Shift work and subfecundity: a causal link or an artefact?

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Aims: The Danish National Birth Cohort (DNBC) was used to examine whether shift work is associated with reduced fecundity as estimated by time to pregnancy (TTP).

Methods: From 1 March 1998 to 1 May 2000, 39,913 pregnant women were enrolled in the DNBC. Data on job characteristics and TTP (0–2, 3–5, 6–12, and >12 months) were used for 17,531 daytime workers and 39,077 shift workers who had planned the pregnancy. Fecundity odds ratios (ORs) were calculated with 95% confidence intervals using the discrete time survival analysis techniques performed by logistic regression. An OR above 1 expresses a shorter TTP and then a higher fecundity. Potential confounders, such as age at conception, gravidity, prepregnant body mass index, smoking, and alcohol consumption, as well as occupational characteristics, were also included in the model.

Results: Fixed evening workers and fixed night workers had a longer TTP. Compared with daytime workers, the adjusted ORs were 0.80 (95% CI 0.70 to 0.92) for fixed evening workers, 0.80 (95% CI 0.63 to 1.00) for fixed night workers, 0.99 (95% CI 0.91 to 1.07) for rotating shift (without night) workers, and 1.05 (95% CI 0.97 to 1.14) for rotating shift (with night) workers. When analysis was restricted to nulliparous women, the estimates remained unchanged. The proportions of unplanned pregnancies and contraceptive failures were higher among fixed evening and fixed night workers.

Conclusions: There was no unequivocal evidence of a causal association between shift work and subfecundity. The slightly reduced fecundity among fixed evening workers and fixed night workers may be mediated by pregnancy planning bias or differential options for sexual contacts.

Main message

- There is no unequivocal evidence of a causal association between shift work and subfecundity.

Policy implication

- Further investigations are warranted to elucidate the risk of other adverse pregnancy outcomes due to shift work.

A study from Sweden found that midwives who worked two-shift, three-shift, or fixed night work had reduced fecundability compared with those working in the daytime shifts. A European multicentre study showed that rotating shift work for women was associated with an increased risk of subfecundity, and a Japanese study on working conditions indicated that pregnancy rates were lower for women doing shift work compared with daytime workers. However, three studies (from Denmark, Italy, and Thailand) did not find an association between shift work and low fertility. These inconsistent results may reflect differences in shift work exposure or differences in work conditions, as well as methodological shortcomings.

The Danish National Birth Cohort (DNBC), a nationwide study of pregnant women and their offspring, provides an opportunity to explore associations between potential hazardous occupational exposures and adverse reproductive outcomes. This study aimed at examining whether exposure to various types of shift work was associated with low fecundity as measured by a prolonged waiting time to pregnancy (TTP). We especially expected rotating shift (without night) to be associated with a longer TTP because it may be more difficult for the endogenous circadian system of the body to adjust to the changing rhythm of rotating shifts (with night). Rotating shifts may be a stressor in itself as well as interfering with coping with stress by interfering with maintaining a social network.

MATERIALS AND METHODS

Study population

The study was carried out within the DNBC, which has been described in detail elsewhere. Candidates for the cohort were all pregnant women in Denmark who, at their first visit to their general practitioner, wanted to carry their pregnancy to term and who spoke Danish well enough to take part in the telephone interviews. Participants were given the opportunity to indicate a preferred day and time for the interviews covering normal working hours, evenings, or weekends. Approximately 60% of all pregnant women accepted the invitation to join the cohort from almost 60% of the general practitioners who took part in the recruitment. From 1 March 1998 to 1 May 2000, 39,913 pregnant women (40,635 pregnancies) were enrolled in

Abbreviations: BMI, body mass index; CI, confidence interval; DNBC, the Danish National Birth Cohort; OR, odds ratio; TTP, time to pregnancy

