

Risk for reduced sperm quality among metal workers, with special reference to welders

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MORTENSEN JT. Risk for reduced sperm quality among metal workers, with special reference to welders. *Scand J Work Environ Health* 14 (1988) 27–30. The purpose of this study was to investigate whether men employed in the metal industry have sperm of poorer quality than men in other types of work. A postal questionnaire was sent to men employed in the metal industry, certain other types of nonmetal industries, and other types of employment in which the factors suspected to influence sperm quality were not present. By means of this questionnaire survey, it was hoped to define the possible influences of the work environment on sperm quality. Out of the total of 3 119 men included in the investigation, 2 517 (81 %) filled out the questionnaire satisfactorily. Semen analysis was performed for all 3 119 men. There was a greater risk for poor sperm quality among welders than among men not employed in welding. The risk for poor sperm quality was increased for those welders who worked with stainless steel. Welding in general, and specifically with stainless steel, is connected with a risk of reduced sperm quality.

Key terms: case-referent study, fertility problems, metal industry, welding, work environment.

Earlier investigations have shown that influences in the work environment can lead to a reduction in sperm quality. Examples of such influences are exposure to lead, exposure to ionizing radiation, and exposure to pesticides such as dibromochloropropane (DBCP) (7, 9).

The purpose of the present study was to investigate the possibility of men employed in the metal industry having poorer sperm quality than men in other types of work.

The possible exposures in the metal industry are metal dust, cutting oil, refrigerant greasing agents, and organic solvents. In welding work, the possible exposures are metals such as aluminum, cadmium, iron, chromium, and nickel, as well as nitrous gases and ozone (4, 10, 11).

Attention has been directed towards the contents of smoke generated by welding on stainless steel. This smoke contains chromium, nickel, manganese, copper, cadmium, and iron (4, 9).

Other exposures that could possibly influence the quality of sperm are heat and ionizing radiation. This last type of exposure is present when welders check the welding seams (12).

Subjects and methods

The investigation was of the multicentered, case-referent type. The men included in the study were those who, in connection with fertility problems, had deliv-

ered a sample or samples of semen to one of the hospitals in Aalborg, Aarhus, Sønderborg, and Odense. This investigation took place from 1 January 1981 to 31 December 1983.

During December 1984, a postal questionnaire was sent to the men in Aalborg, Odense, and Sønderborg. The men in Aarhus were not sent the questionnaire because they filled out a similar questionnaire at the time of their consultation concerning their fertility problem.

The information obtained from the questionnaires from the men in Aalborg, Odense, and Sønderborg has been defined as primary data. The results of the semen analyses of all the men in the investigation, as well as the information obtained from the questionnaires of the men in Aarhus, have been defined as secondary data. The semen analyses in all four hospitals were performed by trained laboratory technicians. The morphological diagnosis was performed by a physician.

The criteria used to classify the men as cases were as follows: (i) sperm concentration less than 20 million/ml, (ii) less than 50 % of the sperm cells motile, and (iii) less than 50 % of the sperm cells with a normal morphological appearance. If any one, two, or all three of these criteria were fulfilled, the quality of the man's sperm was considered to be poor and the man was classified as a case. Men with sperm that did not fulfill any of the criteria were considered to have normal sperm and were classified as referents.

In cases in which more than one semen sample was submitted for analysis, the following decisions were made: (i) if one of the specimens fulfilled the criteria for poor semen quality in the analysis and the other was rated normal, sperm quality was considered normal, and the man was classified as a referent; (ii) if both semen specimens were given a rating of poor, the

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man was classified as a case; (iii) if the results of both semen specimens were normal, the man was classified as a referent.

Information concerning the fertility status (diagnosis) of the wife could be obtained from the questionnaires of the men in Aalborg, Odense, and Soenderborg. This information was not available for the men in Aarhus, nor was information on specific occupational exposure of these men.

It was possible to use the information obtained on the questionnaires to group the men and their wives according to the Danish Industry Code and the Occupational Code of Denmark published by the Statistical Registry in Denmark.

The postal questionnaire included questions on the specific exposures of the men in their work environment six months before they submitted their semen specimens. Questions on the nonoccupational exposure of the men, as well as on smoking habits, alcohol intake, and their consumption of medicines, were also

included. There were also questions concerning health (including health status at the time of the semen analysis), illness, and disease, as well as questions concerning social and educational status.

In accordance with the information obtained from the questionnaires, the men under investigation could be placed in one of the following four groups: (i) welders, (ii) metal workers not exposed to welding, (iii) other industrial workers, and (iv) unexposed workers, ie, men not exposed to chemical or physical agents suspected of influencing sperm quality. This last group included, for instance, clerks, teachers, and hospital staff.

The risk odds ratio (OR) was calculated according to a log-likelihood method as a measurement for an added risk of poor sperm quality. After data were stratified by hospital location, a Mantel-Haenszel odds ratio was calculated (5).

Possible confounders such as living quarters, age, smoking habits, alcohol intake, medicine consumption, and earlier diagnoses of mumps with or without orchitis were investigated by means of a logit regression analysis to determine whether these factors had any influence on the odds ratios of welders working with stainless steel and welders working with nonstainless steel metals.

Out of the 3 119 men, 2 517 men filled out the questionnaires satisfactorily. The response rate was 81 %, and a distribution of the response rate is shown in table 1.

The average age of the respondents was 29.9 years, and that of the nonrespondents was 31.0 years. The welders had an average age of 29.5 years.

