Socioeconomic and Occupational Risk Factors for Rheumatoid Arthritis: A Nationwide Study Based on Hospitalizations in Sweden

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ABSTRACT. ***Objective.*** To investigate possible associations between socioeconomic status, occupation, and hospitalization for rheumatoid arthritis (RA).

Methods. A nationwide database was constructed by linking the Swedish Census to the Hospital Discharge Register in order to obtain data on all first hospitalizations for RA in Sweden during the study period 1964 to 2004. Standardized incidence ratios (SIR) and 95% confidence intervals were calculated by socioeconomic status (education level) and occupation for men and women aged 30 years and older. Three cohorts were defined based on occupational titles recorded in Swedish census data in 1960, 1970, and 1980.

Results. A total of 13,820 male and 14,509 female hospitalizations for RA were identified during the study period. Men and women with an education level > 12 years had significantly decreased SIR. Among men, significantly increased SIR were present in all 3 cohorts among farmers, miners and quarry workers, electrical workers, other construction workers, and engine and motor operators. Among women, assistant nurses and religious, juridical, and other social-science-related workers had significantly increased SIR in all 3 cohorts.

Conclusion. Socioeconomic status and occupation sometimes carry a significantly increased risk of hospitalization for RA. Future studies could investigate specific agents in the occupations for which increased risks are identified. (First Release May 1 2008; J Rheumatol 2008;35:986–91)

Key Indexing Terms:
SOCIOECONOMIC STATUS OCCUPATION FOLLOWUP STUDY
STANDARDIZED INCIDENCE RATIOS RHEUMATOID ARTHRITIS

Rheumatoid arthritis (RA) is an autoimmune disease that causes chronic inflammation of the joints and sometimes inflammation of the extraarticular tissues throughout the body, including the skin, blood vessels, heart, lungs, and muscles. RA affects roughly 1% of the population during their lifetime[1]. The etiology of RA is largely unknown; genetic susceptibility has been proven to play a role. However, the concordance among monozygotic twins of only 12% to 15%[2,3] suggests that environmental factors are also involved in the development of this disease.

A growing body of evidence indicates that socioeconomic status is one risk factor for RA[1,4,5]. However, some studies have not observed an association between socioeconomic status and RA[6,7]. Socioeconomic factors may influence the risk of developing RA in many ways. For example, exposure to harmful agents may be related to occupational, residential, and lifestyle factors, which may in turn depend on socioeconomic status. Although some studies have found increased risks for RA among occupational categories[4,5,8-11], few have reported associations between specific occupations and the incidence of RA[8,10,12,13].

Many previous studies were based on prevalent cases and relied on self-reports for exposure assessments and thus potentially suffer from survivorship and recall bias. Our study contributes to the increasing body of knowledge pertaining to socioeconomic and occupational risks for RA since the focus on a total population constitutes a novel approach. We assessed hospitalizations for RA in the economically active Swedish population between 1964 and 2004. Data were based on nationwide hospital registers, which allowed us to analyze large sample sizes in each occupational category and perform almost complete followup of all individuals who had an occupational title and were living in Sweden during that period.

MATERIALS AND METHODS

Data used in this study were retrieved from the MigMed database, located at the Center for Family and Community Medicine at the Karolinska Institute in Stockholm. MigMed is a single comprehensive database that

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contains individual-level information on all people in Sweden, including age, sex, socioeconomic status (education level), occupation, region of residence, hospital diagnoses and dates of hospital admissions in Sweden between 1964 and 2004[14], date of emigration or immigration, and date and cause of death. This unique database was constructed using several national Swedish data registers, including but not limited to the total population register, the Multi-Generation Register, and the Swedish Hospital Discharge Register. These are markedly complete and were provided to us by Statistics Sweden (the Swedish government statistics bureau) and the National Board of Health and Welfare[14-17].

Information retrieved from the various registers in the MigMed database was linked at the individual level via the national 10-digit civic registration number assigned to each person in Sweden for his or her lifetime. Prior to inclusion in the MigMed database, civic registration numbers were replaced by serial numbers to ensure the anonymity of all individuals. These numbers were used to check that individuals with hospital diagnoses of RA appeared only once in the dataset, for their first hospital diagnosis of RA during the study period.