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ally, the woman was asked if the pregnancy was planned, partly
months, 3–5 months, 6–12 months, or >12 months?” Addition-
TTP was recorded according to the following questions: “How
Measurement of outcome and potential confounders
reported having no job. 
numbers for an internal contrast in work schedules: nurses
Test, compared with daytime workers. 
Table 1 Exclusion criteria by work schedules
<table>
<thead>
<tr>
<th>Pregnancies</th>
<th>Daytime work n (%)</th>
<th>Fixed evening work n (%)</th>
<th>Fixed night work n (%)</th>
<th>Rotating shift work (without night) n (%)</th>
<th>Rotating shift work (with night) n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24605</td>
<td>809</td>
<td>290</td>
<td>2334</td>
<td>2429</td>
</tr>
<tr>
<td>The second pregnancies†</td>
<td>184 (0.7)</td>
<td>7 (0.9)</td>
<td>1 (0.3)</td>
<td>21 (0.9)</td>
<td>17 (0.7)</td>
</tr>
<tr>
<td>Endometriosis</td>
<td>68 (0.3)</td>
<td>2 (0.2)</td>
<td>1 (0.3)</td>
<td>6 (0.3)</td>
<td>9 (0.4)</td>
</tr>
<tr>
<td>Ovarian or cervical cancer</td>
<td>18 (0.1)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Parity planned</td>
<td>2136 (8.7)</td>
<td>85 (10.5)</td>
<td>27 (9.3)</td>
<td>223 (9.6)</td>
<td>237 (9.8)</td>
</tr>
<tr>
<td>Unplanned</td>
<td>3078 (12.5)</td>
<td>167 (20.6)**</td>
<td>56 (19.3)**</td>
<td>365 (15.6)**</td>
<td>344 (14.2)*</td>
</tr>
<tr>
<td>Treatment for infertility</td>
<td>1590 (6.5)</td>
<td>53 (6.8)</td>
<td>28 (9.7)*</td>
<td>144 (6.2)</td>
<td>157 (6.5)</td>
</tr>
<tr>
<td>Final study pregnancies</td>
<td>17531 (71.2)</td>
<td>493 (60.9)</td>
<td>177 (61.0)</td>
<td>1572 (67.4)</td>
<td>1665 (68.5)</td>
</tr>
</tbody>
</table>

The numbers in parentheses represent percentages.
†One woman contributed two pregnancies during the study period.
*p<0.05 and **p<0.01, χ² test, compared with daytime workers.

the DNBC, giving their first telephone interview (12–16
completed gestational week), and still being pregnant at that
time. They were asked to state their occupation and work
schedule. We identified 30 467 pregnancies in women who had
a job and had stated their occupation and work schedule. We
excluded pregnancies in women with endometriosis, ovarian
cancer, or cervical cancer. We excluded unplanned pregnancies,
partly planned pregnancies, and pregnancies that occurred after
infertility treatment from the main analysis. The proportions of
unplanned pregnancies were higher among shift workers. Some
women participated in the cohort with two pregnancies during the
study period; we excluded the second reported pregnancies
to achieve statistical independence. We ended up with 17 531
daytime workers, 493 fixed evening workers, 177 fixed night
workers, 1572 rotating shift (without night) workers, and 1665
rotating shift (with night) workers, who were eligible for the
main analyses (table 1).

**Exposure assessment**
In the first interview, the women were asked in detail about
their occupation, including the number of jobs, their job title,
type of work, working hours, work schedule, and number of
night shifts. Their partners’ occupations were also recorded.
We grouped the women by occupation according to the Danish
version of the International Standard Classification of Occupation (DISCO-88)23 into: managers and professionals
(0110–2470), technicians (3111–3480), service and sales
workers (4110–6210), and industrial workers (7111–9333).
We classified weekly working hours into two categories: <35
hours and 35+ hours. The work schedule question was asked
as follows: “Do you primarily work during the day, during the
evening or during the night, or do you have changing working
hours?” The mutually exclusive answering categories were:
1, daytime; 2, fixed evening; 3, fixed night; 4, rotating shift
(without night); 5, rotating shift (with night). We grouped the
frequency of night shifts into 1–8 and 9+ times per month. We
furthermore identified two specific job types with the largest
numbers for an internal contrast in work schedules: nurses
(n = 1624) and nursing assistants (n = 899). Their partners’
jobs were classified in the same categories, except when they
reported having no job.

**Measurement of outcome and potential confounders**
TTP was recorded according to the following questions: “How
long did you try to become pregnant, before you succeeded? 0–2
months, 3–5 months, 6–12 months, or >12 months?” Addition-
ally, the woman was asked if the pregnancy was planned, partly
planned, or not planned. Only planned pregnancies were
included in the analyses presented in the tables.

