ORIGINAL ARTICLE

Parkinson's disease and other basal ganglia or movement disorders in a large nationwide cohort of Swedish welders

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Introduction: Although it has been hypothesised that metal welding and flame cutting are associated with an increased risk for Parkinson's disease due to manganese released in the welding fume, few rigorous cohort studies have evaluated this risk.

Methods: The authors examined the relation between employment as a welder and all basal ganglia and movement disorders (ICD-10, G20–26) in Sweden using nationwide and population based registers. All men recorded as welders or flame cutters (n = 49 488) in the 1960 or 1970 Swedish National Census were identified and their rates of specific basal ganglia and movement disorders between 1964 and 2003 were compared with those in an age and geographical area matched general population comparison cohort of gainfully employed men (n = 489 572).

Results: The overall rate for basal ganglia and movement disorders combined was similar for the welders and flame cutters compared with the general population (adjusted rate ratio (aRR) = 0.91 (95% CI 0.81 to 1.01). Similarly, the rate ratio for PD was 0.89 (95% CI 0.79 to 0.99). Adjusted rate ratios for other individual basal ganglia and movement disorders were also not significantly increased or decreased. Further analyses of Parkinson's disease by attained age, time period of follow up, geographical area of residency, and educational level revealed no significant differences between the welders and the general population. Rates for Parkinson's disease among welders in shipyards, where exposures to welding fumes are higher, were also similar to the general population (aRR = 0.95; 95% CI 0.70 to 1.28).

Conclusion: This nationwide record linkage study offers no support for a relation between welding and Parkinson's disease or any other specific basal ganglia and movement disorders.

Fumes that contain several respirable substances including manganese are produced in metal welding and flame cutting.[1–4] Exposure to high airborne levels of manganese in foundry and mine workers has been associated with a neurotoxicity that resembles Parkinson's disease.[5] It has been conjectured that low grade exposure to manganese fumes may increase the risk for Parkinson's disease and other basal ganglia and movement disorders.[6 7] It has also been proposed that compounds released during welding and flame cutting may accelerate the onset of Parkinson's disease.[8] The number of well designed epidemiological studies which have evaluated these occupational issues is small, however, in part because Parkinson's disease is relatively rare and most often occurs in older age groups. Thus, a large number of welders and flame cutters must be studied over a long time period in order to evaluate a potential occupational component to the development of Parkinson's disease and other basal ganglia and movement disorders. To provide such data, we performed a cohort study among 49 488 male welders and flame cutters in Sweden, followed for up to 40 years, to examine the occurrence of Parkinson's disease and other basal ganglia and movement disorders compared with an age and geographical area matched general population comparison cohort of gainfully employed men.

METHODS

Setting

This study was conducted in Sweden using nationwide and population based healthcare and census registers. Unique personal identifiers (national registration numbers (NRN)) assigned to each Swedish resident since 1947, allowed record linkage of register data which have been recorded prospectively since the 1960s with few losses to follow up. Swedish health care is public and population based and hospital referrals are based on geographical residency determinants rather than financial capacity or health insurance, ensuring an unbiased and complete ascertainment of patients receiving hospital care for any basal ganglia or movement disorders including Parkinson's disease. The study was approved by the Stockholm Regional Research Ethics Committee.

Study cohorts

The cohorts were assembled from the Swedish National Census Register, located at Statistics Sweden. In Sweden, coordinated nationwide censuses were completed every fifth year between 1960 and 1990. For each individual, the census includes information on their NRN, the occupation and industry in which they worked, their residence, and their educational level. Occupations were coded according to the Nordic Occupational Classification (NYK) which is a partly modified version of the International Standard Classification of Occupations (ISCO).[9] For this study, the male welder and flame cutter cohort (NYK code = 755) was assembled from the 1960 and the 1970 censuses. We also identified a subcohort of shipyard welders (census industry code = 360, 361 in 1960, and 3841 in 1970) for additional study, as their work conditions may involve welding within an enclosed environment leading to higher fume exposures. Female welders or flame cutters were omitted from the cohort due to their small numbers (n = 913).