Swedish census data (included in the MigMed database) from 1960, 1970, and 1980 were used to define occupational status among economically active individuals. Three cohorts were defined for both men and women. For men, the first cohort included men aged ≥ 30 years in 1960 and categorized according to their occupational status in 1960, the second included men aged ≥ 30 years in 1970 and categorized according to their occupational status in 1970, and the third cohort included men aged ≥ 30 years in 1960 who retained the same occupational title in 1960 and 1970. For women, the same cutoff point was used for age (≥ 30 years) and the same principle was used to define the 3 cohorts. However, the corresponding 3 cohorts for women were defined a decade later because few women were active on the labor market before 1970. The starting point for the followup periods differed between the 3 cohorts (see Tables 2 and 3). All followup periods proceeded until hospitalization for RA, death, emigration, or the end of the study on December 31, 2004.

Outcome variable. The 7th, 8th, 9th, and 10th revisions of the International Classification of Diseases (ICD-7, ICD-8, ICD-9, and ICD-10) were used to identify all first hospital admissions for the outcome variable "RA" during the study period (ICD-7, code 722; ICD-8, code 712; ICD-9, code 714; and ICD-10, codes M05 and M06). Juvenile forms of RA were not included. Only primary diagnoses of RA were included in the analysis.

Individual variables controlled for in the analysis

Gender: male and female. Age at diagnosis (defined as first hospitalization during the study period) was categorized in 5-year groups, starting at 30 years. We included only individuals over 30 years of age because many people do not have a stable occupation at younger ages.

Occupation. Occupation was coded according to national adaptations of the Nordic Occupational Classification (NYK). Three-digit codes were combined into 53 NYK occupational groups and one economically inactive group[18]. Occupational groups were combined, based on similarities in the included occupations. People without paid employment were excluded.

Socioeconomic status. Socioeconomic status was based on education level, classified into 3 categories: < 9, 9–12, and > 12 years of education.

Geographic region. Geographic region was divided into (1) large cities (cities with a population > 200,000 inhabitants, i.e., Stockholm, Gothenburg, and Malmö); (2) Southern Sweden; and (3) Northern Sweden. Geographic region was included as an individual variable to adjust for possible differences between regions in Sweden regarding hospital admissions for RA. The boundary between Southern and Northern Sweden was drawn at the river Dalälven, the traditional border between Southern and Northern Sweden.

Statistical analysis. Person-years were calculated from the start of the followup until hospitalization for RA, death, emigration or the closing date on December 31, 2004. Age-specific incidence rates were calculated for the whole followup period, divided into five 5-year periods.

Standardized incidence ratios (SIR) were calculated for different education and occupational groups as the ratio of the observed to the expected number of cases[19], using all economically active individuals in the entire cohort as reference. The expected number of cases was based on the number of cases in the entire cohort. The expected number of cases was calculated for age (5-yr groups), sex, time period (5-yr groups), region, education level, and occupational group, i.e., specific standardized incidence rates. Ninety-five percent confidence intervals (95% CI) were calculated assuming a Poisson distribution[19]. SAS software was used in the statistical analysis (SAS version 9.1; SAS Institute, Cary, NC, USA). The use of SIR was based on the circumstance that the incidence rates of RA were low and the age intervals were calculated for narrow age intervals, which allows comparison with relative risks[20].

The construction and use of the database was approved by the appropriate organizations, such as the Ethics Committee at Karolinska Institute, Stockholm.

RESULTS

Table 1 shows the number of cases and SIR for hospitalizations for RA by socioeconomic status (education level), region, and age at diagnosis among men (1964–2004) and women (1970–2004). All SIR are also adjusted for time period. A total of 13,820 men and 14,509 women over 30 years of age were hospitalized for RA during the followup periods. Men and women with education level > 12 years had significantly decreased SIR.

Table 2 shows SIR for hospitalizations for RA for men by occupation in the 3 cohorts (census 1960, census 1970, and census 1960 and 1970, i.e., men who retained the same occupational title in 2 consecutive censuses). Only occupations with more than 50 cases in each cohort are presented. All SIR were adjusted for age, period, region, and socioeconomic status (education). Among men, significantly increased SIR that were present in all 3 cohorts were

Table 1. Number of cases and SIR for hospitalization for RA by education level, region, and age at diagnosis (first hospitalization during the study period) among men (followed 1964–2004) and women (1970–2004).

