SHORT REPORT

Risk of fatal industrial accidents and death from other external causes among asphalt workers

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The hypothesis that asphalt workers are at increased risk of mortality from industrial accidents and other external causes was tested. Mortality rates for external and violent causes of death in a cohort of asphalt industry employees from seven European countries and Israel were compared to that of the general population. There was no evidence that mortality from external causes was increased among long term employees in asphalt application and mixing. There was an increased risk for mortality due to external causes among short term workers. However, none of the fatal accidents among short term workers appear to have occurred during employment in the studied asphalt companies.

Overall, no evidence was found supporting the hypothesis that asphalt workers are at increased risk of fatal industrial or road accidents. Mortality from other external causes did not increase in this population as a whole, but increased risks among short term workers deserve further attention.

Work in the asphalt industry in the USA has been associated with increased risk of fatal industrial and/or road accidents, but not with deaths due to any other external causes (for example, suicide, road accidents, poisoning, violence). Statistically significant increased proportional mortality ratios for fatal motor vehicle accidents among pavers in the order of 1.4 to 2.0 were recorded in the 1980s.[1 2] Increased risk of suicide among highway maintenance workers was also reported.[1] However, it is not clear whether the same situation exists either outside the USA, or even in recent times in the USA. We investigated whether employees of the asphalt industry in Western Europe and Israel were at increased risk of death due to accidents and other external causes. The reported results were not part of the original objective of the cohort study, which was to address the issue of cancer risk due to bitumen fumes.

METHODS

A detailed description of this historical cohort can be found elsewhere,[3–5] but its main features are described below. The studied cohort included 79 822 male workers, first employed during 1913–99 in companies applying and mixing asphalt in seven countries (Denmark, Finland, France, Germany, Israel, Netherlands, and Norway) and in a nationwide health surveillance programme in Sweden.[6] Sites where bitumen is distilled from crude oil (that is, oil refineries) were excluded from the study. The basic requirement for inclusion of a company in the study was the availability of a complete retrospective employee roster. In all countries, except for Sweden, personal identifiers and employment histories of workers were abstracted from company records. In the combined analysis, inclusion criteria of a minimal duration of employment for one work season (continuous time period within a calendar year when asphalt work is carried out) was applied. The current analysis was restricted to 29 820 persons that were ever employed in asphalt jobs (road paving, roofing, and asphalt mixing).

A follow up for mortality was conducted in all participating countries, obtaining data on primary causes of death. The earliest follow up started in 1953, and the latest ended in 2000 (1999 for the five cohorts with no minimal employment duration criteria; see below). Average duration of follow up was 16.7 (standard deviation (SD) 8.2) years. These figures were similar for all countries. The combined cohort accumulated 481 089 person-years of observation in the asphalt jobs. The overall loss to follow up was 0.7%; an additional 0.5% of cohort members emigrated during the follow up. Causes of death were coded according to the 9th revision of the International Classification of Diseases (ICD9).

Separate analyses were also performed in national cohorts that did not impose minimal duration of employment (France, Israel, Netherlands, Norway) or had only one week of employment (Denmark) as criteria for cohort membership, thus expanding these national cohorts compared to the data they provided for analysis of cancer mortality.[3–5] These five cohorts included 29 060 persons (contributing 483 696 person-years), of whom 9486 persons were employed for less than one full season. Denmark contributed the majority of these "short term" persons (65%) and person-years (66%). Age at entry into these five cohorts was similar for short term (mean 32.2, SD 13.3 years) and long term (mean 33.4, SD 11.9) workers.

Standardised mortality ratios (SMRs) for fatal industrial accidents (ICD9 codes 919 (accidents caused by machinery) to 920 (accidents caused by cutting and piercing instruments or objects)) and other main groups of external causes of death (suicide, ICD9: 950–959; road accidents, ICD9: 810–819; other external causes, ICD9: 800–807, 820–918, 921–949, 960–999.8) were computed, allowing comparison of risk to the general population. National mortality reference rates specific to age, calendar period, and gender were computed using the mortality data bank of the World Health Organisation. The expected numbers of deaths were derived by multiplying the accumulated person-years by the national reference rates across sex, age, and calendar year strata; SMRs were calculated as ratios of observed and expected numbers of deaths. An in-house computer program was used to estimate the individual contribution to each stratum and to calculate SMRs and 95% confidence intervals (95% CI) based on the Poisson distribution of observed numbers of deaths.[7] SMRs were not calculated if the number of expected deaths was zero. Statistical analyses were carried out in SAS 6.12 (SAS Institute, Cary, North Carolina, USA).

Main messages

- There is no evidence that employment in European and Israeli asphalt industries is linked to increased risk of fatal occupational accidents or other external causes.
- However, short term workers are at an increased risk of death due to external causes, and thus may need to be the focus of an intervention.

RESULTS

In the cohort that excluded short term workers, all-cause mortality was below the expected, as was the mortality rate for all external causes of deaths (table 1). The SMR for industrial accidents among asphalt workers was non-significantly increased due to excess deaths in Sweden (five deaths observed (obs), SMR 4.85, 95% CI 1.57 to 11.32). The SMR for road accidents was increased, but was not statistically different from the general population.