A comparison cohort of gainfully employed males not recorded as welders or flame cutters in any census, individually matched on year of birth and county of residence

Abbreviations: ICD, International Classification of Diseases; ISCO, International Standard Classification of Occupations; MAG, metal arc gas welders; MMA, manual metal arc welders; NRN, national registration number; NYK, Nordic Occupational Classification

Table 1 Characteristics of Swedish welders and flame cutters and the general population referent cohort, 1964–2003

	Welders and flame cutters n = 49 488; person years* = 1 436 645		General population n = 489 572; person years* = 14 583 796	
Mean years of follow up	29.0		29.8	
Vital status, n (%)				
Alive	28817	(58.2)	301341	(61.6)
Dead	17518	(35.4)	168487	(34.4)
Emigrated	3153	(6.4)	19744	(4.0)
Year of birth, n (%)				
<1920	9991	(20.2)	99697	(20.4)
1920–29	10081	(20.4)	100161	(20.5)
1930–39	13003	(26.3)	128624	(26.3)
1940–49	13737	(27.8)	135181	(27.6)
1950+	2676	(5.4)	25909	(5.3)
Geographical area, n (%)				
Götaland (south of Sweden)	15199	(30.7)	150536	(30.7)
Svealand (middle area)	25902	(52.3)	256500	(52.4)
Norrland (northern area)	8387	(16.9)	82536	(16.9)
Year of census†, n (%)				
1960	15580	(31.5)	–	–
1970	23908	(48.3)	–	–
Both 1960 and 1970	10000	(20.2)	–	–
Education‡, n (%)				
Compulsory school, <9 years	12076	(50.5)	93418	(39.6)
Compulsory school, 9 years	2121	(8.9)	29021	(12.3)
High school, 2 years	7714	(32.3)	46627	(19.8)
High school, 3 years	1075	(4.5)	36249	(15.4)
University, <3 years	17	(0.1)	5497	(2.3)
University, ⩾3 years	3	(0.01)	9696	(4.1)
Postgraduate education	0	0	590	(0.3)
Missing information	902	(3.8)	14560	(6.2)

*The person time is calculated from 1 January 1964 for welders and comparison cohort identified from the 1960 census (the date the hospital discharge register began) and from 1970 for those identified from the 1970 census.
†Censuses in which welders and flame cutters are registered (NYK code = 755).
‡Information on education is only available for 23 908 welders and flame cutters and 235 658 individuals in the comparison cohort identified in the 1970 census.

to the welders and flame cutters (10 to 1 matching), was assembled from the general population in the 1960 and 1970 censuses.

Follow up

The cohorts were linked to the Hospital Discharge Register, the Death Register, and to the Register of Population and Population Changes through the NRN. Men in the welder and comparison study cohorts were followed from 1 January 1964 (the date the Hospital Discharge Register began) if identified in the 1960 census or 1 January 1970 if identified in the 1970 census, until the first hospitalisation for a basal ganglia or movement disorder, date of emigration, date of death, or 31 December 2003—whichever occurred first. Information on basal ganglia and movement disorders was obtained from the Swedish Hospital Discharge Register, which has recorded information on all hospital admissions countywide since 1964 and nationwide since 1987,[10] and the Swedish Cause of Death Register. Each Hospital Discharge Register record contains (1) the patient's NRN, (2) the date of hospital admission and discharge, (3) one primary discharge diagnosis, and up to seven additional diagnoses coded according to the International Classification of Diseases (ICD)-7 until 1968, ICD-8 from 1968 through 1986, ICD-9 from 1986 to 1996, and ICD-10 thereafter. The nationwide Death Register contains information on the date and the primary cause of death, and contributing causes of death. The outcomes of interest for this study included PD (ICD-7 350, ICD-8 342.0, ICD-9 332A, ICD-10 G20), secondary parkinsonism (ICD-8 342.08, 342.09, ICD-9 332B, ICD-10 G21), other degenerative diseases of basal ganglia (ICD-9 333A-D, ICD-10 G23), dystonia (ICD-9 333G-H, ICD-10 G24), other extrapyramidal and movement disorders (ICD-9 333 B W-X, ICD-10 G25), and poisoning due to manganese and its compounds (ICD-10 T57.2). All primary and additional discharge diagnoses and cause of death diagnoses were examined for the first occurrence of any of the outcomes of interest. Dates of emigration for cohort members who left Sweden were identified through the Register of Population and Population Changes.

Industrial hygiene data

Data on manganese exposure among welders were assembled from a large survey conducted in Sweden during 1974 and 1975.[11–14] A total of almost 500 welding sampling stations were investigated at 70 industrial sites, and at 21 track sections of the Swedish State Railways. These sites included several different processes and materials, and covered a wide variety of manufacturing conditions. Concentrations of air pollutants were measured in the breathing zone of the welders, and at the work site.