	Men (1964–2004)		Women (1970–2004)	
Education/Region	N	SIR (95% CI)	N	SIR (95% CI)
Education, yrs				
< 9	10,122	**1.0 (1.0 1.1)**	8,244	**1.0 (1.0 1.1)**
9–12	3,043	1.0 (0.9 1.0)	4,819	1.0 (0.9 1.0)
> 12	655	**0.8 (0.7 0.8)**	1,446	**0.9 (0.8 0.9)**
Region				
Large cities	4,250	1.0 (0.9 1.0)	5,325	1.0 (0.9 1.0)
Northern Sweden	2,872	**1.0 (1.0 1.1)**	2,487	**1.0 (1.0 1.1)**
Southern Sweden	6,698	1.0 (0.9 1.0)	6,697	1.0 (0.9 1.0)
Age at diagnosis, yrs				
30–39	494	**0.5 (0.4 0.5)**	873	**0.5 (0.5 0.6)**
40–49	1,488	**0.6 (0.6 0.7)**	2,077	**0.7 (0.6 0.7)**
50–59	3,207	0.9 (0.9 1.0)	3,845	1.0 (0.9 1.1)
60–69	4,162	**1.1 (1.1 1.2)**	3,950	**1.2 (1.2 1.3)**
70–79	3,546	**1.4 (1.4 1.5)**	2,959	**1.4 (1.3 1.4)**
≥ 80	923	**1.1 (1.0 1.1)**	805	**1.1 (1.0 1.2)**
All	13,820	1.00 reference	14,509	1.00 reference

N: number observed; SIR: standardized incidence ratio. Data in bold type: 95% CI does not include 1.00.

Table 2. SIR for hospitalization for RA among men by occupation in 3 cohorts (census 1960, census 1970, and census 1960 and 1970, i.e., men who retained the same occupational title in 2 consecutive censuses).

