

## Spontaneous Abortions and Shift Work in a Cohort of Nurses in Norway

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### Abstract

**Background:** An association between spontaneous abortions and shift work has been suggested, but present research results are conflicting. The aim of the study is to evaluate the relationship between spontaneous abortions among nurses, shift schedules, and nights worked.

**Methods:** This is a longitudinal study where we identified 914 females from a cohort of nurses in Norway who had worked the same type of shift schedule 2008-2010; either permanent day shift, three-shift rotation or permanent night shift. Information on age, work and life-style factors, as well as spontaneous abortions during lifetime and the past three years (2008-2010) was obtained by annual questionnaires.

**Results:** A higher prevalence of experienced spontaneous abortions before study start (2008) was found among nurses working permanent night shift compared to other nurses. In a linear regression analysis, a risk of 1.3 was found for experienced spontaneous abortions before study start among permanent night shift nurses, with day shift as reference, when adjusting for age, smoking, caffeine and job strain, but the finding was not statistical significant (95 per cent confidence interval 0.8-2.1). Permanent night shift workers had a risk of 1.5 experiencing spontaneous abortions in 2008-2010 compared to day shift nurses, although not statistical significant (95 per cent confidence interval 0.7-3.5). The number of night shifts the past three years was not associated with experiencing spontaneous abortions 2008-2010, but associated with a reduced risk of experiencing spontaneous abortions during lifetime. The results must be interpreted in the light of a possible selection bias; both selections into the occupation of nursing and into the different shift types of the more healthy persons may have occurred in this population.

**Conclusion:** No significant increased risk of spontaneous abortion among permanent night shift nurses compared to day-time nurses was found in this study, and no association was found between spontaneous abortions and the number of worked night shifts.

**Keywords:** Night shift nurses; Occupational health; Shift work; Spontaneous abortions; Work organization

### Introduction

Reproductive health is an important issue for human beings. In the past years, various occupational factors have been examined and suggested to be related to different reproductive outcomes of women [1,2]. Shift work is one such factor, possibly related to a risk of spontaneous abortion (SA) and reduced fertility. Most studies about shift work and SA have been performed among nurses, as this occupational group has the highest number of female shift workers in most countries. Previous studies among nurses from various countries several years back in time have suggested a relationship between shift work and SA [3-5]. However, the results from these studies are not conclusive [1,2,6]. Some studies show a relationship between shift work and SA [3-5], while others do not [7-9]. In addition, the studies

do not show the same associations when different types of work schedules are compared. Some find SA to be related to work schedules with night shifts only [4,5], while others suggest a relation to rotating shift schedules that include nights [3,10]. Several studies on this topic suffer from methodological limitations, such as a lack of prospective design, different and unclear definitions of shift work, and a lack of adjustment for confounding factors [6]. Very few longitudinal studies have been conducted among nurses in this field. Two cohort studies [5,10] and one case-control study [11] have suggested an association between SA and shift work, however, the findings in these studies were not significant.

The potential mechanisms behind the effects of shift work on reproduction are not clear. Hormonal disturbances might play a role, as night work disturbs many circadian physiological processes [1,12,13]. However, both direct mechanisms related to the disturbed circadian rhythm and indirect mechanisms such as life-style factors

may have possible adverse effects. Some studies also lack evaluation of life-style factors such as smoking, alcohol, and caffeine, all of which may be risk factors for SA [14,15]. However, as life-style factors might also be caused by the shift work situation, analyses both with and without these factors included should be performed [16]. Large groups of nurses are employed in all countries of the world, and many of them are young and of reproductive age. It is therefore important to perform more studies in this area.

The aim of this study was to examine the relationship between three different shift-work schedules and SA among nurses. In addition, we wanted to study the relationship between SA and the number of night shifts worked.

## Material and Methods

A prospective cohort study was designed, where nurses working the same type of shift were examined at baseline as well as one and two years later. Nurses were chosen as this occupational group includes the largest number of female shift workers in Norway. Also, the majority of nurses in Norway are organized in one union only, the Norwegian Nurses Organisation (NNO). This organisation has a member register which made it possible to make a random sample of the population.