Statistical methods

We computed and compared rates of hospitalisation and mortality from Parkinson's disease and other diseases of the basal ganglia and movement disorders in the cohort of welders and flame cutters to those in the general population comparison cohort. The adjusted relative risks (aRR) and 95% confidence intervals (CI) of basal ganglia and movement disorders, including Parkinson's disease, were calculated using Cox proportional regression models.[15] We also conducted analyses using Hospital Discharge Register diagnosis disclosures confined to neurology and internal medicine hospital clinics as the outcome, in the possibility that these specialty clinics would more reliably diagnose Parkinson's disease and other basal ganglia and movement disorders. Further stratified analyses for Parkinson's disease were

Table 2 Manganese exposure in the breathing zone of welders in Sweden, 1974–75

Welding method and type of steel	Samples	Median or geometric mean (GM) (mg/m^3)	Highest level (mg/m^3)
MMA mild steel with or without local exhaust ventilation	13	0.26 (GM)	0.77
MAG mild steel with or without local exhaust ventilation	49	0.30 (GM)	1.8
MMA mould welding of rails	92	0.13 (GM)	1.14
MMA stainless steel without local exhaust ventilation	67	0.14 (Median)	0.78

MMA, manual metal arc welding; MAG, metal arc gas welding.

conducted for attained age, time period of follow up, geographical area of residence, and educational level.

RESULTS

A cohort of 49 488 male welders and flame cutters and a comparison cohort of 489 572 men from the general population were studied (table 1). Approximately 20% of the welders and flame cutters were found on both the 1960 census and the 1970 census, about 30% in the 1960 census alone, and almost half identified from the 1970 census only. Mean follow up was comparable for both cohorts (29.0 years for the welders and flame cutters and 29.8 years for the comparison cohort). Approximately 60% of the men studied were alive at the end of the follow up period. Reflecting the matching criteria, the proportions of men in each year of birth category, as well as each geographical area category were nearly identical. Most of the men (>65%) were born before 1940 and lived in the Svealand area (mid-Sweden, 52%). In both cohorts, a majority of the subjects had nine or fewer years of education (59% of the welders or flame cutters, 52% of the comparison cohort).

Table 2 shows welding exposure levels for various welding methods and types of steel for Swedish welders during 1974 and 1975, abstracted from a large Swedish survey of welding in various environments.[11–14] The geometric mean for manganese exposure among either mild steel manual metal arc welders (MMA) (0.26 mg/m^3) or mild steel metal arc gas welders (MAG) (0.30 mg/m^3) was higher than for stainless steel MMA welders (0.14 mg/m^3).

We identified 403 welders and flame cutters diagnosed between 1964 and 2003 with any basal ganglia or movement disorder (table 3), of whom 353 were diagnosed with PD, 44 with secondary parkinsonism, 21 with other degenerative diseases of the basal ganglia, four with dystonia, and 26 with other extrapyramidal and movement disorders. No cases of poisoning due to manganese and its compounds were observed. The incidence rate of basal ganglia and movement disorders overall was 28.1 per 100 000 person years among the welders and flame cutters compared with 31.2 per 100 000 person years in the comparison cohort, yielding an adjusted incidence rate ratio (aRR) of 0.91 (95% CI 0.81 to 1.01). A similar aRR was found for Parkinson's disease (aRR = 0.89; 95% CI 0.79 to 0.99). No statistically significantly increased or decreased aRR was observed for any of the other outcomes of interest with adjusted incidence rate ratio estimates ranging from 0.77 to 1.42. When the outcomes were restricted to hospital discharges from neurology or internal medicine hospital clinics, no material alterations were observed in the rate ratios for basal ganglia and movement disorders overall or for any of the specified disorders studied. In order to ensure complete ascertainment for basal ganglia and movement disorders, we searched both hospital records and mortality data. Analyses restricted to only those identified in the hospital records were not meaningfully different from those identified from both hospital records and mortality data (aRR = 0.92 (95% CI 0.82 to 1.03) for all basal ganglia and movement disorders combined and aRR = 0.90 (95% CI 0.80 to 1.01) for PD). This is not surprising, since the mortality search only uncovered an additional 35 cases of basal ganglia and movement disorders.