Occupation	Census 1960 (1964–2004*)		Census 1970 (1970–2004*)		Census 1960 to Census 1970 (1970–2004*)	
	N	SIR (95% CI)	N	SIR (95% CI)	N	SIR (95% CI)
Technical, chemical, physical and biological workers	983	**0.9 (0.8 0.9)**	1,266	**0.9 (0.8 0.9)**	594	0.9 (0.8 1.0)
Teachers	179	1.0 (0.8 1.1)	251	1.0 (0.9 1.1)	126	1.0 (0.9 1.2)
Religious, juridical and other social-science-related workers	104	**0.7 (0.6 0.9)**	185	0.9 (0.7 1.0)	59	0.8 (0.6 1.0)
Artistic workers	56	0.9 (0.7 1.2)	51	0.8 (0.6 1.0)	28	0.9 (0.6 1.2)
Administrators and managers	348	0.9 (0.8 1.0)	383	0.9 (0.8 1.0)	138	0.9 (0.8 1.1)
Clerical workers	489	0.9 (0.8 1.0)	566	1.0 (0.9 1.1)	185	0.9 (0.8 1.1)
Sales agents	620	**0.9 (0.8 0.9)**	641	**0.9 (0.8 0.9)**	284	0.9 (0.8 1.0)
Shop managers and assistants	300	0.9 (0.8 1.0)	249	0.9 (0.8 1.0)	104	0.9 (0.7 1.1)
Farmers	1,633	**1.1 (1.0 1.1)**	954	**1.1 (1.0 1.2)**	821	**1.2 (1.1 1.2)**
Gardeners and related workers	236	1.1 (0.9 1.2)	184	1.0 (0.8 1.1)	92	1.1 (0.8 1.3)
Forestry workers	364	1.0 (0.9 1.1)	197	0.9 (0.7 1.0)	90	0.9 (0.7 1.1)
Miners and quarry workers	175	**1.7 (1.5 2.0)**	145	**1.8 (1.6 2.2)**	43	**1.4 (1.0 1.9)**
Transport workers	129	0.9 (0.8 1.1)	165	1.0 (0.9 1.2)	45	1.1 (0.8 1.5)
Drivers	1,011	1.0 (0.9 1.1)	798	1.0 (0.9 1.0)	424	0.9 (0.8 1.0)
Postal and communication workers	149	1.0 (0.8 1.1)	157	1.1 (0.9 1.2)	70	1.0 (0.8 1.2)
Textile workers	139	0.8 (0.7 1.0)	102	0.9 (0.7 1.0)	56	0.8 (0.6 1.1)
Shoe and leather workers	54	1.1 (0.8 1.4)	22	0.9 (0.5 1.3)	11	0.7 (0.3 1.3)
Smelter and metal foundry workers	292	1.1 (0.9 1.2)	271	**1.2 (1.1 1.4)**	94	1.0 (0.8 1.2)
Mechanics, iron and metalware workers	1,466	**1.1 (1.0 1.1)**	1.314	1.0 (0.9 1.0)	654	**1.0 (1.0 1.1)**
Plumbers	172	1.1 (0.9 1.2)	153	1.0 (0.9 1.2)	99	1.1 (0.9 1.4)
Welders	181	1.0 (0.8 1.1)	188	1.0 (0.8 1.1)	59	0.8 (0.6 1.1)
Electrical workers	507	**1.1 (1.0 1.2)**	501	**1.1 (1.0 1.2)**	282	**1.2 (1.1 1.3)**
Wood workers	714	0.9 (0.9 1.0)	778	1.0 (0.9 1.1)	368	1.0 (0.9 1.1)
Painters and wallpaper hangers	197	**0.8 (0.7 0.9)**	205	0.9 (0.8 1.0)	123	0.8 (0.7 1.0)
Other construction workers	498	**1.2 (1.1 1.4)**	561	**1.3 (1.2 1.5)**	210	**1.4 (1.2 1.6)**
Bricklayers	105	1.0 (0.8 1.2)	105	1.1 (0.9 1.4)	69	1.1 (0.9 1.4)
Printers and related workers	133	0.9 (0.8 1.1)	158	**1.1 (1.0 1.3)**	80	0.9 (0.7 1.2)
Chemical process workers	191	1.0 (0.8 1.1)	136	0.9 (0.7 1.0)	49	0.9 (0.6 1.2)
Food manufacturing workers	225	0.9 (0.8 1.1)	161	0.9 (0.8 1.1)	87	0.9 (0.7 1.1)
Glass, ceramic and tile workers	234	1.1 (0.9 1.2)	233	1.0 (0.9 1.1)	54	0.8 (0.6 1.0)
Packers, loaders and warehouse workers	807	**1.1 (1.1 1.2)**	612	**1.1 (1.0 1.1)**	173	1.1 (0.9 1.2)
Engine and motor operator workers	383	**1.2 (1.1 1.3)**	435	**1.1 (1.0 1.3)**	128	**1.2 (1.0 1.5)**
Public safety and protection workers	157	1.0 (0.9 1.2)	190	1.0 (0.9 1.2)	88	1.0 (0.8 1.2)
Building caretakers and cleaners	112	1.1 (0.9 1.3)	223	**1.2 (1.0 1.4)**	47	1.1 (0.8 1.5)
Launderers and dry cleaners	57	0.8 (0.6 1.0)	60	0.9 (0.7 1.1)	22	0.7 (0.4 1.1)
Military personnel	110	1.1 (0.9 1.3)	94	**1.2 (1.0 1.5)**	64	1.2 (0.9 1.5)
All	13,820	1.0 reference	13,003	1.0 reference	6,097	1.0 reference

* Followup intervals. N: number observed; SIR: standardized incidence ratio. Data in bold type: 95% CI does not include 1.00.

observed in the following occupational groups: farmers, miners and quarry workers, electrical workers, other construction workers, and engine and motor operators. Significantly increased SIR were present in at least one of 3 cohorts among the following occupational groups: smelter and metal foundry workers; mechanics and iron and metalware workers; printers and related workers; packers, loaders, and warehouse workers; building caretakers and cleaners; and military personnel.

