ORIGINAL ARTICLE

Employment status and use of respiratory protection among metalworkers, solderers and welders

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Objectives: Reported associations of self-employment with occupational injury and cerebrovascular disease suggest that worker safety and health precautions may vary by occupational status. The authors assessed the extent to which use of respiratory protection and ventilation equipment is associated with self-employed versus employee status among adults in an international study.

Methods: The European Community Respiratory Health Survey II (ECRHS II) is a follow-up study conducted in a population-based random sample of adult ECRHS I participants. Men and women enrolled in the ECRHS II completed interviewer-administered questionnaires to provide information about their occupational status and job history during the 9-year ECRHS follow-up period. Respondents in selected occupational groups completed supplemental questionnaires about their jobs and use of respiratory protection and ventilation equipment on-the-job. The authors assessed self-reported use of respiratory and ventilation equipment among 72 self-employed and 371 employed adults in metalworking, soldering and welding occupations.

Results: Local exhaust ventilation (fixed extraction: OR 0.37, 95% CI 0.17 to 0.80; mobile extraction: OR 0.23, 95% CI 0.09 to 0.60; on-tool extraction: OR 0.39, 95% CI 0.18 to 0.88) was reported less frequently among self-employed respondents than among employed respondents. The magnitude of the negative association between self-employment status and any of the three types of local exhaust ventilation was not attenuated by adjustment for duration of work per day or week or asthma and/or wheezing symptoms. Respiratory protection was not associated with employment status in these data.

Conclusions: More limited use of local exhaust ventilation among self-employed workers compared to employees suggests the need to promote occupational safety among self-employed workers.

Information about the working conditions of employees may not reflect the experiences of self-employed individuals working in the same fields. Self-employed people who work independently or operate their own businesses may take advantage of the increased autonomy often associated with self-employment to organise their work schedules and practices to more closely suit their professional preferences. In many industries, self-employed workers have the opportunity to select their own hours, work settings, clients and equipment. Workers with this degree of flexibility may develop their own occupational health and safety practices, but existing information describing the working conditions of self-employed individuals is insufficient to indicate how practices differ from those of employees, or how these differences affect health and safety.

Recent research provides evidence that health and safety precautions and job training vary between workers in self-employed and employed work situations.[1] Results from a 2005 survey conducted in the EU indicate that self-employed workers experienced greater autonomy and less violence, harassment and/or discrimination on the job and had fewer days of health-related absence over the past year compared to employed respondents. In contrast, the self-employed respondents more frequently reported that they considered their health and safety to be at risk because of work and a slightly smaller percentage reported wearing personal protective clothing or equipment at work (self-employed 29% vs employed 35%).[1] Although the survey did not include industry- or job-specific estimates or health outcomes related to the use of personal protective equipment, overall these responses reveal some of the reasons individuals may seek self-employment situations, and raise the possibility that self-employed work arrangements may result in important health and safety risks.

Previous research has shown differences in the rates of work-related mortality among the self-employed and privately-employed populations.[2 3] For example, using data reported through a medical examiner's surveillance system, notably higher fatal occupational injury rates were observed among self-employed workers in the agricultural sector and in retail and transportation industries.[2] The surveillance-based study found lower rates among self-employed workers in the construction industry, suggesting differences in the occupational health and safety practices of self-employed and employed individuals.[2] Such variations in the rates of occupational injury may reflect differences in work-related tasks, settings, use of protective equipment or differences in the age and/or levels of work experience between the two populations. In contrast, lower rates of cerebrovascular disease have been reported among self-employed men than among employed men. Although the differences were not observed for overall mortality or other circulatory disorders, the investigators concluded that the effect of self-employment status was independent of those associated with other lifestyle and medical factors and thus may be considered an additional determinant of health.[4] Differences in mortality rates between self-employed and employed populations led the investigators to suggest considering employment status as a proxy for differences in working practices, including the physical work environment.

Abbreviation: ECRHS, European Community Respiratory Health Survey

Despite these observed differences in occupational practices, mortality and cardiovascular morbidity, occupational health and safety practices of self-employed workers remain largely unreported in the public health literature. For this analysis, we investigated a hypothesis for which there is little epidemiological evidence—that is, whether employment status is associated with use of respiratory protection and/or ventilation equipment. We used data from the European Community Respiratory Health Survey (ECRHS), a population-based cohort of adult men and women, to examine self-reported use of respiratory protection and ventilation equipment among self-employed and employed respondents.

