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Spontaneous abortions among veterinarians

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Objectives The objective of the study was to determine whether female veterinarians have an increased risk of spontaneous abortion and whether the potential risk is related to the type of work veterinarians do.

Methods The investigation was a retrospective cohort study among all the female members of the Finnish Veterinary Association (N=549). Information on pregnancies was obtained from hospital records from 1973—1990. The risk of spontaneous abortion among the veterinarians was compared with that of all other Finnish women and other upper-level employees. Odds ratios from logistic regression analyses were used as the estimates of the risk ratios.

Results The risk of spontaneous abortion was 10.5% for the veterinarians. In the 1970s, practicing veterinarians had an increased risk of spontaneous abortion as compared with other Finnish women (adjusted odds ratio 1.8, 95% confidence interval 1.0—3.1) or other upper-level employees (adjusted odds ratio 2.0, 95% confidence interval 1.1—3.4). In the 1980s, the risk fell below that of other Finnish women. No essential differences were observed in the risk between the veterinarians employed in different occupational categories.

Conclusions The results suggest that the veterinarians had an increased risk of spontaneous abortion in the 1970s, but not in the 1980s. Factors which might have contributed to this decrease in risk include decreases in the prevalence and level of exposure to harmful agents, improvements in the occupational hygiene of the work environment, and an increased awareness of reproductive hazards and the use of sick leave during pregnancy.

Key terms occupational exposure, pregnancy, reproductive health.

Veterinarians may be occupationally exposed to several chemical, physical, and biological agents (1—2). Many of these agents are potential reproductive hazards, such as anesthetic gases, natural and administered prostaglandins, organic solvents, X radiation, physical workload and trauma, and zoonotic diseases (eg, toxoplasmosis and listeriosis). Industrial hygienic measurements indicate that the concentrations of anesthetic gases (eg, halothane and methoxyflurane) may be high, exceeding the national occupational exposure limit, in animal surgery (2—3). A relatively high level of radiation exposure was reported by Moore et al (2), the mean monthly whole-body dose for female veterinarians being 22.3 mrem. The Finnish maximum permissible fetal dose during pregnancy is 1 mSv (100 mrem). Restraining animals during X-ray procedures seems to be common (1).

Some epidemiologic studies suggest that veterinarians, or certain groups of veterinarians, may have an increased risk of spontaneous abortion. A register-based

study of fetal death by maternal occupation found an increased risk for veterinarians and pet store workers (4). Two cohort studies (5, 6) showed no overall increased risk of spontaneous abortion among veterinarians. The analysis of pregnancy outcome by specific exposure in 2 studies indicated, however, an increased risk of abortion among veterinarians performing radiographic examinations (5, 7). A third study showed a weak but statistically insignificant increase in risk related to radiation exposure (6). Elevated risks of spontaneous abortion and preterm delivery have also been reported for veterinarians employed in large-animal practice (6, 8).

The number of women among Finnish veterinarians is rapidly increasing. In 1969 about 10% of all licensed veterinarians were women, whereas in 1993 the corresponding proportion was 47%. In a younger age group of 24- to 39-year-old veterinarians the proportion was even higher, 76% (unpublished statistics of the Finnish Veterinary Association). A similar trend has been

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observed also in some other countries (eg, the United States) (6). A survey among Finnish municipal veterinarians, mainly involved in production animal practice, indicated that most (73%) of the female veterinarians considered their work to be too heavy during pregnancy (9). A high proportion (44%) of them was also on sick leave before their normal maternity leave began, mainly because of threatened abortion. These factors point to the need to examine and control for potential occupational reproductive hazards among female veterinarians.

The objective of our retrospective cohort study was to determine whether female veterinarians have an increased risk for spontaneous abortion and whether the potential risk is related to job type.

Subjects and Methods

The investigation was a retrospective cohort study. It covered all female members of the Finnish Veterinary Association in 1992 (N=549). The unionization of Finnish veterinarians is high, 94% in 1993. The pregnancies of the women were identified by linking the data on women to the nationwide database on pregnancies from 1973 to 1990. This data base includes information on all births, spontaneous abortions, and induced abortions retrieved from the Hospital Discharge Register and hospital polyclinic records in Finland. The register covered about 94% of all officially recorded births in Finland in 1975—1983, and we have estimated that 80—90% of all recognized spontaneous abortions can be detected from the register and polyclinic records (10). Altogether 505 pregnancies of 239 female members of the Finnish Veterinary Association were identified from these records.