Table 3 shows SIR for hospitalizations for RA among women by occupation in the 3 cohorts (census 1970, census 1980, and census 1970 and 1980, i.e., women who retained the same occupational title in 2 consecutive censuses). Only occupations with more than 50 cases in each cohort are presented. Among women, assistant nurses and religious, juridical, and other social-science-related workers had a significantly increased SIR that was present in all 3 cohorts. Among the following occupational groups, significantly increased SIR were present in one of 3 cohorts: shop managers and assistants; electrical workers; wood workers; and glass, ceramic, and tile workers.

DISCUSSION

The main finding of our study is that socioeconomic status and occupation sometimes carry a significantly increased risk of hospitalization for RA. Among men, significantly

Table 3. SIR for hospitalization for RA among women by occupation in 3 cohorts (census 1970, census 1980, and census 1970 and 1980, i.e., women who retained the same occupational title in 2 consecutive censuses).

Occupation	Census 1970 (1970–2004*)		Census 1980 (1980–2004*)		Census 1970 to Census 1980 (1980–2004*)	
	N	SIR (95% CI)	N	SIR (95% CI)	N	SIR (95% CI)
Technical, chemical, physical and biological workers	152	0.9 (0.8 1.0)	231	1.1 (0.9 1.2)	62	0.9 (0.7 1.2)
Nurses	350	0.9 (0.8 1.0)	392	0.9 (0.8 1.0)	173	0.9 (0.8 1.0)
Assistant nurses	1,192	**1.1 (1.1 1.2)**	1,272	**1.1 (1.1 1.2)**	484	**1.1 (1.0 1.2)**
Other health and medical workers	238	1.0 (0.9 1.2)	277	1.1 (0.9 1.2)	114	1.2 (0.9 1.4)
Teachers	676	1.0 (0.9 1.0)	791	1.0 (0.9 1.0)	399	1.0 (0.9 1.1)
Religious, juridical and other social-science-related workers	245	**1.1 (1.0 1.3)**	427	**1.1 (1.0 1.2)**	99	**1.2 (1.0 1.5)**
Artistic workers	54	1.0 (0.8 1.4)	53	0.9 (0.7 1.2)	20	1.0 (0.6 1.6)
Administrators and managers	126	1.1 (0.9 1.3)	158	0.9 (0.8 1.0)	24	1.0 (0.6 1.4)
Clerical workers	2,780	1.0 (0.9 1.0)	2,776	1.0 (0.9 1.0)	1,322	1.0 (0.9 1.1)
Sales agents	263	1.0 (0.9 1.1)	277	0.9 (0.8 1.0)	46	1.0 (0.7 1.3)
Shop managers and assistants	1,775	**1.0 (1.0 1.1)**	962	0.9 (0.9 1.0)	490	1.0 (0.9 1.1)
Farmers	562	1.0 (0.9 1.1)	511	1.0 (0.9 1.1)	189	1.0 (0.9 1.2)
Gardeners and related workers	194	1.0 (0.9 1.2)	50	0.9 (0.7 1.2)	14	1.0 (0.5 1.6)
Drivers	89	0.9 (0.7 1.1)	93	1.0 (0.8 1.2)	19	0.8 (0.5 1.3)
Postal and communication workers	444	1.0 (0.9 1.1)	380	1.0 (0.9 1.2)	163	1.0 (0.8 1.2)
Textile workers	488	0.9 (0.8 1.0)	191	0.8 (0.7 1.0)	98	0.8 (0.7 1.0)
Mechanics, iron and metalware workers	218	1.0 (0.8 1.1)	201	1.1 (0.9 1.2)	35	0.7 (0.5 1.0)
Electrical workers	148	**1.2 (1.0 1.4)**	112	1.1 (0.9 1.4)	38	1.3 (0.9 1.8)
Wood workers	46	0.9 (0.7 1.2)	72	**1.3 (1.0 1.6)**	14	1.4 (0.8 2.4)
Printers and related workers	90	1.2 (0.9 1.4)	60	1.0 (0.8 1.3)	23	1.1 (0.7 1.6)
Chemical process workers	58	1.0 (0.7 1.3)	59	1.3 (0.9 1.6)	10	0.9 (0.5 1.7)
Food manufacturing workers	156	1.0 (0.8 1.1)	73	0.9 (0.7 1.1)	22	0.8 (0.5 1.3)
Glass, ceramic, and tile workers	172	0.9 (0.8 1.1)	139	**1.2 (1.0 1.5)**	37	1.1 (0.8 1.5)
Packers, loaders, and warehouse workers	279	0.9 (0.8 1.1)	196	1.0 (0.9 1.2)	50	1.1 (0.9 1.5)
Cooks and stewards	607	1.0 (0.9 1.1)	443	0.9 (0.9 1.0)	125	1.0 (0.8 1.2)
Home helpers	1,002	1.0 (0.9 1.0)	998	1.0 (0.9 1.1)	223	1.0 (0.9 1.1)
Waiters	359	0.9 (0.8 1.0)	207	0.9 (0.7 1.0)	66	0.9 (0.7 1.1)
Building caretakers and cleaners	1,153	1.0 (0.9 1.0)	994	1.0 (0.9 1.0)	288	1.0 (0.8 1.1)
Hairdressers	168	1.1 (0.9 1.2)	101	1.0 (0.8 1.2)	70	1.1 (0.9 1.4)
Launderers and dry cleaners	204	1.0 (0.8 1.1)	156	0.9 (0.8 1.1)	34	1.0 (0.7 1.4)
All	14,509	1.0 reference	12,872	1.0 reference	4,804	1.0 reference