MATERIALS AND METHODS

The European Community Respiratory Health Survey

The ECRHS is a prospective population-based cohort study of respiratory health among adults. The study design and methods have been described previously.[5 6] Briefly, the ECRHS population is a fixed cohort that participated in an initial interviewer-administered baseline survey beginning in 1991 (ECRHS I). In 1999, a follow-up survey was conducted among participants from 14 countries (ECRHS II). Participants from 22 study centres located in 10 countries completed extensive interviewer-administered questionnaires that included a seven-item screening questionnaire to determine whether he/she would complete one or more of seven occupational modules included in the follow-up survey. Institutional review boards from each participating study centre approved the protocol and instruments and participants provided written informed consent.

Employment status

The ECRHS II questionnaire prompted each respondent to report his/her employment status with the statement ''are you currently:'' and providing options that included ''employed (including military service)'' and ''self-employed''; these responses were used to classify each respondent's current employment status, with ''current'' indicating within the past three months. Respondents who identified themselves as currently employed or self-employed were then asked to complete a job history, including the job title/occupation, industry and dates of employment for each job held during the ECRHS follow-up period.

Respiratory protection and ventilation equipment use

Use of respiratory protection was reported in identical survey questions included in the modular questionnaires administered to metalworkers, solderers and welders: ''which of the following respiratory protection devices did you use while metalworking/soldering/welding (yes/no): face piece, face mask with filter, face shield with fresh air supply''. Respondents also answered a series of questions about ventilation: ''which of the following types of ventilation was in use at your workplace (yes/no): general mechanical ventilation, local exhaust ventilation: fixed extraction, local exhaust ventilation: mobile extraction, local exhaust ventilation: on-tool tip extraction''.

Final study population

Our analyses were restricted to the 72 self-employed and 371 employed respondents from the random sample of the ECRHS II population who completed occupational survey modules for metalworking (n = 261), soldering (n = 195) and/or welding (n = 200) jobs and for whom complete data were available for the covariates included in our final statistical models. These restrictions limited our final population to ECRHS II participants from 20 study centres in eight European countries. Because ECRHS II respondents indicated their current employment status, the final study population was limited to data provided in occupational survey modules about current jobs, defined as those held within the past three months. In addition, we excluded one respondent who indicated that at the time of the ECRHS II survey he/she held two jobs—one as an employee and one as a self-employed business owner.

Statistical analysis

We evaluated associations between employment status and respiratory protection and ventilation using generalised estimating equations, specified with a binomial probability distribution, a logit link, a cluster-level variable indicating country of residence and an independent structure for estimating covariance of within-country data. Measures of association are reported as odds ratios (ORs) with 95% confidence intervals (95% CIs) and models were adjusted for age, age at completion of full-time education (after a natural log transformation), sex and occupational module(s) completed (metalworker, solderer, welder). We examined as potential confounders smoking status reported in the ECRHS II survey (current smoker, ex-smoker, never smoker) and asthma and/or wheezing symptoms reported in the baseline ECRHS I survey. Respondents were identified as having asthma and/or wheezing symptoms at the time of the baseline survey if they gave positive answers to any of the following ECRHS I survey questions ''have you been woken by an attack of shortness of breath at any time in the last 12 months?'', ''have you had an attack of asthma in the last 12 months?'', ''are you currently taking any medicines including inhalers, aerosols or tablets for asthma?'', or ''have you had wheezing or whistling in your chest at any time in the last 12 months [when you did not have a cold?]''. In module-stratified models, we examined as potential confounders days of metalworking/soldering/welding work per week (<1 day/week, 1–3 days/week, 4–7 days/week) and hours of work per day (<1 h/day, 1–4 h/day, >4 h/day) among solderers and welders, the two occupations for which respondents indicated durations of work per day in the occupational questionnaires. As potential modifiers of the association between employment status and use of local exhaust ventilation, we examined age at completion of full-time education, asthma and/or wheezing symptoms at baseline and geographic region in the population with current metalworking, soldering and welding jobs. We categorised countries as northern European (Norway, Sweden), central European (Belgium, France, Germany, UK) and southern European (Italy, Spain). All analyses were performed with SAS version 9.1 (SAS Institute Inc, Cary, North Carolina, USA).