Potential confounders were categorised as shown in table 2.
They included age at conception, gravidity, prepregnancy body
mass index (BMI), smoking, and alcohol consumption. Maternal
age at conception was computed by subtracting the
woman’s birth date from the last menstrual period and adding
14 days. Prepregnancy BMI was calculated on the basis of the
women’s report on height and weight before pregnancy. We
used the question whether they had smoked at any time in the
first trimester to categorise them as either smokers or
non-smokers. Alcohol consumption was classified in catego-
ries as described elsewhere.21 In brief, we added beer, wine,
and spirits to one variable of total alcohol consumption per
week, according to the woman’s report on her drinking habits
before pregnancy. One bottle of beer contains 11.6 g of alcohol,
and 12 g of alcohol is an approximate average for one unit of
wine or spirits in Denmark. If less than one unit per week was
reported by the woman, 0.5 units were coded. We then
grouped them by these levels: 0, 0.5–7, 7.5+ units (12 g alco-
hol per unit) per week. It has previously been shown21 that
neither interviewee’s habits nor her attitudes towards smok-
ing and alcohol consumption during pregnancy had con-
sequences for responses obtained. Likewise, the education, age,
or parity of the interviewer did not correlate with the answers
obtained. We had limited data on the partner and no
information on sexual activity or sperm quality.

**Statistical analysis**
In general, fecundability is defined as the probability to
conceive in a menstrual cycle. In our study, we estimated the
probability of obtaining a clinically recognised pregnancy in a
waiting time interval among women not pregnant in the pre-
vious interval, conditionally that they did get pregnant. Fecundity
odds ratio (OR) measures the odds of a conception
within each waiting time interval among the exposed divided
by the odds among those not exposed. This measure will cor-
relate with fecundability under most conditions, but it is not a
measure of fecundability. ORs were calculated with 95% con-
fidence intervals (95% CI) using the discrete time survival
analysis techniques performed by logistic regression, which is
a non-proportional hazard model,24 to estimate the effects on
shift workers compared with daytime workers. TTPs in our
study were measured in discrete times (four intervals). We
first broke down each individual’s TTP into a set of intervals
that were treated as distinct observations. After pooling these
observations, the next step was to estimate a binary regression
model (logistic model) predicting whether a conception
occurred in each interval and a variable to indicate that the
interval was fitted into the model while covariates were
allowed. We repeated all analyses for only those women who
tried to become pregnant for the first time, since a previous
TTP may modify risk behaviour in subsequent attempts in
such a way that may be impossible to adjust for. All analyses
were restricted to women who had a job at the first interview.
We estimated the effect of night shifts on TTP by including
only fixed night workers and rotating shift (with night) work-
ers in the analysis. Potential confounders were included in the
model, as well as a variable to indicate waiting time interval
and the couple’s occupational characteristics. Analyses were
performed using SPSS 10.0.
RESULTS

The proportion of shift work was 19.1% among women who had a job. Table 2 shows the primary characteristics of the study population. Characteristics of rotating shift workers (with or without night) were similar to that of daytime workers, except that most rotating shift workers were technicians and most daytime workers were service and sales workers. Fixed evening workers and fixed night workers were heterogeneous populations compared with others. They were younger, more often parous, obese, and smokers, and they more often worked as industrial workers, as did their partners. Their median weekly work hours were 28 hours and 30 hours, respectively, while daytime and rotating shift (with or without night) workers worked 37 hours per week. By agreement, full time employment in Denmark equals 37 hours a week. The median number of night shifts was 14 a month for fixed night workers and four for rotating shift workers (with night).

Compared with daytime workers, fixed evening workers and fixed night workers had a longer TTP, while rotating shift (with or without night) workers had similar TTP. The crude ORs were 0.83 for fixed evening workers, 0.75 for fixed night workers, 1.00 for rotating shift (without night) workers, and 1.11 for rotating shift (with night) workers. The adjusted risk estimates never changed more than the 10% limit (table 3).

This study did not change when we included only the first pregnancies (data not shown). When we restricted the analysis to nurses, none of the shift workers had a statistically significant low fecundity; the adjusted ORs were 0.99 (95% CI 0.71 to 1.38) for fixed evening work, 0.67 (95% CI 0.39 to 1.15) for fixed night work, 0.96 (95% CI 0.73 to 1.24) for rotating shift work (without night), and 0.99 (95% CI 0.81 to 1.22) for rotating shift work (with night), compared with daytime work (data not shown).

When we did an analysis for nursing assistants, only fixed evening work (OR 0.73; 95% CI 0.54 to 0.99) showed a statistically significantly decreased fecundity (data not shown).