* Followup intervals, N: number observed; SIR: standardized incidence ratio. Data in bold type: 95% CI does not include 1.00.

increased SIR were present in all 3 cohorts among farmers; miners and quarry workers; electrical workers; other construction workers; and engine and motor operators. Among women, assistant nurses and religious, juridical, and other social-science-related workers had a significantly increased SIR that was present in all 3 cohorts. However, no increased SIR were found for most occupational groups.

To our knowledge, this is the first study to investigate the association between socioeconomic and occupational status and the risk of hospitalization for RA in an entire population aged ≥ 30 years. This approach yielded 13,820 cases among men and 14,509 among women. The study also has a number of other strengths. For example, the civic registration number (changed to a serial number to ensure anonymity) assigned to each individual in Sweden made it possible to track the records of every person for the whole followup period. This ensured that there was no loss to followup. Data on occupational status were almost 100% (99.2%) complete. Additionally, the data in the Swedish Hospital Discharge Register are also remarkably complete. In 2001, the main diagnosis was missing in 0.9% and the national registration number in 0.4% of hospitalizations[15]. Another strength is that we report all results with only one significant digit. This approach minimizes an overinterpretation of the results[21-24]. Finally, the study was based on practically complete nationwide coverage of all hospitalizations for RA in a country with a high healthcare standard[14] during a defined study period.

Our study also has some limitations. For example, we had no data on individual risk factors for RA, such as lifestyle factors. In a register that includes an entire population, it is not feasible to include individual data on, for example, smoking, drinking, and other individual risk factors. However, we adjusted our results for hospitalization for socioeconomic status, which is associated with, for example, smoking. Further, there have been large changes in the

labor market in Sweden during the study period[25-27]. Lack of information on the duration of employment was partly remedied by the analysis of individuals who maintained the same occupation through 2 consecutive censuses. The quality of data on occupational titles has been assessed by Warnryd and coworkers[28]. Their results showed that the proportion of concordant occupational titles was 72%, suggesting a reasonable quality of the census data. In terms of reliability, the coding showed about 10% misclassifications. Half of the errors were due to variation in the subjects' responses, while the other half were due to variation in the coding of equivalent responses. The large number of comparisons could be regarded as both a strength and a limitation, as some associations might have been due to chance. In addition, early onset may influence a person's choice of occupation, which may in turn influence the results. The absence of outpatient data is also a limitation, as only the most severe cases were included, i.e., those that required hospitalization. However, the relatively long followup periods increase the probability of identifying RA cases in the population by means of the hospital registers. Further, we were unable to test for the validity of the diagnoses because our data were based on the entire population. However, we used only primary diagnoses for RA recorded in the hospital registers, i.e., all patients were hospitalized mainly for RA, which increases the possibility that the diagnoses are valid. We also investigated the number of subsequent hospitalizations for RA. Two or more admissions for RA were recorded among 60.2% of the cases, whereas 39.8% had only one admission for RA. However, this bias is present in all the occupational groups in the comparison. We have no reason to believe that the magnitude of this bias differed among the occupational groups and therefore it ought to be of minor importance.