RESULTS

Self-employed occupational status was reported among 16.3% (72/443) of the final study population, with slight variation in the percentages between the three occupational groups (metalworkers, 14.9%; solderers, 17.9%; welders, 19.0%). Both the self-employed and employed populations were predominantly male, with similar percentages of current smokers and similar distributions of age and age at completion of full-time education. Nearly 17% of self-employed respondents and 10.8% of employed respondents completed survey modules for each of the three occupations (table 1).

In these data, similar percentages of self-employed and employed respondents reported using face pieces and filtered face masks (table 2). The odds of reported use of ventilation equipment were lower in the self-employed population than those of the employed population for each of three types of local exhaust ventilation, as well as for use of any of the three types of local ventilation equipment (OR 0.35, 95% CI 0.22 to 0.56). Adjusting for asthma and/or wheezing symptoms reported in the baseline ECRHS I survey did not attenuate the magnitude

Table 1 Demographic and occupational characteristics of currently self-employed and employed ECRHS II participants working in metalworking, soldering and welding jobs

	Self-employed (n = 72)	Employed (n = 371)
	n (%)	n (%)
Demographic characteristics		
Age (years)		
Mean (SD)	42.8 (7.36)	42.2 (7.05)
Median	41.8	41.7
Minimum–maximum	29.0–54.2	28.8–55.5
Age at completion of full-time education (years)		
Mean (SD)	19.7 (5.80)	19.3 (4.81)
Median	18	18
Minimum–maximum	10–50	8–46
Sex		
Female	6 (8.3%)	34 (9.2%)
Male	66 (91.7%)	337 (90.8%)
Smoking status		
Current smoker	24 (33.3%)	113 (30.5%)
Ex-smoker	21 (29.2%)	121 (32.6%)
Lifetime non-smoker	27 (37.5%)	137 (36.9%)
Occupational characteristics		
Number of occupations (metalworking, soldering, welding) per individual		
1	44 (61.1%)	238 (64.2%)
2	16 (22.2%)	93 (25.1%)
3	12 (16.7%)	40 (10.8%)
Metalworking (days/week)		
<1	4 (10.3%)	28 (12.6%)
1–3	8 (20.5%)	27 (12.2%)
4–7	27 (69.2%)	167 (75.2%)
Total	39 (54.2%)	222 (59.8%)
Soldering (days/week)		
<1	19 (54.3%)	107 (66.9%)
1–3	9 (25.7%)	31 (19.4%)
4–7	7 (20.0%)	22 (13.8%)
Total	35 (48.6%)	160 (43.1%)
Welding (days/week)		
<1	19 (50.0%)	81 (50.0%)
1–3	13 (34.2%)	35 (21.6%)
4–7	6 (16.8%)	46 (28.4%)
Total	38 (52.8%)	162 (43.7%)

of this negative association (OR 0.35, 95% CI 0.21 to 0.57), nor did the inclusion of smoking status reported in the ECRHS II survey (OR 0.35, 95% CI 0.22 to 0.57). When the data were stratified by occupational module, negative associations with the use of any local exhaust ventilation were observed for each of the three occupations (metalworkers: OR 0.43, 95% CI 0.18 to 1.02; solderers: OR 0.20; 95% CI 0.07 to 0.56; welders: OR 0.21, 95% CI 0.11 to 0.39) and these module-stratified associations were largely unchanged following adjustment for days per week performing metalworking (OR 0.41, 95% CI 0.17 to 1.01), days per week and hours per day performing soldering (OR 0.18, 95% CI 0.07 to 0.47) and days per week and hours per day performing welding (OR 0.22, 95% CI 0.13 to 0.36).

The association between self-employment status and local exhaust ventilation was also observed when analyses were stratified by the median of the distribution of age at completion of full-time education ($\leqslant$18 years: OR 0.24, 95% CI 0.14 to 0.40; $\geqslant$19 years: OR 0.44; 95% CI 0.20 to 0.98) and by geographic region (northern Europe: 0.29, 95% CI 0.11 to 0.73; central Europe: OR 0.16, 95% CI 0.10 to 0.27; southern Europe: OR 0.48, 95% CI 0.33 to 0.72). In models stratified by asthma and/or wheezing symptoms at baseline, the statistically significant association was limited to that generated for respondents without symptoms at baseline (OR 0.29, 95% CI 0.16 to 0.52), though the negative association between self-employment and local exhaust ventilation is also observed in the estimate generated among the symptomatic respondents (OR 0.83, 95% CI 0.47 to 1.47).

