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Effects of parental occupational exposure to solvents and lead on spontaneous abortion

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Organic solvents and inorganic lead are prevalent sources of chemical exposure among workers. It has been estimated that about 50 000 Finnish workers are occupationally exposed to solvents and about 20 000 to lead (1). Some epidemiologic studies have suggested that maternal occupational exposure to solvents and lead may increase the risk of spontaneous abortion, but negative results have also been obtained (2). Solvent or lead exposure has also been reported to affect male reproduction harmfully (3). However, information on the effects of paternal exposure on spontaneous abortion is meager.

This paper is a review of six Finnish studies which investigated whether parental occupational exposure to organic solvents or inorganic lead is related to spontaneous abortion. The effects of solvent exposure were examined in the following four groups: pharmaceutical factory workers, laundry and dry-cleaning workers, and men and women biologically monitored for solvent exposure (4—7). The association between lead exposure and abortion was investigated among workers biologically monitored for inorganic lead (8—9).

Subjects and methods

The study populations were identified through Finnish national registers and the records of the workers. In a study among pharmaceutical factory workers (4), the cohort comprised workers employed in eight pharmaceutical factories. Information on women for the laundry and dry-cleaning study (5) was obtained from the workers' union and the personnel files of the employers. All men and women who had been biologically monitored for exposure to solvents (styrene, toluene, xylene, trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane) or lead at the Institute of Occupational Health formed the cohorts of workers in the solvent and lead studies (6—9).

The pregnancies of the workers, or the wives of the male workers, were identified from the nationwide data base on births and spontaneous abortions treated in hospitals in Finland between 1973 and 1983. The data base covered 94% of all officially recorded births, and we have estimated that about 80—90% of all recognized spontaneous abortions can be detected from the data base (10).

The studies were conducted using a case-referent design. All of the women or the wives of male workers with a spontaneous abortion were defined as cases. Only one pregnancy per woman was included. Two or three referents were selected for every case from among the women who had given birth to a child. The referents were individually matched with the cases for age.

The woman's occupational exposure was assessed for the first trimester of pregnancy and the husband's exposure for the time of spermatogenesis of the study pregnancy (an 80-d period before conception). In the pharmaceutical factory study (4), the factory physicians determined the occupational exposure of the workers using information obtained from the health cards, labor protection chiefs, and the foremen of the departments. In other studies, the women or the men and their wives were sent a questionnaire to obtain information on their occupational exposure. The response rate varied from 74 to 86% in different studies, and there were no essential differences between the cases and the referents, except for those in the laundry and dry-cleaning study (68% for the cases and 80% for the referents). The number of cases and referents, respectively, in the final analyses was 41 and 121 in the pharmaceutical factory study, 130 and 289 in the laundry and dry-cleaning study, 73 and 167 for the women and 120 and 251 for the men in the solvent studies, and 77 and 152 for the women and 213 and 300 for the men in the lead studies.

The laundry and dry-cleaning workers' exposure was defined according to the women's own reports on their work tasks and handling of tetrachloroethylene (5). In the solvent studies (6—7) and the lead study among the women (8), the exposure classification was based on the occupation, job description, and use of solvents or lead as reported by the study subjects, and on biological monitoring data when available. In the lead study among the men (9), exposure was defined on the basis of blood lead (PbB) measurements for those holding the same job during the measurements and spermatogenesis in question (56% of the study subjects). The exposure of the other men was classified similarly as in the solvent studies. The exposure classifications were made without knowledge of who was a case or a referent.

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Results

The odds ratio of spontaneous abortion for maternal exposure to solvents was increased among the pharmaceutical factory workers and significantly increased among the women monitored for solvents (table 1). For the individual solvents, high exposure to methylene chloride, tetrachloroethylene, and aliphatic hydrocarbons was associated with the occurrence of spontaneous abortion. The analysis by occupational task showed that the odds ratio (OR) for toluene was elevated in a small group of shoe workers [5 cases, 2 referents, OR 9.3, 95% confidence interval (95% CI) 1.0—84.7].

Maternal exposure to lead was not related to spontaneous abortion. For those who had been monitored during pregnancy or during the year preceding pregnancy, the odds ratio was slightly elevated (OR 1.9, 95% CI 0.4—9.4) in the group having a PbB concentration of ≥ 1.4 µmol · l^{-1} (3 cases, 3 referents).

The odds ratios for spontaneous abortion in relation to paternal exposure to organic solvents in general and high exposure to toluene and miscellaneous solvents such as thinners were significantly increased. In the analysis by occupation the wives of solvent-exposed painters (OR 3.3, 95% CI 1.6—6.8) and woodworkers (OR 3.8, 95% CI 1.2—11.9) had an increased odds ratio.

The analysis of all the men biologically monitored for lead did not show a statistically significant association between paternal lead exposure and spontaneous abortion. However, in the high-exposure group (PbB ≥ 1.5 µmol · l^{-1}), the women whose husbands had been monitored during or close to the relevant period of spermatogenesis were found to have an increased odds ratio (OR 3.8, 95% CI 1.2—12.0). The association between the husband's exposure to lead (PbB ≥ 1.0 µmol · l^{-1}) and spontaneous abortion was modified by the age of the wife. The odds ratio for lead exposure was increased (OR 2.2, 95% CI 1.2—4.1) for the younger wives (<27 years) but not for the older ones.

