SHORT REPORT

Incidence of myocardial infarction in Swedish chimney sweeps 1991–2005: a prospective cohort study

Per Gustavsson,[1,2] Catarina Jansson,[3] Christer Hogstedt[1]

[1]Unit of Occupational Medicine, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden
[2]Centre for Occupational and Environmental Medicine, Stockholm County Council, Stockholm, Sweden
[3]Division of Insurance Medicine, Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden

Correspondence to
Professor Per Gustavsson, Unit of Occupational Medicine, Institute of Environmental Medicine, Karolinska Institutet, Norrbacka, SE-171 76 Stockholm, Sweden; per.gustavsson@ki.se

Received 9 January 2013
Revised 12 March 2013
Accepted 24 March 2013
Published Online First 17 April 2013

ABSTRACT

Objectives Previous studies of chimney sweeps have shown an excess mortality from cardiovascular diseases, although the extent of confounding from tobacco smoking is uncertain. The present study used referents of similar socioeconomic background as the chimney sweeps in order to reduce confounding, included both lethal and surviving cases of myocardial infarction, and investigated dose–response in terms of duration of employment.

Methods A cohort of 4436 male chimney sweeps was identified from nationwide trade union records from 1918 to 2006. Myocardial infarctions during 1991–2005 were identified from the Swedish nationwide register of first-time myocardial infarctions. Standardised incidence ratios (SIRs) were estimated using skilled manual workers in the service sector in Sweden to calculate expected numbers.

Results There was a strong and statistically significant excess of myocardial infarction among the chimney sweeps, SIR 1.39 (95% CI 1.24 to 1.55). The excess was observed among both short- and long-term employed.

Conclusions While the excess of myocardial infarction among the short-term employed may be due to tobacco and, possibly, alcohol use, it is likely that the excess noted among the long-term employed was caused by the high exposure to combustion products, particles or metals still occurring among chimney sweeps. Preventive measures to reduce hazardous occupational exposures as well as smoking and alcohol use among chimney sweeps are urgently needed.

What this paper adds

- Previous studies of chimney sweeps have shown an excess mortality from cardiovascular diseases, although the extent of confounding from tobacco smoking is uncertain.
- The present study used a reference population of similar socioeconomic status in order to reduce potential confounding by adverse lifestyle factors and improved statistical power by inclusion of both lethal and surviving cases of myocardial infarction.
- This large prospective cohort study of chimney sweeps showed a strongly increased risk of myocardial infarction among both short- and long-term-employed chimney sweeps.
- Preventive measures to reduce hazardous occupational exposures as well as smoking and alcohol use among chimney sweeps are urgently needed.

INTRODUCTION

The Swedish chimney sweeps cohort study comprises over 6000 trade union organised chimney sweeps employed during 1918–2006. A recent update of the mortality in this cohort showed significantly increased standardised mortality ratios (SMRs) for diseases of the circulatory and respiratory system, as well as alcohol-related causes of deaths.[1] Moreover, the incidence of several cancers was increased, including cancer of the lung, pleura, liver, bladder, oesophagus, colon and haematolymphatic organs.[2]

The finding in our recent update[1] of a marked excess of deaths from ischaemic heart disease (SMR 1.20, 95% CI 1.10 to 1.32) may be due to occupational chemical exposures in view of the well-known association between exposure to particulate matter in urban air and cardiovascular disease.[3] However, a national health examination survey of Swedish chimney sweeps performed in 1972 showed excess smoking and alcohol habits compared with the general population.[4] Thus, it is uncertain to what extent the excess of myocardial infarction could be attributed to occupational exposures like dust, combustion products or metals or to lifestyle exposures such as tobacco smoking or alcohol consumption associated with low socioeconomic status.

The aim of the present study was to further investigate the excess mortality from ischaemic heart disease by focusing on both lethal and non-lethal myocardial infarctions, that is, incident acute myocardial infarctions, to investigate dose–response associations by studying duration of employment, and to use a comparison group of similar socioeconomic status as the chimney sweeps in order to reduce potential confounding from lifestyle exposures.

METHODS

The design of this cohort study has been described in detail elsewhere.[1 2] In brief, the cohort comprises more than 6000 male Swedish chimney sweeps who were members of the Swedish chimney sweeps' trade union between 1918 and 2006. Data on deaths and emigrations were obtained from nationwide Swedish registers of the Total Population and Causes of Deaths, linked to the cohort by the personal identity numbers (a unique number assigned to all Swedish residents). Data on

To cite: Gustavsson P, Jansson C, Hogstedt C. *Occup Environ Med* 2013;**70**:505–507.

incident acute myocardial infarctions were obtained by matching to the nationwide register of first-time, that is, incident myocardial infarctions held by the Swedish National Board of Health and Welfare. This register includes information on both lethal and non-lethal first-time myocardial infarctions since 1987 and is based on inpatient diagnoses and causes of deaths classified according to the International Classification of Diseases.

The cohort members were followed from the date of their first membership/employment period or 1 January 1991, whichever came last, up to 31 December 2005, first myocardial infarction, death or emigration, whichever came first.