The membership register of the association provided data on the dates of the veterinarians' graduation. Information on occupational category within the veterinary profession and years of employment in each category was acquired from the name register of the Finnish veterinarians. These data, collected by the Association in 1991, were obtained for 98.2% of the members (11). The women were classified into the following 3 categories according to their employment during the first trimester of their pregnancy: practicing veterinarians, veterinary students, and women whose employment remained unknown. All women who had been employed for at least a month during their first trimester of pregnancy were defined as practicing veterinarians during pregnancy. If the estimated date of conception occurred in the same year as the beginning of employment, it was assumed that the date of employment was the first of July. Pregnancies occurring before graduation were defined as

pregnancies of veterinary students, because most of them (94%) occurred within 6 years before graduation. The group of women whose employment remained unknown includes the members who reported the practice type but not years of employment, and members who reported neither practice type nor years of employment, probably because of maternal leave, postgraduate education, or unemployment during early pregnancy.

The risk of spontaneous abortion was defined as the number of spontaneous abortions divided by the sum of spontaneous abortions, induced abortions and births. The risk among the veterinarians was compared with the risk among all other Finnish women and with the risk among other upper-level employees. Information on the risk of spontaneous abortion among upper-level employees was based on the data of our previous study (12), and it was available only for the period 1973—1982. In this study (12), the 1975 and 1980 national censuses of the Central Statistical Office of Finland provided information on the socioeconomic status of all women with pregnancies identified from the Hospital Discharge Register and polyclinic records. According to the classification used by the Statistical Office, upper-level employees include persons with administrative, managerial, professional, and related occupations. Because all the pregnancies of the veterinarians occurred in the age bracket 25—44 years, the reference group was restricted to women of the same age. The pregnancies of veterinary students occurred between the ages of 20 and 34 years, and analyses of their data were limited to this age group. The risk of spontaneous abortion was also analyzed by calendar time. For this purpose, the study period was divided into 2 equal periods (1973—1981 and 1982—1990), based on the examination of the annual frequencies of spontaneous abortions.

The odds ratios comparing the odds of spontaneous abortion for veterinarians with those of spontaneous abortion for other women were obtained using a linear logistic regression analysis. Odds ratio estimates were used as the estimates of the risk ratio because the outcome was rare. The effect of age and region were controlled in the analysis.

Results

The risk of spontaneous abortion among the veterinarians was 10.5% in 1973 through 1990, and there was no essential difference in the risks of the members of the veterinary association in a comparison with other Finnish women (table 1). In the 1970s, the risk was, however, higher among practicing veterinarians (15.6%) than among all Finnish women (9.7%) or other upper-level employees (9.0%), but in the 1980s the veterinarians' risk

Table 1. Pregnancy outcome among veterinarians and other Finnish women between 25 and 44 years of age, 1973—1990.

Occupation	Spontaneous abortions (N)	Pregnancies (N)	Risk of spontaneous abortion (%)
Veterinarians	32	308	10.4
Veterinary students ^a	11	96	11.5
Employment unknown	10	99	10.1
All Finnish women	99 185	952 301	10.4
Upper-level employees ^b	5 087	56 432	9.0

^a 20—34 years of age.^b 1973—1982.

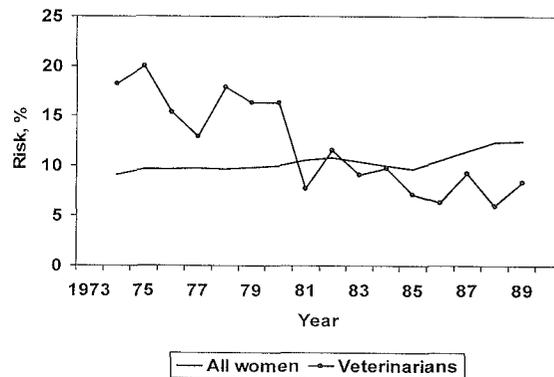
fell below that of other Finnish women (figure 1). The adjusted odds ratio for employment as a veterinarian during early pregnancy was 1.8 in 1973—1981 (95% CI 1.0—3.1) (table 2). When the reference group was restricted to other upper-level employees, the odds ratio was 2.0 (95% CI 1.1—3.4). In the earlier years, the odds ratio was elevated also among the veterinary students (table 2).

The analysis of the data by occupational category within the veterinary profession showed no essential differences between the various groups (table 3). The risk of spontaneous abortion was high among inspection veterinarians (18.0%), but it fell to the level of all veterinarians after the exclusion of women with more than 2 spontaneous abortions (9.1%). During the earlier years of the study period the risk for each occupational category was higher than that for all other women.