We found a decreased risk of hospitalization for RA in individuals with high socioeconomic status (> 12 years of education), which is consistent with findings from previous research[4]. Low socioeconomic status may be a risk factor in the development of RA[1,4,5] because social and economic deprivation are associated with psychosocial stressors, occupational exposures, infections, and poor nutrition. Low socioeconomic status may influence the risk for RA through factors that are seen more frequently in other autoimmune diseases[29,30].

Occupational factors have been suggested to be involved in the etiology of RA. The association between occupation and proximity to specific agents has been assessed according to job title[8-10,13]. A similar excess risk was demonstrated in a case-control study in Sweden in which the occupational exposures associated with an increased risk of RA were summarized as follows: vibrations, asbestos, fertilizers, crops and/or forage, and mineral dust (e.g., silica dust)[31]. A study from the United States found that crystalline silica exposure was associated with RA[12]. In accord with these, our study shows that the risk of hospitalization for RA was increased among men with similar occupational exposures. For men, this applied more or less for the following occupations: farmers; miners and quarry workers; electrical workers; other construction workers; engine and motor operators; smelter and metal foundry workers; mechanics and iron and metalware workers; printers and related workers; packers, loaders, and warehouse workers; building caretakers and cleaners; and military personnel. For women, fewer occupations were associated with increased risk of hospitalization for RA, i.e., assistant nurses; religious, juridical, and other social-science-related workers; shop managers and assistants; electrical workers; wood workers; and glass, ceramic, and tile workers.

The main exposures in the occupations associated with increased risks in this study would be fertilizers, crops and/or forage, mineral dust, mineral oils, vibrations and engine oils, metal, exhaust fumes, solvents, chemical cleaning agents, and asbestos.

Our finding of an increased risk of hospitalization for RA among male farmers is consistent with findings from earlier studies[9,31]. In Sweden, farming tasks are performed mainly by men. The risk factors for RA in the farming environment seemed to involve pig farming and the handling of hay, rural living, and well-water use. The reason for the increased risk could also be greater use of various chemicals and pesticides in farming. Farmers and those living in rural areas would be more likely to have more exposure to pesticides, although such exposures could not be directly established in our study. In addition, we had no information about specific exposures to, for example, chemicals, so it is not feasible to identify the kinds of agents that are involved in the causal pathways. Finally, we had no access to data on smoking, i.e., a risk factor for RA, according to previous research[32].

Socioeconomic status and occupation sometimes carry a significantly increased risk of hospitalization for RA. Future studies could investigate specific agents in the occupations for which increased risks are identified.

REFERENCES

1. Alamanos Y, Drosos AA. Epidemiology of adult rheumatoid arthritis. Autoimmun Rev 2005;4:130-6.
2. Aho K, Koskenvuo M, Tuominen J, et al. Occurrence of rheumatoid arthritis in a nationwide series of twins. J Rheumatol 1986;13:899-902.
3. Silman AJ, MacGregor AJ, Thomson W, et al. Twin concordance rates for rheumatoid arthritis: results from a nationwide study. Br J Rheumatol 1993;32:903-7.
4. Reckner Olsson A, Skogh T, Wingren G. Comorbidity and lifestyle, reproductive factors, and environmental exposures associated with rheumatoid arthritis. Ann Rheum Dis 2001;60:934-9.
5. Zeng QY, Darmawan J, Xiao ZY, et al. Risk factors associated with rheumatic complaints: a WHO-ILAR COPCORD study in Shantou, Southeast China. J Rheumatol 2005;32:920-7.
6. Uhlig T, Hagen KB, Kvien TK. Current tobacco smoking, formal education, and the risk of rheumatoid arthritis. J Rheumatol 1999;26:47-54.

