could explain, at least partially, the different patterns of mortality observed.

Previous findings relating to risk excesses among filling station attendants stem from surveillance systems of occupational mortality or cancer incidence. Auto service and gasoline station workers in California (1959–1961) showed significantly elevated proportional mortality ratios (PMR) for oral cavity, lung, and testicular cancers (12). Among the service station owners and attendants in Washington State (1950–1979) elevated PMR values were found for cancers of the oral cavity, kidney, bladder, and testis and for aplastic anemia (13). In Massachusetts (1971–1973) a small increase in the PMR for leukemia was found for auto mechanics and gasoline station attendants (14). Service station workers in New Hampshire (1975–1985) showed increased mortality for leukemia, suicide, emphysema, and mental and psychoneurotic conditions (15). Owners of filling stations in Denmark, as defined on the basis of the 1970 Danish census, showed an increased incidence of kidney cancer over the period 1970–1980 (16). They were also found to be at increased risk of dying from respiratory cancers over the period 1970–1987 (17). A significantly

increased standardized incidence ratio (SIR) for acute myeloid leukemia was found among Swedish gasoline station attendants, as of the 1970 census, followed-up over the period 1971–1984 (18). In the Montreal multisite, multiple-exposure case-referent study, exposure to automotive gasoline was associated with a significantly increased risk of stomach cancer, with a dose-response effect (19), while exposure to gasoline exhausts proved to be associated with excess risk of rectal cancer, also with a dose-response effect (20).

Further evidence about increased risk at different cancer sites in association with exposures relevant to filling station attendants (benzene, hydrocarbons, fuels, vehicle exhausts, and combustion products) was found in case-referent studies on leukemia (21–26), multiple myeloma (27–28), and esophageal (29), laryngeal (30), bladder (31–35), kidney (19, 36–42) and lung (43–46) cancers. An excess risk of developing soft-tissue sarcomas for long-term occupational exposure to benzene and other solvents was reported in a case-referent study from north-eastern Italy (47). Increasing risk with increasing level of exposure to benzene was found in a case-referent study in the United States on non-Hodgkin's lymphoma (48). Excess risks for brain tumors have been associated with employment in petroleum refining (49). Finally, increased risks of kidney cancer, leukemia, and cancers of the larynx and prostate were found in a cohort of 23 306 British oil distribution workers (50).

Our findings essentially confirm previously reported excess risks, with the remarkable exclusion of kidney cancer, for which no death was recorded. The deficit in mortality from all causes, cardiovascular diseases, and respiratory diseases could be ascribed to the relatively low duration of the follow-up, and to the combination of factors generally referred to as the "healthy worker effect." In spite of an increase in mortality from lung cancer, as reported in association with exposure to exhausts from engines operating on diesel fuel (3), we observed an SMR below the null value. The observed excesses of blood and nervous system diseases deserve attention, in view of the exposure to the hematological and neurological toxicants present in gasoline vapors.

A major drawback is that the power of this study, for most of the causes of interest, was low and the duration of the follow-up might have been insufficient for cancers that have a long induction period. Furthermore, because of the lack of information on employment termination dates, we did not examine the observed excess risks by length of employment, a usual proxy for duration of exposure.

Lack of information about smoking habits and alcohol consumption is undoubtedly a weakness of this study. Nevertheless, mortality due to tobacco- and alcohol-related causes of death (lung cancer, respiratory diseases, and digestive diseases, particularly cirrhosis of the liver) was not increased in the co-

hort. Alcohol consumption is of major concern in relation to the observed increased risk of esophageal tumors. However, in the sample of current filling station attendants (9), only 27.3% of the subjects drank one glass of wine or more per day. In the Italian population in 1983, among men aged 30–>60 years, there were 52.5% drinkers of a quarter liter or more of wine (51). Therefore, confounding from alcohol consumption, in respect of the association between exposure to gasoline vapors and esophageal cancer, seems unlikely.

In conclusion, filling station attendants are exposed to gasoline vapors containing aromatic hydrocarbons, including benzene. This group of workers seems at risk of cancer at various sites. The observed increased risks are consistent with the hazards to which they are exposed. Due to the power limitations of this study, a precise estimate of the risk for many causes of death is not achievable. Further cohort studies of greater size are warranted.

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