## Sample and procedure

The data used in this study was obtained from “The SURvey of Shift Work, Sleep and Health” (SUSSH). The baseline data collection took place among nurses in Norway during the period December 2008 to March 2009. A survey sample ( $n = 6000$ ) comprising a total of five strata, each containing 1200 nurses holding at least a 50% work position, was randomly selected from the member register of the NNO. The criterion for the different strata was time elapsed since graduation, in this case 0-11 months (stratum 1), 1-3 years (stratum 2), 3.1-6 years (stratum 3), 6.1-9 years (stratum 4), and 9.1-12 years (stratum 5). Each nurse in the sample received a questionnaire by post. Upon completion, the respondents could return the baseline questionnaire in pre-paid envelopes. Reminders were sent out twice. A total of 600 letters were returned due to incorrect addresses. Hence, the survey sample consisted of 5400 nurses. A total of 2058 nurses completed and returned the questionnaire, yielding a response rate of 38.0%. A second questionnaire was sent out by mail one year (2009/2010) later to these 2 058 nurses as a follow-up; 1586 of the 2058 responded (90% females), giving a response rate of 77%. A third questionnaire was sent out in 2010/2011, and 1533 responded (91% females), a response rate of 74%. Only females were included in the present study.

## Questionnaire

The study was a part of a large survey of shift work, including several instruments on sleep and different health measures [17]. Only questions relevant for the present analysis on SA are described here.

Both at baseline, one and two years later we asked the respondents to provide information about living with a partner (yes/no), number of children they had given birth to, present place of work (hospital, nursing home, home care service, public health centre), hours worked per week, current daily smoking (yes/no), caffeine consumption (number of cups of coffee/tea/cola daily), and height and weight (calculated to body mass index, BMI). The following factors were assessed only at baseline: Age, gender, years worked as a nurse, and frequency of alcohol consumption during the past year (scale 1-6;

never, less than once a month, once a month, 2-3 times a month, once a week, 2-4 times a week, and daily). At baseline and one year later, questions were also asked about job demands (six items) and job control (five items) in the past three months, based on the Swedish Demand-Control Questionnaire [18]. Each item was scored on a five-point scale. The scores for each item were summarised, yielding subscale scores ranging from 5 to 20 for demands and from 6 to 24 for control. Job strain was defined as the score for job demands divided by the score for job control. In all three questionnaires we asked for the number of night shifts worked the past years. These figures were added into a sum of night shifts the past three years. In the analyses the sum of night shifts were categorized into three groups (0, 1-67 and >67), based upon the tertile distribution.

In the baseline questionnaire, women were asked if they had ever experienced any SA after confirmed pregnancy (yes, no, and unsure), which gives us their experiences of SA before the study start [19]. If the answer was yes, they were asked to provide the number of SA. We did not provide any definition of SA in the questionnaire, but for Norwegian women, this expression clearly means a miscarriage, a natural death of a fetus in the womb. The expression does not include induced abortions. In the second and third questionnaire, the nurses were asked about SA during the past year (yes, no, or unsure). In the statistical analyses, the participants with SA either the second year or the third year or both were categorized as having SA in the period 2008-2010.

## Schedules and inclusion criteria

The baseline questionnaire established the type of working schedule to which the nurses were assigned. The nurses could choose between six shift alternatives in the questionnaire: Day only, evening only, day and evening only, night only, a three-shift rotating system (rotating between day, evening, and night shifts), and “other”. The shift work categories used in the analyses were categorised into three types: Permanent day shift (including day or evening work), three-shift rotation (rotating between day, evening, night), and permanent night shift. There were 14 nurses with “other” schedules; these were excluded from the analyses. In the present study, all females who reported that they worked the same shift system both at baseline and at two year follow-up were included. This left us with a study population of 914 female nurses.

## Statistics

Descriptive statistics were used for calculating means, medians, standard deviations, numbers, and percentage. To test the differences between the nurses in the different shift groups, chi square tests were used regarding categorical data and ANOVA were used for continuous variables with normal distribution. The non-parametric Kruskal-Wallis test was used for comparing variables which were not normal distributed. As the prevalence of the outcomes was rather high, relative risks (RR) with 95% confidence intervals (CI) were measured using general linear regression analyses. The associations were analysed unadjusted and adjusted for age, smoking, job strain and cups of coffee/tea/cola daily in a generalized linear model with log link and binomial distribution specified. The adjustment factors included were those which differed significantly between the shift groups of nurses. Relative risk was calculated using a categorical variable for age (below and above 30 years). In addition, the analyses were repeated using a linear age variable. Also, regression analyses of the relationship between SA and number of night shifts the past three years were

performed, both unadjusted and with adjustments for age, smoking, job strain and cups of coffee/tea/coke daily.

Analyses were conducted including all nurses who reported that they had experienced SA before the study start and only for nurses below 50 years of age when analysing experienced SA 2008-2010. Fifty years was chosen, as few Norwegian women give birth after this age. The risk was calculated for one or more SA versus zero SA in the given time frame. The data were analysed using Predictive Analytics Soft Ware (PASW) Statistical Package, version 18. The significance level was set to 0.05.