We performed separate analyses for smokers and non-smokers, since smoking was more prevalent among fixed evening work and fixed night work and correlated with TTP (OR 0.82; 95% CI 0.78 to 0.87). Shift work did not show any statistically significant association with fecundity among

### Table 2: Characteristics of participants according to work schedules

<table>
<thead>
<tr>
<th></th>
<th>Daytime work</th>
<th>Fixed evening work</th>
<th>Fixed night work</th>
<th>Rotating shift work (without night)</th>
<th>Rotating shift work (with night)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age at conception</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;25</td>
<td>1639 9.3</td>
<td>85 17.2</td>
<td>31 17.5</td>
<td>173 11.0</td>
<td>101 6.2</td>
</tr>
<tr>
<td>25–29</td>
<td>7432 42.4</td>
<td>218 44.2</td>
<td>68 38.4</td>
<td>712 45.3</td>
<td>843 50.6</td>
</tr>
<tr>
<td>30–34</td>
<td>6730 38.4</td>
<td>144 29.2</td>
<td>65 36.7</td>
<td>520 33.1</td>
<td>558 33.5</td>
</tr>
<tr>
<td>35+</td>
<td>1729 9.9</td>
<td>46 9.3</td>
<td>13 7.3</td>
<td>167 10.6</td>
<td>161 9.7</td>
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<td>0</td>
<td>5529 31.5</td>
<td>137 27.8</td>
<td>45 25.4</td>
<td>549 34.9</td>
<td>564 33.9</td>
</tr>
<tr>
<td>1</td>
<td>6690 38.2</td>
<td>168 34.1</td>
<td>64 36.2</td>
<td>547 34.8</td>
<td>564 33.9</td>
</tr>
<tr>
<td>2+</td>
<td>5306 30.3</td>
<td>188 38.1</td>
<td>68 38.4</td>
<td>476 30.3</td>
<td>535 32.1</td>
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<td>&lt;18.5</td>
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<td>16 3.2</td>
<td>8 4.5</td>
<td>62 3.9</td>
<td>61 3.7</td>
</tr>
<tr>
<td>18.5–30</td>
<td>15350 87.6</td>
<td>421 85.4</td>
<td>145 81.9</td>
<td>1364 86.8</td>
<td>1480 88.9</td>
</tr>
<tr>
<td>&gt;30</td>
<td>1214 6.9</td>
<td>48 9.7</td>
<td>20 11.3</td>
<td>120 7.6</td>
<td>112 6.7</td>
</tr>
<tr>
<td>Missing</td>
<td>259 1.5</td>
<td>8 1.6</td>
<td>4 2.3</td>
<td>26 1.7</td>
<td>12 0.7</td>
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<td>Smoking</td>
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</tr>
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<td>No</td>
<td>13693 78.1</td>
<td>346 70.2</td>
<td>105 59.3</td>
<td>1161 73.9</td>
<td>1293 77.7</td>
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<tr>
<td>Yes</td>
<td>3835 21.9</td>
<td>147 29.8</td>
<td>72 40.7</td>
<td>410 26.1</td>
<td>371 22.3</td>
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<td>0</td>
<td>1 0.1</td>
<td>1 0.1</td>
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<td>Alcohol consumption</td>
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<td>No</td>
<td>1864 10.6</td>
<td>71 14.4</td>
<td>30 16.9</td>
<td>162 10.3</td>
<td>143 8.6</td>
</tr>
<tr>
<td>Yes</td>
<td>14170 80.8</td>
<td>391 79.3</td>
<td>133 75.1</td>
<td>1268 80.7</td>
<td>1395 83.8</td>
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<td>Occupation, mother</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Managers and professionals</td>
<td>3785 21.6</td>
<td>15 3.0</td>
<td>7 4.0</td>
<td>299 19.0</td>
<td>259 15.6</td>
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<tr>
<td>Technicians</td>
<td>5177 29.2</td>
<td>176 35.7</td>
<td>49 27.7</td>
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<td>1077 64.7</td>
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<td>Service and sales workers</td>
<td>7465 42.6</td>
<td>234 47.5</td>
<td>81 45.8</td>
<td>530 33.7</td>
<td>278 16.7</td>
</tr>
<tr>
<td>(Nurses)*</td>
<td>521 2.9</td>
<td>43</td>
<td>106</td>
<td>92</td>
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<td>Industrial workers</td>
<td>1164 6.6</td>
<td>68 13.8</td>
<td>40 22.6</td>
<td>112 7.1</td>
<td>51 3.1</td>
</tr>
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</tr>
<tr>
<td>Managers and professionals</td>
<td>5204 29.7</td>
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<td>26 14.7</td>
<td>458 29.1</td>
<td>541 32.5</td>
</tr>
<tr>
<td>Technicians</td>
<td>3313 18.9</td>
<td>72 14.6</td>
<td>24 13.6</td>
<td>278 17.7</td>
<td>334 20.1</td>
</tr>
<tr>
<td>Service and sales workers</td>
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<td>76 15.4</td>
<td>30 16.9</td>
<td>195 12.4</td>
<td>205 12.3</td>
</tr>
<tr>
<td>Industrial workers</td>
<td>5529 31.5</td>
<td>209 42.4</td>
<td>80 45.2</td>
<td>458 29.1</td>
<td>435 26.1</td>
</tr>
<tr>
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<td>10 5.6</td>
<td>126 8.0</td>
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<td>57 3.6</td>
<td>45 2.7</td>
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<td>Working hours per week</td>
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</tr>
<tr>
<td>&lt;35</td>
<td>4110 23.4</td>
<td>389 78.9</td>
<td>109 61.6</td>
<td>455 28.9</td>
<td>467 28.0</td>
</tr>
<tr>
<td>35+</td>
<td>13397 76.4</td>
<td>101 20.5</td>
<td>68 38.4</td>
<td>1105 70.3</td>
<td>1187 71.3</td>
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<td>3 0.6</td>
<td>0 0.0</td>
<td>12 0.8</td>
<td>11 0.7</td>
</tr>
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<td>Number of night shifts per month</td>
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<td></td>
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<td>1555 93.4</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>9+</td>
<td>162 91.5</td>
<td>99 5.9</td>
<td>99 5.9</td>
<td>99 5.9</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>4 2.3</td>
<td>11 0.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percentages may not add to 100.0 because of rounding.