Discussion

The results of our study showed that there is no difference in the overall risk of spontaneous abortion between the veterinarians and all Finnish women. This observation is in agreement with the results of Schenker et al (5) and Steele et al (6), who did not find any essential difference between veterinarians and their reference group. Our results suggest, however, that the veterinarians had an increased risk for spontaneous abortion in the 1970s, but no longer in the 1980s.

The excess risk in the earlier years may have been related to the veterinarians' exposure to reproductive hazards in their work. The frequency of exposure varies by the practice type within the veterinary profession. In a survey in the United States, the highest rates of exposure to anesthetic gases, X radiation, and pesticides were reported by small-animal practitioners; large-animal

**Figure 1.** Risk of spontaneous abortion among the veterinarians and other Finnish women (3-year moving averages), 1973—1990.**Table 2.** Adjusted odds ratio of spontaneous abortion among the Finnish veterinarians and veterinary students. (95% CI = 95% confidence interval)

Occupation	Pregnancies	Adjusted odds ratio ^a	95% CI
Veterinarians^b			
All subjects	308	1.0	0.7—1.4
1973—1981	96	1.8	1.0—3.1
1973—1981 ^c	96	2.0	1.1—3.4
1982—1990	212	0.7	0.4—1.1
Veterinary students^b			
All subjects	96	1.4	0.7—2.6
1973—1981	37	1.8	0.7—4.6
1982—1990	59	1.2	0.5—2.7

^a Odds ratio for veterinarians adjusted for age (25—29, 30—34, 35—44 years) and region (central hospital district of Helsinki, other hospital districts); odds ratio for veterinary students adjusted for age.^b Reference group for veterinarians: other 25- to 44-year-old women; reference group for veterinary students: other 20- to 34-year-old women.^c Reference group: other upper-level employees.**Table 3.** Odds ratios for spontaneous abortion by occupational category for the veterinarians. (95% CI = 95% confidence interval)

Occupation	Pregnancies	Risk of spontaneous abortion (%)	Adjusted odds ratio ^a	95% CI
Municipal veterinarians				
Rural communities	106	9.4	0.9	0.4—1.6
Cities	29	13.8	1.3	0.4—3.6
Private practitioners	57	5.3	0.5	0.2—1.6
Inspection veterinarians	39	18.0	1.7	0.7—3.9
Researchers and assistants	51	11.8	1.1	0.5—2.7
Other veterinarians	26	7.7	0.7	0.2—3.0
Unknown employment	99	10.1	1.1	0.6—2.1

^aAdjusted for age; reference group: other Finnish women.

practitioners reported high rates of exposure to trauma, prostaglandins, and X rays (1). We, however, found no essential difference in the risk of spontaneous abortion between the veterinarians employed in different occupational categories, but the small numbers of pregnancies in each category limit the power of the study to detect effects. The risk of abortion also seemed to be increased in each occupational category within the veterinary profession in the 1970s, and this finding suggests that the excess risk cannot be assigned to any single occupational factor.

In previous studies among veterinarians, an increased risk of spontaneous abortion has been related to employment in large-animal practice, with potential exposure to prostaglandins (6), and exposure to ionizing radiation (5–7). The proportion of veterinarians involved in production animal practice has diminished in Finland, whereas jobs in small-animal practice have increased during the study period, but no data are available on changes in the prevalence of exposure to prostaglandins or radiation among veterinarians. A survey among veterinarians in the United States showed a decrease in the potential for exposure to X radiation during pregnancy from the 1960s to the 1980s (1). A slight reduction was also noted in the prevalence of exposure to prostaglandins.

Maternal infection with *Toxoplasma gondii* has been considered an occupational reproductive hazard for veterinarians. Comparisons of the prevalence of antibodies to toxoplasma among veterinarians and other workers have not suggested an increased risk, however, except for veterinarians in large-animal practice (13). They may have an increased risk through mucous membrane contact with blood or the excretions of infected animals, while helping with labor and while making field autopsies (14). Thus the decreasing proportion of veterinarians in large-animal practice may have resulted in a decrease in the potential for exposure to toxoplasmosis. The increased use of protective clothing, gloves, and masks may also have decreased the exposure.