DISCUSSION

Our results suggest that among European workers, use of local exhaust ventilation equipment is less common in the self-employed population than among those employed by others. We did not observe a similar association with the use of respiratory protection but, nonetheless, these findings suggest important opportunities to promote the use of both respiratory protection and ventilation equipment and to make improvements in occupational health and safety conditions among self-employed metalworkers, solderers and welders.

Our analysis are based on a subset of data from the ECRHS II, a large population-based survey that included occupational histories and brief questionnaires for individuals who reported working in specific jobs during the ECRHS follow-up period. As a result of the lack of detailed information in our data source describing the occupational characteristics of the self-employed workforce, interpretation of our results is not entirely straightforward. If the observed associations are the result of differences in work settings, experiences or occupational health and safety practices attributable to self-employment status, then these results raise concerns about the respiratory health of

Table 2 Associations between self-employment status and use of respiratory protection and/or ventilation among ECRHS II participants working in metalworking, soldering and welding jobs

Respiratory/ventilation equipment	Self-employed (n = 72) n (%)	Employed (n = 371) n (%)	OR (95% CI)*†
Respiratory protection			
Face piece	17 (23.6)	85 (22.9)	1.10 (0.78 to 1.54)
Face mask with filter	8 (11.1)	49 (13.2)	0.84 (0.37 to 1.86)
Face shield with fresh air supply	0 (0.0)	23 (6.2)	–
Ventilation equipment			
General mechanical ventilation	42 (58.3)	227 (61.2)	0.82 (0.50 to 1.36)
Local exhaust ventilation‡	17 (23.6)	160 (43.1)	0.35 (0.22 to 0.56)
Fixed extraction	13 (18.1)	125 (33.7)	0.37 (0.17 to 0.80)
Mobile extraction	4 (5.6)	64 (17.3)	0.23 (0.09 to 0.60)
On-tool extraction	4 (5.6)	47 (12.7)	0.39 (0.18 to 0.88)

*Adjusted for age, age at completion of full-time education, sex, metalworking, soldering and welding.
†Employed = referent categories.
‡Fixed extraction and/or mobile extraction and/or on-tool extraction.

self-employed metalworkers, solderers and welders. If differences in the lengths of time spent performing specific tasks, the types of equipment used or the settings in which the work was performed cause self-employed individuals to have fewer potential inhalation exposures than employed workers in similar occupations then these results may indicate that self-employed individuals work in settings that, in general, do not involve exposures at levels that prompt the use of such protective equipment. Our results likely reflect a combination of both possibilities. In these analyses the strength of association between employment status and local exhaust ventilation was not attenuated by adjustment for days per week and/or hours per day spent metalworking, soldering or welding. And although the frequency of work and the duration of time spent working cannot completely describe the intensity or type of exposure, our results favour the hypothesis that despite the level of exposure, self-employed workers are less frequent users of ventilation equipment.

Currently, few data exist about occupational health and safety practices or respiratory health status of self-employed workers. Considerably more data are available to assess the role of work-related inhalation exposures among employed workers, especially among welders, who are likely to be exposed to mixtures of gases, metals and particles. In a sample of 351 employed welders in Québec, investigators reported the prevalence of welding-related occupational asthma, defined as reporting two or more respiratory symptoms suggestive of occupational asthma, as 5.2%.[7] Using the same definition of welding-related occupational asthma, these investigators reported an incidence rate of 5.6% during the approximately 15-month follow-up period among welding apprentices in Montreal.[8] In a workplace-based study of employed welders in New Zealand, two of eight worksites were noted to have provided local exhaust ventilation equipment and only one worker was identified as using respiratory protection.[9] In a follow-up survey of this cohort, investigators observed a steeper decline in pulmonary function over a two-year observation period among welders not using personal respiratory protection or local exhaust ventilation than among welders using either type of protection.[10] In conjunction with such observations, our findings of lower use of local exhaust ventilation among self-employed workers raise the possibility that the self-employed population may be at increased risk for adverse respiratory health effects because of their worksite conditions. Due to the small number of self-employed respondents and the low cumulative incidence of respiratory symptoms among self-employed metalworkers, solderers and welders in the ECRHS II population, we are unable to assess whether the observed differences in use of respiratory protection and ventilation equipment by occupational status are reflected in the respiratory health status of this study population. In our data, the prevalence of asthma at ECRHS II was similar in the self-employed population (7% (5/72)) and the employed population (8% (30/371). Such sparse data limit our ability to draw meaningful conclusions about respiratory health effects resulting from employment status-based differences in the use of respiratory protection and/or ventilation equipment. In addition, our finding of a stronger negative association between self-employment and local exhaust ventilation among respondents without asthma symptoms at baseline than among those with asthma symptoms at baseline appears driven by the higher percentage of employed individuals with asthma-like symptoms at baseline using local exhaust ventilation equipment (38.5%) than employed individuals without baseline symptoms (20.3%). The difference was smaller among the self-employed (asthma symptoms at baseline, 46.9%; no asthma symptoms at baseline, 42.4%), raising the possibility that the employed may take advantage of more readily available equipment or that company policies may encourage symptomatic individuals to further protect themselves.