Expected numbers of infarctions were derived from a reference data set including all Swedish residents participating in the Swedish census of 1980, holding information on incidence of myocardial infarctions during 1991–2005 for each of 18 socioeconomic groups in total.[5] For this reference population, myocardial infarctions were identified from the same nationwide register as for the chimney sweeps. The expected numbers of myocardial infarctions were based on incidence rates among all those classified as skilled manual workers in the service sector (ie, code 22 in the Swedish socioeconomic classification scheme) in the 1980 census. Persons who were too young or too old to be economically active in 1980 could not be classified regarding socioeconomic status and the present analyses were restricted to men in the ages 40–79 during follow-up during 1991–2005. Person-years were stratified by 5-year age groups (40–44, 45–49, …, 75–79 years) and 5-year calendar periods (1991–1995, 1996–2000, 2001–2005). Standardised incidence ratios (SIRs) were estimated by the person-year method. Exact 95% CIs for the SIRs were estimated assuming that the observed events followed a Poisson distribution.

We performed analyses stratified by employment duration as a proxy for cumulative exposure and by latency (time since first employment). All analyses were performed with SAS, release V.9.2. The study was approved by the Regional Ethical Review Board in Stockholm (Dnr 2007-306-31).

RESULTS

Our prior analyses of mortality included 6374 chimney sweeps. In the present study, we excluded 1033 persons who had died before the start of follow-up in 1991, 24 persons who had emigrated before the start of follow-up, 46 persons who had had myocardial infarction before the start of follow-up and 832 persons who were either too young or too old to contribute any person-years during follow-up. Thus, the present cohort comprised 4436 male chimney sweeps, contributing in total 49 268 person-years.

We observed an almost 1.4-fold increased risk of myocardial infarction (SIR 1.39, 95% CI 1.24 to 1.55) among chimney sweeps compared with the male Swedish population of similar socioeconomic status (table 1). The point estimates were above unity within all duration groups and were significantly increased both for those employed less than 10 years and for those employed more than 30 years. However, SIRs did not increase with duration of employment; rather, there was a tendency to a U-shaped dose–response curve (table 1).

An analysis of SIRs by time since first employment (ie, latency) showed that only six myocardial infarctions had occurred within 20 years since first employment. Most chimney sweeps start their employment at a young age when the baseline rate of myocardial infarction is very low. The point estimates were significantly increased both for the group with latency 20–29 years (SIR 1.54; 95% CI 1.03 to 2.23) and 30+ years (SIR 1.36; 95% CI 1.21 to 1.53).

Table 1 Standardised incidence ratios (SIRs) of myocardial infarction and 95% CIs for the total cohort of Swedish chimney sweeps and by employment duration

	Observed	Expected	SIR	95% CI
Total cohort (n=4436)	318	229.5	1.39	1.24–1.55
Years of employment				
>0–9	137	89.7	1.53	1.28–1.81
10–19	67	52.2	1.28	0.99–1.63
20–29	45	38.0	1.18	0.86–1.59
30+	69	49.6	1.39	1.08–1.76

DISCUSSION

In this large prospective cohort study we observed a significantly increased risk of myocardial infarction among Swedish chimney sweeps compared with skilled manual workers in the service sector. The risk did not increase with duration of employment. The risk among those employed >30 years was almost as high as among those employed >0–9 years, while there was a tendency to lower risks in the intermediate duration categories.

If there were no harmful effect from the occupational exposure, lower risk estimates would be expected with increasing employment duration due to the so-called healthy worker survivor effect (HWSE).[6] The HWSE effect is partly caused by an over-representation of individuals with a less healthy lifestyle among short-term employed workers. In a prior study, Swedish chimney sweeps showed excess smoking and alcohol habits as compared with the general male Swedish population.[4] This is a potential explanation for the excess risk observed among the short-term employed, although the use of a comparison group of similar socioeconomic status would reduce potential confounding from lifestyle associated factors. Another mechanism contributing to the HWSE is that individuals who suffer from negative health effects from an occupational exposure tend to change job, thus causing an over-representation of healthy persons among those still in the occupation after long employment.

As no reduction in risk with longer employment was observed, occupational exposures may explain the increased risk among the long-term employed (see below). Chimney sweeps are exposed to high levels of particulate air pollution. Very high dust levels of 3–19 mg/m^3 were found during the most common work operations in 1985–1986.[7] High dust exposures were confirmed in a recent survey of the chimney sweeps trade: sweeping in private homes showed an 8 h average level of inhalable dust of 3.8 mg/m^3 and sweeping in industrial settings was associated with exposures exceeding 1 g/m^3.[2] Studies of air pollution in large cities have shown an association between particulate matter <2.5 μm in diameter and both mortality as well as non-fatal events of cardiovascular disease.[3] Urban air pollution is derived partly from traffic and partly from heating and it is not unlikely that the high exposure to combustion-generated particles for the chimney sweeps may have caused the increased risk of myocardial infarction in the long-term exposed. In addition, chimney sweeps are exposed to polycyclic aromatic hydrocarbons, arsenic, chromium, cadmium, nickel, lead and asbestos.[7–9] Arsenic has been associated with an increased risk of cardiovascular disease.[10]