For the cohort with at most one week of employment duration as inclusion criteria, SMR for industrial accidents was 1.06 (obs = 9, 95% CI 0.48 to 2.01). SMRs were increased for deaths from all external causes. This was probably the result of asphalt workers in Denmark being at an increased risk of death due to all external causes (obs = 347, SMR 1.33, 95% CI 1.20 to 1.48), industrial accidents (obs = 6, SMR 1.20, 95% CI 0.44 to 2.61), suicide (obs = 147, SMR 1.25, 95% CI 1.06 to 1.47), road accidents (obs = 78, SMR 1.51, 95% CI 1.19 to 1.88), and other external causes (obs = 116, SMR 1.35, 95% CI 1.11 to 1.62). After excluding Denmark from the cohort with at most one week of employment (that is, with only France, Israel, Netherlands, and Norway left), SMRs were not increased for all external causes (obs = 150, SMR 0.79, 95% CI 0.67 to 0.93), industrial accidents (obs = 3, SMR 0.86, 95% CI 0.17 to 2.51), suicide (obs = 43, SMR 0.73, 95% CI 0.52 to 0.98), road accidents (obs = 28, SMR 0.74, 95% CI 0.49 to 1.07), and other external causes (obs = 76, SMR 0.93, 95% CI 0.73 to 1.17).

Only in Denmark (obs = 5) and Norway (obs = 2) were there any deaths from industrial accidents among asphalt workers employed for less than one full season. These deaths occurred more than four months after the last known employment in an asphalt job, and for six of the deaths, more than three years afterwards.

DISCUSSION

We could have under-estimated the risk of fatal industrial accidents by imposing a minimal employment duration on the cohort, if such an accident occurred prior to the expiry of minimal employment duration required for entry into the cohort. The analyses of the expanded national cohorts that imposed only a one week minimal duration of employment as a criterion for cohort membership (at most) showed that bias from this source was not large in our study. Some evidence was obtained that deaths from all external causes tend to cluster among workers who do not stay long in the industry. However, none of the fatal industrial accidents among short term workers appear to have occurred during employment in the studied asphalt companies.

Generally, it should be noted that nosologists have limited options in classifying very specific causes of death, resulting in great risk of outcome misclassification. Thus, it is not certain that all deaths classified as belonging to ICD9 919–920 were indeed due to industrial accidents arising in asphalt work. These differences can vary between countries, and may account for the observed increased SMR for industrial accidents in Sweden, where special codes are used to classify work related fatal accidents. However, the findings for Sweden were based on small numbers, implying that chance is a plausible explanation for the increased SMR.

We had no details of the industrial accidents that occurred, which precludes any assessment as to whether they took place during employment in the asphalt industry. This can result in either under- or over-estimation of risk estimates attributable to employment in the asphalt industry. We attempted to address this issue by examining the fourth digit in the ICD codes for causes of death (E919.5, E919.6, E919.7, E822, E823, E824, E929.0, E929.1) in an attempt to identify paving related deaths. However, we identified only five cases in such manner, precluding meaningful analysis, since general population reference rates for this group of causes of death were not available, and the numbers were too small to perform internal analysis by duration of employment. Only one of these deaths occurred during employment as an asphalt paving worker (24 year old person, in 1995) and was attributed to "earth moving, scraping, and other excavating machines" (E919.7). To overcome these complications, in future studies of occupational accidents in the asphalt industry, it would be preferable to focus on examination of reports from all occupational accident and injuries, not just the mortality statistics. Unfortunately, registries of occupational accidents and injuries do not exist in all studied countries.

Yet another possible source of bias stems from the fact that the companies selected for the study had better employment records than other companies, and this may reflect better safety management in them. This may limit the generalisability of our findings, and implies that the risk of fatal industrial accidents may be higher in companies that were not studied. The small number of observed fatal industrial accidents also limits the generalisability of the results.

Table 1 Standardised mortality ratios (SMRs) for selected causes in the cohort of asphalt workers in subgroups with different inclusion criteria with respect to duration of employment

	Employed for more than one season† (n = 29820)			Employed for less than one full season or longer‡ (n = 29060)		
Cause of death (9th ICD revision)	O*	SMR	95% CI	O*	SMR	95% CI
All causes (001–999)	3987	0.96	0.93 to 0.99	4531	1.02	0.99 to 1.05
All external causes (800–999.8)	439	0.97	0.88 to 1.07	497	1.10	1.01 to 1.21
Industrial accidents (919–920)	10	1.23	0.59 to 2.26	9	1.06	0.48 to 2.01
Suicide (950–959)	158	0.91	0.77 to 1.06	190	1.08	0.93 to 1.24
Road accidents (810–819)	94	1.16	0.94 to 1.42	106	1.18	0.97 to 1.43
Other external causes (800–807, 820–918, 921–949, 960–999.8)	177	0.99	0.85 to 1.15	192	1.15	0.99 to 1.32

*Observed deaths; †all countries; ‡only in Denmark, France, Israel, Netherlands, and Norway.

Increased mortality from all external causes among short term workers, especially in Denmark, is troubling. It warrants further investigation, but may be a product of the living conditions of workers in the past, as was suggested by the results from Finland.[8] However, such a mortality pattern has been reported previously for short term workers in other cohorts.[9]

It should be noted that any fatal industrial accidents are unacceptable, but in our study they cannot be attributed to a specific industry. We did not find that the asphalt workers in our cohort were at increased risk of fatal accidents. However, we observed that short term workers are at an increased risk of death due to external causes, and thus may need to be the focus of an intervention.

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