Table 1. Odds ratio (OR) of spontaneous abortion for maternal and paternal exposure to organic solvents or inorganic lead, conditional logistic regression models (95% CI = 95% confidence interval)

Exposure	Cases (N)	Referents (N)	OR[a]	95% CI
Maternal exposure				
Pharmaceutical factory workers				
Solvents	12	26	1.5	0.7—3.5
Methylene chloride	11	17	2.3	1.0—5.7
Biologically monitored workers				
Solvents	42	70	2.2	1.2—4.1
Aliphatic hydrocarbons (high)	8	5	3.9	1.1—14.2
Laundry and dry-cleaning workers				
Tetrachloroethylene (high)	9	6	3.4	1.0—11.2
Lead (estimated blood lead level)				
<0.5 µmol/l	23	45	0.9	0.5—1.7
0.5—0.9 µmol/l	9	22	0.7	0.3—1.6
≥1.0 µmol/l	5	11	0.8	0.2—2.5
Paternal exposure				
Solvents	103	182	2.7	1.3—5.6
Toluene (high)	28	29	2.3	1.1—4.7
Miscellaneous solvents (high)	32	36	2.1	1.1—3.9
Lead (estimated blood lead level)				
1.0—1.4 µmol/l	36	51	1.0	0.6—1.7
1.5—1.8 µmol/l	9	10	1.3	0.5—3.4
≥1.9 µmol/l	11	11	1.6	0.6—4.0

[a] Adjusted for potential confounding factors.

Discussion

In studies using hospital records to identify spontaneous abortions, there was a possibility of selection bias due to differing patterns of use of medical services. This bias was probably avoided because the populations studied were relatively homogeneous. The possibility of selection bias due to nonresponse cannot be totally excluded. However, the examination of the data did not suggest that selective participation might have an essential effect on the findings.

Differential recall of exposure may also induce bias in case-referent studies based on self-reported data. The comparison between the workers' reports and the employers' reports in the laundry and dry-cleaning study and between the workers' reports and biological monitoring data in the solvent study did not indicate selective reporting of exposure. In the lead study among the men, the possibility of recall bias was diminished by the use of PbB measurements for the assessment of exposure. Underreporting of solvent and lead exposure was observed, and this underreporting may have led to an underestimation of the associations.

In summary, the results of the studies suggested that maternal occupational exposure to certain organic solvents may increase the risk of spontaneous abortion. An increased risk of abortion was observed for exposure to organic solvents in general, and for high exposure to some specific solvents, such as tetrachloroethylene, methylene chloride, and aliphatic hydrocarbons. Paternal occupational exposure to solvents in general, and high exposure to toluene or miscellaneous solvents in particular, was also associated with spontaneous abortion. Other individual solvents were not related to spontaneous abortion, but, because of the small number of exposed pregnancies, the statistical power of the studies was low for separate solvents. The interpretation of the results on individual solvents is also limited because simultaneous exposure to different agents was frequent among the workers.

Maternal exposure to lead during pregnancy was not related to spontaneous abortion. However, the level of exposure among Finnish women was rather low, and an increased risk at high exposure levels could not be ruled out. The study among the lead-exposed men suggested that there may be an association between paternal exposure to inorganic lead and abortion. The results encourage further research on the effects of paternal occupational exposure on pregnancy outcome.

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References

1. Anttila A, Jaakkola J, Tossavainen A, Vainio H. Työperäinen kemikaalialtistuminen Suomessa: yhteenveto [Work-related chemical exposure in Finland: a summary]. Helsinki: Institute of Occupational Health and the Finnish Work Environment Fund. In press. (Altisteet työssä, no 34.)
2. Barlow SM, Sullivan FM. Reproductive hazards of industrial chemicals. London: Academic Press, 1982.
3. Schrag SD, Dixon RL. Occupational exposures associated with male reproductive dysfunction. Annu Rev Pharmacol Toxicol 1985;25:567—92.
4. Taskinen H, Lindbohm, M-L, Hemminki K. Spontaneous abortions among women working in the pharmaceutical industry. Br J Ind Med 1986;43:199—205.
5. Kyyrönen P, Taskinen H, Lindbohm M-L, Hemminki K, Heinonen OP. Spontaneous abortions and congenital malformations among women exposed to tetrachloroethylene in dry cleaning. J Epidemiol Community Health 1989;43:346—51.
6. Taskinen H, Anttila A, Lindbohm M-L, Sallmén M, Hemminki K. Spontaneous abortions and congenital malformations among the wives of men exposed to organic solvents. Scand J Work Environ Health 1989;15: 345—52.
7. Lindbohm M-L, Taskinen H, Sallmén M, Hemminki K. Spontaneous abortions among women exposed to organic solvents. Am J Ind Med 1990;17:449—63.
8. Taskinen H. Spontaneous abortions among women occupationally exposed to lead. In: Hogstedt C, Reuterwall C, ed. Progress in occupational epidemiology. Amsterdam: Elsevier Science Publishers BV, 1988:197—200.
9. Lindbohm M-L, Sallmén M, Anttila A, Taskinen H, Hemminki K. Paternal occupational lead exposure and spontaneous abortion. Scand J Work Environ Health 1991;17:95—103.
10. Lindbohm M-L, Hemminki K. Nationwide data base on medically diagnosed spontaneous abortions in Finland. Int J Epidemiol 1988;17:568—73.