A harmful effect of occupational exposure to combustion products/particles on the cardiovascular system is supported by several earlier studies: a study of Norwegian smelter workers showed an excess of cardiovascular disease related to tar exposure,[11] and a study of Canadian aluminium smelter workers showed a smoking-adjusted excess of ischaemic heart disease in association

with pot-room work.[12] Moreover, a Swedish cohort of construction workers exposed to particulate air pollution showed a smoking-adjusted increased risk of ischaemic heart disease,[13] and exposure to combustion products was associated with a smoking-adjusted increased risk of myocardial infarction in a Swedish population-based case-control study.[14] Finally, a recent Swedish record-linkage study found an association between occupational exposure to particles and myocardial infarction.[5] However, an association between occupational exposure to combustion products is not consistently reported in cohorts with high exposure to combustion products (see[14] for references).

In conclusion, this study showed a strongly increased risk of myocardial infarction among Swedish chimney sweeps compared with a referent population of men of similar socioeconomic status. While the excess among the short-term employed might be explained by excess smoking or alcohol use, a likely explanation for the excess risk among the long-term employed is occupational exposure to dust, polycyclic aromatic hydrocarbons or metals. Preventive measures to reduce hazardous occupational exposures as well as smoking and alcohol use among chimney sweeps are urgently needed.

Acknowledgements We thank statistician Marcus Hugosson for performing the statistical analyses.

Contributors All the three authors participated in the design and conduct of the study, and drafting of the manuscript, and have approved the final version.

Funding This study was funded by a grant from the Swedish Council for Working Life and Social Research (grant number 2006-0482) and supported by the Swedish Municipal Workers' Union.

Competing interests None.

Ethics approval The study was approved by the Regional Ethical Review Board in Stockholm (Dnr 2007-306-31).

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 Jansson C, Alderling M, Hogstedt C, *et al*. Mortality among Swedish chimney sweeps (1952–2005): an extended cohort study. *Occup Environ Med* 2012;69:41–7.
2 Hogstedt C, Jansson C, Hugosson M, *et al*. Cancer incidence in a cohort of Swedish chimney sweeps 1958–2006. *Am J Publ Health* 2013 Jan 17. [Epub ahead of print]
3 Brook RD, Rajagopalan S, Pope CA III, *et al*. American Heart Association Council on Epidemiology and Prevention, Council on the Kidney in Cardiovascular Disease, and Council on Nutrition, Physical Activity and Metabolism. Particulate matter air pollution and cardiovascular disease: an update to the scientific statement from the American Heart Association. *Circulation* 2010;121:2331–78.
4 Evanoff BA, Gustavsson P, Hogstedt C. Mortality and incidence of cancer in a cohort of Swedish chimney sweeps: an extended follow up study. *Br J Ind Med* 1993;50:450–9.
5 Wiebert P, Lönn M, Fremling K, *et al*. Occupational exposure to particles and incidence of acute myocardial infarction and other ischaemic heart disease. *Occup Environ Med* 2012;69:651–7.
6 Arrighi HM, Hertz-Picciotto I. The evolving concept of the healthy worker survivor effect. *Epidemiology* 1994;5:189–96.
7 Andersson K. *Chimney wweeps' exposure to dust, PAH, metals, and asbestos [in Swedish]*. Gothenburg, Sweden: Swedish Environmental Research Institute (IVL), 1987, Report no B 850, 3.
8 Knecht U, Bolm-Audorff U, Woitowitz H-J. Atmospheric concentrations of polycyclic aromatic hydrocarbons during chimney sweeping. *Brit J Ind Med* 1989;46:479–82.
9 IARC. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Chemical agents and related occupations, Vol 100F. France: International Agency for Research on Cancer Lyon, 2012:209–11.
10 Balakumar P, Kaur J. Arsenic exposure and cardiovascular disorders: an overview. *Cardiovasc Toxicol* 2009;9:169–76.
11 Rønneberg A. Mortality and cancer morbidity in workers from an aluminium smelter with prebaked carbon anodes—Part III: mortality from circulatory and respiratory diseases. *Occup Environ Med* 1995;52:255–61.
12 Thériault GP, Tremblay CG, Armstrong BG. Risk of ischemic heart disease among primary aluminum production workers. *Am J Ind Med* 1988;13:659–66.
13 Torén K, Bergdahl IA, Nilsson T, *et al*. Occupational exposure to particulate air pollution and mortality due to ischaemic heart disease and cerebrovascular disease. *Occup Environ Med* 2007;64:515–9.
14 Gustavsson P, Plato N, Hallqvist J, *et al*. A population-based case-referent study of myocardial infarction and occupational exposure to motor exhaust, other combustion products, organic solvents, lead and dynamite. *Epidemiology* 2001;12:222–8.