Main messages

- Use of local exhaust ventilation equipment is less common among self-employed than employed metalworkers, solderers and welders in Europe.
- More limited use of local ventilation equipment suggests the need to promote occupational safety among self-employed metalworking professionals.

Metalworking, soldering and welding are not identical occupations. Differences in the processes, technologies and materials used by workers in these metal-related jobs necessitate different types of personal protective equipment, though potential inhalation exposures pose respiratory risks for workers in each of the three occupations. The ECRHS II questionnaires for workers in these occupations included identical survey questions about respiratory protection and ventilation, which made possible our comparisons between self-employed and employed workers in a pooled population of metalworking professionals. However, the data do not include information about the frequency of use of either type of protection equipment, nor is additional information available with which to gauge whether such equipment functions properly or is used correctly by self-employed or employed workers in any of the three occupations. More detailed exposure assessment and more specific questions about personal protective equipment and other control measures are needed to address specific hypotheses about occupational safety and health practices among self-employed workers. Although self-employed workers are not a homogeneous population and few population-based occupational health data are available to describe the working conditions or health status of this diverse group of workers, our findings suggest the need to promote occupational health and safety among self-employed workers in these industries.

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REFERENCES

1 **European Foundation for the Improvement of Living and Working Conditions**. *Ten years of working conditions in the EU: charting the trends*, Available at http://www.eurofound.ie/pubdocs/2006/85/en/1/ef0685en.pdf (accessed January 2007).
2 **Mirabelli MC**, Loomis D, Richardson DB. Fatal occupational injuries among self-employed workers in North Carolina. *Am J Ind Med* 2003;**44**:182–90.
3 **Feyer AM**, Langley J, Howard M, *et al*. The work-related fatal injury study: numbers, rates and trends of work-related fatal injuries in New Zealand 1985–1994. *N Z Med J* 2001;**114**:6–10.
4 **Fujino Y**, Iso H, Tamakoshi A, *et al*. A prospective cohort study of employment status and mortality from circulatory disorders among Japanese workers. *J Occup Health* 2005;**47**:510–17.
5 **Burney PG**, Luczynska C, Chinn S, *et al*. The European Community Respiratory Health Survey. *Eur Respir J* 1994;**7**:954–60.
6 **The European Community Respiratory Health Survey Steering Committee**. The European Community Respiratory Health Survey II. *Eur Respir J* 2002;**20**:1071–9.
7 **El-Zein M**, Malo JL, Infante-Rivard C, Gautrin D. Prevalence and association of welding related systemic and respiratory symptoms in welders. *Occup Environ Med* 2003;**60**:655–61.
8 **El-Zein M**, Infante-Rivard C, Malo JL, *et al*. Is metal fume fever a determinant of welding related respiratory symptoms and/or increased bronchial responsiveness? A longitudinal study. *Occup Environ Med* 2005;**62**:688–94.
9 **Bradshaw LM**, Fishwick D, Slater T, *et al*. Chronic bronchitis, work related respiratory symptoms, and pulmonary function in welders in New Zealand. *Occup Environ Med* 1998;**55**:150–4.
10 **Erkinjuntti-Pekkanen R**, Slater T, Cheng S, *et al*. Two year follow up of pulmonary function values among welders in New Zealand. *Occup Environ Med* 1999;**56**:328–33.

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