Mean age at first occurrence for a basal ganglia or movement disorder was not different for the welder and flame cutter cohort (mean age 70.4 years; range 30–91) and comparison cohort (mean age 70.7 years; range 26–95). Similarly, the mean age at first occurrence for Parkinson's disease was not different for welders and flame cutters (mean 71.9 years; range 31–91), and the comparison cohort (mean 72.0; range 31–95).

Table 3 Number, incidence rates, and adjusted rate ratios for Parkinson's disease and other basal ganglia and movement disorders diseases for Swedish welders and flame cutters and the general population referent cohort, 1964–2003

	Welders and flame cutters		General population			
	n	Incidence rate per 100 000 PYR	n	Incidence rate per 100 000 PYR	Adjusted rate ratio*	95% CI
Any basal ganglia or movement disorder (ICD-10, G20-G26)	403	28.1	4539	31.2	0.91	(0.81–1.01)
Discharge from neurology or internal medicine clinic†	296	20.6	3212	22.1	0.96	(0.85–1.09)
Parkinson's disease (G20)	353	24.6	4047	27.8	0.89	(0.79–0.99)
Discharge from neurology or internal medicine clinic†	248	17.3	2768	19.0	0.92	(0.80–1.06)
Secondary parkinsonism (G21)	44	3.1	366	2.5	1.19	(0.85–1.65)
Discharge from neurology or internal medicine clinic†	27	1.9	217	1.5	1.23	(0.79–1.91)
Other degenerative diseases of the basal ganglia (G23)	21	1.5	248	1.7	0.77	(0.49–1.21)
Discharge from neurology or internal medicine clinic†	19	1.3	188	1.3	0.81	(0.48–1.38)
Dystonia (G24)	4	0.3	43	0.3	1.42	(0.49–4.14)
Discharge from neurology or internal medicine clinic†	4	0.3	39	0.3	1.37	(0.40–4.72)
Other extrapyramidal and movement disorders (G25)	26	1.8	282	1.9	0.95	(0.63–1.43)
Discharge from neurology or internal medicine clinic†	22	1.5	218	1.5	1.15	(0.73–1.82)

*Relative risk for hospital discharge or death calculated by a Cox regression analysis matched for year of birth and county of residence.
†Restricted to subjects diagnosed at discharge from inpatient care at a neurology or internal medicine clinic.

Table 4 Number, incidence rates, and adjusted rate ratios for Parkinson's disease (ICD-10, G20), by attained age, time period of follow up, geographical area of residency, shipyard welding, and education, Sweden 1964–2003

	Welders and flame cutters		General population			
	n	Incidence rate/ 100 000 person years	n	Incidence rate/ 100 000 person years	Adjusted rate ratio*	95% CI
Attained age						
<65 years	104	8.6	1121	9.2	0.94	(0.77–1.16)
⩾65 years	249	108.1	2926	124.9	0.86	(0.75–0.99)
Time period						
1964–76	39	8.5	398	8.7	1.02	(0.72–1.44)
1977–86	77	18.1	912	21.2	0.82	(0.63–1.05)
1987–96	148	40.3	1754	46.5	0.87	(0.72–1.04)
1997–2003	89	47.8	983	50.8	0.99	(0.78–1.26)
Geographical area of residency						
Götaland (south of Sweden)	112	25.7	1366	31.1	0.76	(0.57–1.02)
Svealand (middle area)	171	23.0	2081	27.1	0.84	(0.71–0.99)
Norrland (northern area)	70	27.5	600	24.0	1.23	(0.95–1.59)
Shipyard welding	53	29.6	558	28.6	0.95	(0.70–1.28)
Education†						
Compulsory school level	60	15.9	440	20.4	0.85	(0.64–1.13)
High school level and higher	41	24.6	247	17.5	1.02	(0.71–1.46)

*Relative risk calculated by a stratified Cox regression analysis matched for year of birth and county of residence.
†Information on education is only available for 23 908 welders and flame cutters and 235 658 individuals in the comparison cohort identified in the 1970 census.

Table 4 presents analyses for Parkinson's disease stratified by categories of attained age, time period of follow up, geographical area of residency, and educational level. No significant differences or trends were found. The rate ratios for welders and flame cutters aged 65 and older (aRR = 0.86; 95% CI 0.75 to 0.99) compared to welders and flame cutters less than age 65 (aRR = 0.94; 95% CI 0.77 to 1.16) were not meaningfully different. Analyses by time period, geographical area of residency, welding in shipyards, and education were uneventful with most rate ratios near 1.00. A total of 4952 welders and flame cutters were employed in the shipyard or boat building industry. Their rate of PD in relation to the matched general population was 0.95 (95% CI 0.70 to 1.28).