### Ethical considerations

This study was approved by the Regional Committee for Medical and Health Research Ethics, West Norway (REK-West; 088.08). Confidentiality was guaranteed throughout the research process, and all respondents provided written consent to participate in the study.

### Results

Demographic and personal data, life-style, working hours, and psychosocial working conditions. The mean age of the 914

participating nurses was 33 years, range 21-63 at baseline. The baseline information showed that the nurses who worked permanent day shift were significantly older than the two other shift groups (Table 1). Permanent night shift workers reported fewer weekly work hours than did the other two shift groups. Nurses who worked three-shift rotation had lower caffeine consumption than the other groups. Ten per cent of the total population smoked daily, and the nurses who worked permanent day shift had the highest smoking prevalence. The nurses in three-shift rotation had fewer children than the others. There were no differences between the shift groups regarding years worked as a nurse, BMI, living with a partner, or alcohol use (Table 1). Ninety per cent of the nurses worked at a hospital at baseline, four per cent in nursing homes, four per cent in home care services, and two per cent in public health centres. Nurses with three-shift rotation reported higher job strain than the two other shift groups (Table 1). Comparing results from baseline, one and two years later for smoking, caffeine consumption and BMI did not show significant changes within each shift-schedule group. The level of strain was similar at baseline and one year later.

Variables	Permanent day shift (n= 322)	Three-shift rotation (n=541)	Permanent night shift (n=51)
Age; mean (SD) median*	35 (10) 33	32 (8) 31	32 (7) 31
Years worked as a nurse; mean (SD) median	5 (5) 4	5 (4) 4	6 (5) 5
Number of work hours weekly; mean (SD) median**	35 (6) 35	34 (5) 35	28 (8) 27
Number of nights worked the past year; mean (SD) median	2 (6) 0	30 (17) 30	76 (41) 90
BMI; mean (SD) median	24 (4) 24	24 (4) 23	26 (5) 24
Cups of coffee/tea/cola daily; mean (SD) median*	3 (3) 3	2 (2) 2	3 (5) 3
Living with partner; number (%)	239 (74)	394 (74)	40 (78)
Number of children borne; mean (SD) median*	1.5 (1.0) 1.0	1.1 (1.2) 1.0	1.4 (1.3) 1.0
Daily smokers; number (%)*	38 (12)	37 (7)	7 (9)
Alcohol consumption; number (%)			
Never	34 (10)	37 (7)	7 (9)
Less than once a month	70 (21)	131 (24)	23 (45)
Once a month	61 (19)	107 (20)	8 (17)
2-3 times a month	79 (25)	143 (26)	9 (22)
Once a week	50 (16)	82 (15)	3 (6)
2-4 times a week	25 (8)	40 (7)	1
Daily	2 (1)	1	0
Job Strain; mean (SD) median**	0.7 (0.1) 0.7	0.8 (0.1) 0.8	0.7 (0.1) 0.7
Not all participants answered all questions, missing figures varied but not more than five values are missing for any of the variables. * 0.01 < p < 0.05 **p<0.001			

**Table 1:** Demographic and personal data, life style, working hours, psychosocial working conditions at baseline among 914 nurses working three different shift schedulesa.

### Spontaneous abortions before study start in 2008

Experienced SA before study start in 2008 was reported by a total of 166 nurses (18%) at baseline. This occurred more often among permanent night-shift workers than in the other shift groups (Table 2). The number of abortions ranged from one to four in all individual shift groups, and 22% had experienced two abortions or more. The

permanent night-shift workers had experienced significantly more abortions than the other shift groups (Table 2) and the three-shift rotation workers had the lowest number of SA. Thirty-four nurses reported to be unsure of experiencing an abortion before study start. These nurses were evenly distributed among the three shift groups, and were handled as missing answers in the following analyses.

Outcomes	Permanent day shift (n= 322)	Three-shift rotation (n=541)	Permanent night shift (n=51)
Experienced spontaneous abortion before study start; number (%) <sup>a</sup>	66 (21)	85 (16)	15 (29)
Experienced spontaneous abortion the past two years; number (%) <sup>a</sup>	24 (9)	31 (7)	6 (14)
No. of spontaneous abortions ever; mean (SD) median <sup>a</sup>	1.3 (0.9) 1.0	1.3 (0.9)1.0	2.1 (2.0) 2.0
No. of spontaneous abortions the past two years; mean, (SD) median	2.6 (1.6) 2.0	2.1 (1.7) 2.0	2.5 (0.7) 2.0
<sup>a</sup> p<0.05			

**Table 2:** Spontaneous abortions among 914 nurses working three different shift schedules. <sup>a</sup>53 nurses with age >50 were excluded when calculating this figure. This information comes from the second questionnaire (two years after baseline).