Exposure to anesthetic gases has been associated with an increased risk of spontaneous abortion in hospital and dental personnel (15). In the past few decades, a marked increase has occurred in the use of waste anesthetic gas scavenging units in animal clinics and hospitals in the United States (1). According to our inquiry among 12 experienced veterinarians, improvements in ventilation and anesthetic gas scavenging systems also took place in Finland during the 1980s (unpublished results). The veterinarians also reported other changes in work practices in Finland, for example, the work environment has improved, car driving has decreased among large-animal practitioners in rural communities, and, along with improved cars, exposure to vibration has decreased. At the same time, however, work-related stress and time pres-

sure have increased in veterinary work. These changes may reflect some reduction in physical workload but also an increase in the psychosocial workload of veterinarians. Both physical workload (16) and psychosocial job stress (17) have been related to spontaneous abortion.

In our study, we noted an elevated risk of spontaneous abortion for veterinary students in the 1970s. Students may also be exposed to potential reproductive hazards during clinical practice in the last years of their studies. The risk of abortion was higher in pregnancies beginning during the last 2 years preceding graduation (13%) than in those beginning more than 2 years before graduation (7%).

All previous studies (4–8) on the reproductive outcome of veterinarians have used self-reported data on pregnancies. Our study was based on hospital records, and spontaneous abortions were medically diagnosed. Thus we could avoid bias due to selective reporting and response which may arise from self-reported data on pregnancy outcome. Hospitalization for spontaneous abortion varies by the length of gestation, and early abortions occurring in the very first weeks of gestation are not treated in the hospital. If the exposures of the veterinarians caused preferentially early abortions, the odds ratio reported would underestimate the true risk.

We identified our subjects from the 1992 files of the Veterinary Association and followed their pregnancies retrospectively from 1973 to 1990. We had no information about the members who had resigned from the Association before 1992. If the pregnancy outcome of the subjects affected the likelihood of resigning, there is a potential for selection bias. However, the bias induced by missing data on resigned members is probably negligible because the annual frequency of resigned members was small (0.3% of all members in 1987–1991 according to the unpublished statistics of the Association).

We compared the risk of spontaneous abortion of the practicing veterinarians with that of all other Finnish women or other upper-level employees, including both employed and unemployed women. When employed women are compared with unemployed women, a selection bias may also arise, if reproductive experience affects the likelihood of entering or remaining in the workforce (18,19). In Finland in 1976 and 1980, the difference in the risk of spontaneous abortion was, however, small between employed (9.8%) and unemployed women (8.6%) in the socioeconomic group of employers, own-account workers, and upper-level employees [Lindbohm et al, some unpublished results from a previous study (12)]. Thus the comparison of the practicing veterinarians with the group of other employed and unemployed women may have enhanced slightly the difference between these groups, but it is unlikely to explain totally the veterinarians' increased risk of spontaneous abortion in the 1970s.

The effect of age, region, decade of pregnancy, and socioeconomic status was considered in the analyses. No information was available on other potential confounding factors, such as reproductive history, smoking, or use of alcohol. The control for the socioeconomic status probably reduced partly the effect of life-style factors.

Different frequencies of induced abortions in the compared populations may introduce bias to the results. Veterinarians had clearly fewer induced abortions than all Finnish women. However, the odds ratio for exposure during the 1970s remained elevated among the veterinarians when they were compared with other upper-level employees having nearly the same frequency of induced abortion (6.0%) as the veterinarians (4.9%).

In the statistical analyses, we used a logistic regression model that assumes statistical independence of all the pregnancies of 1 woman. We could not use statistical techniques developed for addressing nonindependent observations because we had no identification code for women belonging to the reference group, and thus we could not identify different pregnancies of the same woman. The effects of pregnancy dependence have been evaluated in some epidemiologic studies on spontaneous abortions by comparing the results of statistical methods for correlated observations with those obtained from the use of the standard logistic regression model (20, 21). In these studies, the correlation had very little effect on estimated associations, possibly because of the small number of pregnancies per woman in the study populations. Among the veterinarians, the average number of pregnancies of each woman was of the same magnitude as in these studies.

Our results indicate that the veterinarians had an increased risk of spontaneous abortion in the 1970s, but the risk decreased to below the level of other women in the 1980s. The higher risk in the earlier years was not related to any specific type of practice. Because our data were based on register data on employment, we could not evaluate the effects of individual agents. Factors which might have contributed to the decrease in risk during the study period include the decrease in the prevalence and level of exposure to reproductive toxicants, improvements in the occupational hygiene of the work environment, and an increased awareness of reproductive hazards. The increased awareness has probably led also to a more widespread use of sick leave during pregnancy. Although the risk of spontaneous abortion was below the level of other women in the later years, some associations may have been missed because the study population was small and we were not able to analyze the data by specific exposures. To identify the potential effects of individual agents, larger study populations should be investigated, and exact information about the type and levels of exposure should be obtained

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