Additional analyses restricted to welders who appeared in both the 1960 and the 1970 censuses, and were thus assumed to have the most stable job histories, again revealed no increased risks of any basal ganglia and movement disorders. In fact, the risk estimates were slightly lower in this group, with an overall aRR = 0.79 (95% CI 0.65 to 0.96) and for Parkinson's disease aRR = 0.78 (95% CI 0.64 to 0.96). We also were able to examine the effect of socioeconomic status on the relation between welding and basal ganglia and movement disorders. The 1960 and 1970 census information contained a socioeconomic status indicator for each welder in our cohort and for men in the comparison cohort. Controlling for this variable did not meaningfully change the results for the overall aRR (0.96 (95% CI 0.83 to 1.12)) or for Parkinson's disease (0.92 (95% CI 0.78 to 1.08)), in particular. Finally, because of the potential relation between farming exposures and Parkinson's disease,[16 17] we conducted analyses omitting those employed in farming activities (n = 19 960). Again, the aRRs for the overall group of basal ganglia and movement disorders (aRR = 0.93; 95% CI 0.83 to 1.04) and for Parkinson's disease (aRR = 0.91; 95% CI 0.81 to 1.03) were little changed.

DISCUSSION

In this nationwide investigation, we studied nearly 50 000 male welders and flame cutters in Sweden and compared their rates of hospitalisation or death for any basal ganglia and movement disorders with that among nearly 500 000 age and geographical area matched men from the general population. Rates in the two cohorts were not statistically significantly different for basal ganglia and movement disorders overall, nor specifically for Parkinson's disease, secondary parkinsonism, other degenerative diseases of the basal ganglia, dystonia, or other extrapyramidal and movement disorders. Further analyses for Parkinson's disease stratified by attained age, time period of follow up, geographical area of residency, and education level were unremarkable, and a subcohort analysis of shipyard welders with presumably higher exposure to welding fumes showed no increased rate of Parkinson's disease.

A few studies have suggested that welding may be associated with Parkinson's disease and other neurological conditions,[7 18–20] but potential methodological flaws including biased selection of study subjects and/or small numbers of welders weakens the impact of these studies. A proportional mortality study reviewing statements of occupation on US death certificates reported a significantly increased proportion of Parkinson's disease at ages below 65 associated with welding related jobs.[21] Less than 5% of the Parkinson's disease deaths were in this group, however, and overall there was a statistically significantly reduced proportion of Parkinson's disease among those with welding occupations. One previous study reported that the age of onset of Parkinson's disease among 15 male welders was significantly lower than the age of onset of Parkinson's disease in patients in two different control groups,[8] but referral and recall bias are likely.[22] The majority of occupational studies have not found any statistically significant association between welding and Parkinson's disease.[23–31] One of these was a recent cohort study of over 6000 Danish welders which reported that hospitalisations due to Parkinson's disease were not more frequent among welders compared with the general population.[30]

Men were classified as welders based on census data collected in 1960 and 1970 by Statistics Sweden. A validation study of the 1960 census with a re-interview of a random sample of workers demonstrated excellent agreement (95%) for the occupational codes in Sweden.[32] An evaluation of the 1975 census demonstrated even higher agreement (99.4%) for occupational codes, indicating that reporting accuracy in Sweden for occupation was increasing up to that time.[33]

Studies based on census information are a powerful tool for identifying occupations that may have elevated disease risks. Due to the large numbers of subjects that can be identified in the Census Register and the ability to link these individuals through the NRN to other established nationwide medical and population databases in Sweden, medical research questions can be addressed in a scientifically rigorous, cost effective, and unbiased fashion. In fact, occupational census based studies in Sweden have confirmed workplace risks for a variety of diseases including pleural mesothelioma in shipyard workers,[34] and nasal adenocarcinomas in furniture makers.[35]

Complete job histories were not collected for the welders in our study; thus, we did not have information on durations of welding employment. However, the long apprentice training for welders and the social welfare and taxation scheme in Sweden provide little incentive for occupational change among the skilled trades such as welding. We assumed that the welders in our study with the most stable occupational history would be included in more than one census and we calculated the relative rates for basal ganglia and movement disorders for welders who appeared in both the 1960 and the 1970 censuses. These analyses demonstrated that welding among those with the most stable job histories was not associated with basal ganglia and movement disorders.