The number of nurses who had experienced a SA before study start was proportionally the same among nurses above and below 30 years old. Calculating relative risk both with and without adjustments, showed an increased risk of experiencing SA before study start among nurses working permanent night shifts compared to permanent day

shift nurses, but the findings were not significant (Table 3). Using a continuous scale for age in the analyses or analyzing the data using two age strata (below and above 30 years old), yielded similar results. The regression analyses were also performed when excluding nurses who reported more than one SA. This did not change the findings.

	Spontaneous abortion before study start 2008		Spontaneous abortion 2008-2010 <sup>c</sup>	
	RR (95%CI) <sup>a</sup>	Adjusted RR (95%CI) <sup>a</sup>	RR(95%CI) <sup>a</sup>	Adjusted RR (95%CI) <sup>a</sup>
Permanent day shift (n=322)	1	1	1	1
Three-shift rotation (n=541)	0.8 (0.6–1.0)	0.9 (0.6–1.1)	0.7 (0.4-1.3)	0.7 (0.4-1.2)
Permanent night shift (n=51)	1.3 (0.9–2.2)	1.3 (0.8–2.1)	1.6 (0.7-3.7)	1.5 (0.7-3.5)
0 night shifts <sup>b</sup>	1	1	1	1
1-67 night shifts <sup>b</sup>	0.6 (0.4-0.9)	0.6 (0.3-0.9)	0.5 (0.2-1.0)	0.6 (0.3-1.0)
>67 night shifts <sup>b</sup>	0.6 (0.5-0.9)	0.6 (0.6-0.8)	0.8 (0.5-1.5)	0.9 (0.5-1.6)

**Table 3:** Relative risk of one or more spontaneous abortions before study start in 2008 and one or more spontaneous abortions 2008-2010, in relation to different shift work schedules and number of night shifts, among 914 nurses, using regression analysis, both unadjusted results and results with adjustment for age (two categories; below and above 30 years), job strain, smoking and cups of coffee/tea/cola daily. <sup>a</sup>RR= relative risk, CI= confidence interval. <sup>b</sup>Self-reported night shifts the past three years. <sup>c</sup>For the period 2008-2010, 53 nurses > 50 year were excluded in the analyses.

### Spontaneous abortions 2008-2010

Spontaneous abortion the past year, one year after baseline, was experienced by 5% of the nurses. The number of abortions during this year ranged from one to three in the individual shift groups, twelve nurses had more than one abortion. Three per cent of the nurses reported to have experienced an abortion the second year after baseline, and the number of abortions this year ranged from one to two, and only seven nurses had more than one abortion this year.

An increased risk was found related to experiencing spontaneous abortions 2008-2010 comparing nurses working permanent night shifts compared to permanent day shift nurses, but these findings were not significant (Table 3).

Using a continuous scale for age in the analyses or analyzing the data using two age strata (below and above 30 years old) yielded similar results. The regression analyses were also performed when excluding nurses who reported more than one SA. This did not change the findings.

### Relationship between SA 2008-2010 and number of night shifts

No significant relationship between SA the past two years and the number of night shifts worked the past three years were found (Table 3). There was a significantly decreased risk of SA during the whole lifetime related to the number of night shifts worked 2008-2010. However, the risk was similar for working 1-67 nights as for working more than 67 nights.

### Discussion

An increased risk of experiencing SA among nurses working permanent night shift was demonstrated in this study, but the findings were not statistically significant. This was found both when using a two-year prospective design and when asking for SA before study start. No increased risk of SA was found among the nurses working three-shift rotation.

The lack of relationship in our present study between work in the three-shift rotation system and increased risk of SA is in line with the findings of other studies [5,10]. A Finnish study showed an increased risk of OR 1.2 for SA related to a rotating three-shift system, but significance levels were not presented in the article [11].

Although our findings are not significant, the relationship between SA and permanent night shift work are in line with a cohort study from US which reports a similar, but significant, increased risk (RR=1.6) among nurses working night shifts only [10]. This US cohort was established in 1989, and had a longer follow-up period. This US study used other methods than in our present study; information about the nurses was obtained using questionnaires, registers and from the head nurses at the general hospitals. A Danish cohort study also suggests that night shift nurses have an increased risk of SA. These results are borderline significant with a hazard ratio of 1.85, 95% CI 1.00-3.42 [5].