7. Bankhead C, Silman A, Barrett B, et al. Incidence of rheumatoid arthritis is not related to indicators of socioeconomic deprivation. J Rheumatol 1996;23:2039-42.
8. Lundberg I, Alfredsson L, Plato N, et al. Occupation, occupational exposure to chemicals and rheumatological disease. A register based cohort study. Scand J Rheumatol 1994;23:305-10.
9. Olsson AR, Skogh T, Wingren G. Occupational determinants for rheumatoid arthritis. Scand J Work Environ Health 2000;26:243-9.
10. Sverdrup B, Kallberg H, Bengtsson C, et al. Association between occupational exposure to mineral oil and rheumatoid arthritis: results from the Swedish EIRA case-control study. Arthritis Res Ther 2005;7:R1296-303.
11. Gold LS, Ward MH, Dosemeci M, et al. Systemic autoimmune disease mortality and occupational exposures. Arthritis Rheum 2007;56:3189-201.
12. Calvert GM, Rice FL, Boiano JM, et al. Occupational silica exposure and risk of various diseases: an analysis using death certificates from 27 states of the United States. Occup Environ Med 2003;60:122-9.
13. Stolt P, Kallberg H, Lundberg I, et al. Silica exposure is associated with increased risk of developing rheumatoid arthritis: results from the Swedish EIRA study. Ann Rheum Dis 2005;64:582-6.
14. van Vollenhoven RF, Askling J. Rheumatoid arthritis registries in Sweden. Clin Exp Rheumatol 2005;23:S195-200.
15. Rosen M, Hakulinen T. Use of disease registers. In: Ahrens W, Pigeot I, editors. Handbook of epidemiology. Berlin: Springer-Verlag; 2005.
16. Statistics Sweden. The Swedish Multi Generation Register (1960-1990) [Swedish: Registret över totalbefolkningen/RTB], 2005. Internet [cited 2008 Mar 11] http://www.scb.se/templates/Standard_22842.asp
17. The National Board of Health and Welfare. The Swedish Hospital Discharge Register and the Cause of Death Register (1961-2001), 2004.. Internet [cited 2008 Mar 11]. http://www.socialstyrelsen.se/en/
18. Statistics SNCBo. Socioeconomic classification. Report on statistical coordination. Stockholm: Swedish National Central Bureau of Statistics; 1982.
19. Rothman KJ, Greenland S. Modern epidemiology. 2nd ed. Philadelphia: Lippincott-Raven; 1998.
20. Tsai SP, Wen CP. A review of methodological issues of the standardized mortality ratio (SMR) in occupational cohort studies. Int J Epidemiol 1986;15:8-21.
21. Ebrahim S, Clarke M. STROBE: new standards for reporting observational epidemiology, a chance to improve. Int J Epidemiol 2007;36:946-8.
22. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. Ann Intern Med 2007;147:W163-94.
23. Vigano P, Somigliana E, Parazzini F, et al. Bias versus causality: interpreting recent evidence of association between endometriosis and ovarian cancer. Fertil Steril 2007;88:588-93.
24. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. Ann Intern Med 2007;147:573-7.
25. Hemminki K, Li X. Cancer risks in second-generation immigrants to Sweden. Int J Cancer 2002;99:229-37.
26. Hemminki K, Li X. Cancer risks in Nordic immigrants and their offspring in Sweden. Eur J Cancer 2002;38:2428-34.
27. Hemminki K, Li X, Czene K. Cancer risks in first-generation immigrants to Sweden. Int J Cancer 2002;99:218-28.
28. Warnryd B, Ostlin P, Thorslund M. Living conditions. Appendix 11. Quality in retrospective questions on previous occupational exposures: an evaluation of occupational histories in the investigation on living conditions. Stockholm: Statistics Sweden; 1989.
29. Bovenzi M, Barbone F, Pisa FE, et al. A case-control study of occupational exposures and systemic sclerosis. Int Arch Occup Environ Health 2004;77:10-6.
30. Sarzi-Puttini P, Atzeni F, Iaccarino L, et al. Environment and systemic lupus erythematosus: an overview. Autoimmunity 2005;38:465-72.
31. Olsson AR, Skogh T, Axelson O, et al. Occupations and exposures in the work environment as determinants for rheumatoid arthritis. Occup Environ Med 2004;61:233-8.
32. Klareskog L, Padyukov L, Alfredsson L. Smoking as a trigger for inflammatory rheumatic diseases. Curr Opin Rheumatol 2007;19:49-54.