This was a record linkage study and we did not have information on the individual welders' exposures to manganese or other compounds, making it impossible to perform dose-response analyses within the cohort. Breathing zone welding fume exposures were studied in a large industrial hygiene survey in the 1970s in Sweden, however, to measure the concentrations of the most important gaseous and particulate contaminants at representative workplaces, mainly in the manufacturing industry.[11–14] Manganese exposure was measured in a variety of settings for both MMA and MAG with geometric means of about 0.3 mg/m^3. However, levels may be higher for Swedish shipyard workers, with a median level of exposure level of air contaminants between 5 and 10 mg/m^3 and a measured percentage of manganese of 6%,[36] despite the fact that these measurements were performed on the shoulder outside the welding helmet and not in the breathing zone of the welders and thus may overestimate the exposure.

The absence of increased risks of Parkinson's disease and other basal ganglia and movement disorders in our cohort of welders suggests that the above mentioned manganese exposure levels are not sufficient to affect these disorders. Although our results make parkinsonism unlikely as an outcome of welding in Sweden, we could not evaluate subclinical neurological or behavioural conditions. The American Conference of Governmental Industrial Hygienists (ACGIH) concluded that the lowest exposure concentration of manganese at which early effects of the central nervous system may occur is still unknown. The ACGIH recommends a threshold limit value (TLV)-time weighted average of 0.2 mg/m^3 for manganese and its inorganic compounds to reduce the potential for preclinical adverse effects.[37] The Swedish Criteria Group for Occupational Standards likewise concluded in 1997 that the critical effects of occupational exposure to manganese are the effects on the nervous system.[38]

Our study has some additional limitations. As most cases were identified through the Hospital Discharge Register, only cases of Parkinson's disease or other basal ganglia and movement disorders serious enough to require hospitalisation were ascertained. However, Parkinson's disease typically is associated with regular hospital visits, so that workers with manifest Parkinson's disease would likely have a hospitalisation sometime during follow up for their illness.[39 40] Regardless, disease information was collected in a systematic manner unrelated to exposure, using nationwide medical databases, resulting in unbiased disease ascertainment for both the welder and flame cutting cohort and for the general population cohort. The accuracy of the diagnoses in the hospitalisation registry may also be a limitation. In order to examine this possibility, we restricted our analyses to patients discharged from neurology or internal medicine clinics (the places where neurologists work) in order to increase the likelihood that the diagnoses were accurate. We found no difference in results for this analysis when compared with the nationwide Hospital Discharge Register analysis for all patient discharges. Therefore, it is unlikely that this potential limitation significantly biased our results.

Another limitation of this study was the lack of information on cigarette smoking, which has been linked to reduced risk of Parkinson's disease,[41] but not other basal ganglia and movement disorders. Thus, a higher prevalence of smoking among welders compared with the general population could contribute to our observation of a slightly reduced risk of Parkinson's disease among welders. A Swedish survey conducted in the male population between 1986 and 1990 reported that 29% of the men in the general population were smokers compared with 42% of men working as welders.[42] If I_g represents the incidence of Parkinson's disease in men in the general population, I_w represents the incidence of Parkinson's disease in welders, I_o represents the incidence of Parkinson's disease in non-smoking men, and RR_s is the risk ratio for Parkinson's disease among smokers, then $I_g = I_o(1-\%\text{ smokers in general population}) + RR_sI_o(\%\text{ smokers in general population})$ and $I_w = I_o(1-\%\text{ smokers in welders}) + RR_sI_o(\%\text{ smokers in welders})$.[43] Based on a pooled risk estimate of 0.51 for the association between ever smoking and Parkinson's disease (from a recent meta-analysis of all prospective studies between 1966 and 2001,[44]) the estimated reduction in the relative rate due to smoking in welders compared with the general population (I_w/I_g) was 0.92, leading to a smoking adjusted relative rate of 0.96 (0.89/0.92) for the association between welding and Parkinson's disease in our cohort.

CONCLUSIONS

This well defined, large, nationwide cohort study of Swedish welders with up to 40 years of follow up did not reveal any statistically significantly increased risks for Parkinson's disease or other basal ganglia and movement disorders for welders compared with an age and geographically matched general population comparison cohort. Furthermore, analyses restricted to welders in shipyards, with potentially higher levels of exposure to welding fumes, also showed no relation with basal ganglia and movement disorders.

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