Several older cross-sectional studies [4,7,11] do not support the hypothesis that night shifts may be related to SA. However, these studies have methodological shortcomings. The number of participating shift workers in the studies was low, and it is not clear from the studies whether or not the shift-work participants worked in full time permanent night-shift systems. Also these studies examined women in other occupations, making the results difficult to compare with nurses. A study among midwives [20] showed an increased risk for late SA and night work. However, this study did not calculate relative risk, and it is difficult to compare these results with the present findings. The weaknesses of the previous studies mentioned here are described and commented in a systematic review concerning studies of occupational exposures and adverse pregnancy outcomes among nurses [6]. This review concluded that there is an increased risk of SA related to shift work. The reviewers also performed a meta-analysis and found the risk of SA among night-shift workers to be OR 1.44; 95% CI 1.06-1.95 [6]. The relative risk is not provided, making the results difficult to compare.

No clear relationship between SA and the number of night shifts was demonstrated in our study. The results actually suggest that there is a reduced risk of experiencing SA when the nurse has worked night shifts. The findings suggest the presence of a selection bias. Women who have experienced SA might to a lesser degree than other women choose night shift work.

Another explanation might be that the night shift schedule itself is not of main importance for the increased risk we found. Other factors,

related to the night shift work, might have higher influence, and more risk factors, both at work and otherwise should be included in future studies to explore this relationship further. Examples of such factors are the support system at work and use of medication or drugs.

A strength of the present study is the information on SA, obtained from the nurses themselves. In Norway, only minor information on SA is found in health registers, as many women never contact a GP or hospital due to SA. Therefore, self-report is a good way of obtaining information about this topic [19]. On the other hand, the information obtained in our study has weaknesses. We did not ask about induced abortions in the study, as this information is considered as very sensitive in Norway. Therefore we did not obtain the total number of pregnancies experienced among the nurses. Without complete data concerning the total number of pregnancies experienced, it is not possible to study the relationship between SA and the actual number of pregnancies among the nurses in our study. The number of children was lower among nurses working three-shift rotation, but this might be related to their younger age and not the work schedule.

Questionnaires, like those used in the present study, also make it possible to obtain data on background, work situation, and life-style. The participants in our study completed a questionnaire at baseline, one and two years later. This follow-up time was short, but the response rate both years was high. In addition, smoking, caffeine consumption, BMI, and workplace strain among the nurses in the various work schedules did not change significantly during the year; this stability in terms of health behavior and working conditions strengthens the results. Effects from these life-style factors were handled by adjustments in the regression analyses.

The presence of a recall bias cannot be ruled out, especially for the life-time SA. On the other hand, the number of total reported SA was relatively low compared to other studies from Norway indicating that a healthy worker effect might be present [21]. The prevalence is also lower than in previously mentioned follow-up studies on SA and shift work [5,10]. Nurses experiencing reproductive problems might avoid shift work and they can also be advised by medical personnel to choose other types of jobs. The permanent day shift nurses may include nurses selected out of the three-shift rotation system. Unfortunately we had no information about previous work schedules among the participants in our study, and cannot document this possible explanation of the findings. The low prevalence may also be caused by a selection bias among the participants, as the response rate at baseline was low. The data indicate that nurses with SA before the study start did participate to a lesser degree, but this is difficult to know for certain. On the other hand, the response rates at the follow-up surveys were higher.

Also, it must be noted that the working conditions in general might differ between the countries. Norway is at present rated in international studies as a country with good working conditions [22]. This may cause well regulated working hours, more than in other countries, and this may again reduce any adverse effects of working night shifts.

The low prevalence of SA and the low number of participants in the group of permanent night shift workers is a methodological limitation in our present study. The number of nurses working permanent night shifts was only 51, and the comparison of this group to the others gives a low statistical power. This methodological shortcoming was reduced by including analyses of the number of night shifts and SA for the total group of nurses, regardless of the shift schedule. However, with a

higher number of participants, the results from our study probably would have been more robust.

## Conclusion

The results suggest a slightly higher risk of spontaneous abortion among permanent night shift nurses than among day time nurses, although this association did not reach statistical significance. As no association was found between SA and the number of worked night shifts, it might be possible that the risk is related to other factors associated with the night shift work schedule than the night shift work itself. Studies with more participants, longer follow-up periods and measures of other types of stressors at work are needed to conclude with more certainty.

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