The time the couple in question had tried to conceive averaged 34.7 months. Among the 2 276 men answering this question, 142 or 6 % of the couples in question had tried to conceive in a period of less than one year, whereas 359 or 16 % had tried to conceive over a period of more than five years. The distribution of the time periods the couples tried to conceive is shown in table 2.

The percentage of respondents employed at the time of the investigation was 89.7. The percentage of men that were childless was 77, and the corresponding percentage for their wives was 74.

Table 3 shows the distribution of the number of semen specimens by location of hospital. Aalborg required two semen specimens, regardless of the result of the first semen analysis. Aarhus, Odense, and Soenderborg asked for a second semen specimen only if the results of the first semen analysis showed poor sperm quality.

Results

There was an added risk for poor sperm quality among welders when they were compared with men not exposed to chemical or physical agents suspected of influencing sperm quality (table 4).

Table 1. Response to the questionnaires.

Location of hospital	Respondents		Nonrespondents		Total	
	N	%	N	%	N	%
Aalborg	636	76	201	24	837	100
Aarhus	787	100	—	0	787	100
Odense	702	71	286	29	988	100
Soenderborg	392	77	115	23	507	100
Total	2 517	81	602	19	3 119	100

Table 2. Distribution of the number of months tried to conceive among all participants.

Months	Couples ^a	
	N	%
< 12	142	6
12—24	563	25
25—36	641	28
37—48	359	16
49—60	212	9
> 60	359	16
Total	2 276	100

^a Information on 241 couples was missing.

Table 3. Number of semen specimens of respondents to the questionnaires.

Location of hospital	One specimen		Two specimens		Total (N)
	N	%	N	%	
Aalborg	26	4	610	96	636
Aarhus	610	78	177	22	787
Odense	550	78	152	22	702
Soenderborg	294	75	98	25	392
Total	1 480	59	1 037	41	2 517

Table 4. Relative risk for reduced sperm quality among the cases and referents grouped according to the exposure classification.

Exposure classification	Subjects			Odds ratio	95 % confidence limits
	Cases	Referents	Total		
Welders	27	28	55	2.00	1.16—3.45
Metalworkers not exposed to welding	99	178	277	1.15	0.88—1.51
Other industrial workers	294	636	930	0.96	0.80—1.15
Unexposed workers ^a	408	847	1 255	1.00	.
Total	828	1 689	2 517	.	.

^a Men not exposed to chemical or physical agents suspected of influencing sperm quality.

Discussion

Experiments with animals have demonstrated that manganese and cadmium cause atrophy of the testes (2). Furthermore, it has been demonstrated with rodents that cadmium and chromium are stored in the testes (6).

A Danish investigation (8) of persons examined in a fertility clinic showed an odds ratio of 1.7 for poor sperm quality among welders working with stainless steel. When the welders were defined by the Danish Industry Code, the relation was the same. This association, however, was not statistically significant. On the other hand, the association between welding and prolonged conception time (more than one year) was statistically significant (8).

A German investigation showed that the frequency of welders among an infertility clientele was greater than the frequency of welders among men consulting the same clinic for dermatological problems. There were some methodological problems in this study, however, such as selection bias and lack of confounder control (12).

In another German investigation of 61 welders, semen analysis showed that more than 50 % of these men had a sperm count of less than 4 million sperm/ml (3).

In the present study, even after geographic stratification, the welders had an increased risk for poor sperm quality, and this risk was statistically significant. The association was present even after control for the fertility status of the wife (by comparing cases whose wives were normal with referents whose wives had a diagnosis indicating abnormal fertility status).

Except for the men in Aarhus, information was available concerning the extent to which the men had been exposed to welding on stainless steel or on non-stainless steel metals daily or weekly over the six-month period prior to the submission of the semen sample for analysis. The odds ratio was high for the men exposed to welding when they were compared to the non-welders (all men who answered "no" to the question concerning exposure to welding). However, the results were not statistically significant (OR 1.20, 95 % confidence limits 0.92—1.57). This result could be due to the possibility of the group of welding-exposed men including persons who were only sporadically em-

ployed as welders or who could have been only in the vicinity of welding work and thus only been passively exposed to welding.

When the welders were grouped according to work on nonstainless steel metals and work on stainless steel, the odds ratio for the welders working on stainless steel showed a sharp rise (OR 2.34, 95 % confidence limits 0.95—5.73) and that for the welders working on non-stainless steel metals dropped in comparison to the nonwelders.

There was an increased frequency of medication use among the welders as compared to that of the men not exposed to chemical or physical agents suspected of influencing sperm quality. One welder took a beta-blocker, and this type of medicine is suspected to have a negative influence on sperm quality. The other types of medications consumed covered a wide spectrum, but they were not suspected of influencing sperm quality.

There was no association between the other possible confounders and occupation as a welder.

As earlier mentioned, there was a difference in the number of semen samples per man between the different hospitals. Men with one semen sample showing poor sperm quality were classified as having poor sperm quality. This procedure introduced a possibility for misclassification since these men would have been classified as having normal sperm quality if they had had the opportunity to deliver a second sample and it had been normal.

About 20 % (602 of 3 119) of the men did not return the questionnaire to the investigators. If these men had had prior knowledge of the influence of the work environment on sperm quality, motivation to participate in the investigation could have been influenced by this prior knowledge. Thus one can speculate that exposed men agreed to participate in the investigation, whereas unexposed men did not. This selection mechanism is presumably not very meaningful, however, in that there has been no public discussion concerning the possibility of occupational exposures influencing sperm quality.

There was no difference in the sperm quality of the participants as opposed to the nonparticipants.

For Soenderborg, it was possible to evaluate the difference in type of jobs between the participants and nonparticipants. There was no difference.

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