*Specific types of work, not included in column totals.
Table 3  Time to pregnancy and adjusted fecundity odds ratios (ORs) for occupational exposures

<table>
<thead>
<tr>
<th>Work schedule</th>
<th>0–2 months</th>
<th>3–5 months</th>
<th>6–12 months</th>
<th>&gt;12 months</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime work</td>
<td>8700</td>
<td>49.6</td>
<td>4076</td>
<td>23.3</td>
<td>2958</td>
<td>16.9</td>
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<tr>
<td>Fixed evening work</td>
<td>219</td>
<td>44.4</td>
<td>113</td>
<td>22.9</td>
<td>96</td>
<td>19.5</td>
</tr>
<tr>
<td>Fixed night work</td>
<td>75</td>
<td>42.4</td>
<td>42</td>
<td>23.7</td>
<td>31</td>
<td>17.5</td>
</tr>
<tr>
<td>Rotating shift work (without night)</td>
<td>786</td>
<td>50.0</td>
<td>358</td>
<td>22.8</td>
<td>268</td>
<td>17.0</td>
</tr>
<tr>
<td>Rotating shift work (with night)</td>
<td>855</td>
<td>51.4</td>
<td>393</td>
<td>23.6</td>
<td>285</td>
<td>17.1</td>
</tr>
</tbody>
</table>

Occupation, mother

| Managers and professionals | 2344 | 53.7 | 1007 | 23.1 | 624 | 14.3 | 390 | 8.9 | 1.09 | 1.02 to 1.16 |
| Technicians                | 3581 | 50.2 | 1656 | 23.5 | 1178 | 16.7 | 635 | 9.0 | 1.05 | 0.99 to 1.12 |
| Service and sales workers  | 4071 | 47.4 | 2009 | 23.4 | 1550 | 18.0 | 518 | 11.2 | 0.87 | 0.82 to 0.91 |
| Industrial workers         | 639  | 44.5 | 310  | 21.6 | 286  | 19.9 | 200 | 13.9 | 0.79 | 0.72 to 0.86 |

Occupation, father

| Managers and professionals | 3316 | 52.4 | 1452 | 23.0 | 989 | 15.6 | 566 | 9.0 | 1.05 | 0.99 to 1.12 |
| Technicians                | 2019 | 50.2 | 946  | 23.5 | 663 | 16.5 | 363 | 9.8 | 1.00 | 0.99 to 1.01 |
| Service and sales workers  | 1348 | 49.0 | 635  | 23.1 | 491 | 17.9 | 276 | 10.0 | 0.98 | 0.91 to 1.06 |
| Industrial workers         | 3135 | 46.7 | 1560 | 23.2 | 1224 | 18.2 | 792 | 11.8 | 0.90 | 0.83 to 0.96 |
| No job                     | 528  | 51.7 | 242  | 23.7 | 171 | 16.7 | 80  | 7.8 | 1.10 | 0.99 to 1.23 |

Working hour

| <35 | 7769 | 49.0 | 3718 | 23.4 | 2713 | 17.1 | 1658 | 10.5 | 1.08 | 1.02 to 1.13 |
| 35+ | 2841 | 51.4 | 1254 | 22.7 | 918  | 16.6 | 517  | 9.3  | 1.08 | 1.02 to 1.13 |

Number of night shifts per month*

| 1–8 | 805  | 51.4 | 370  | 23.6 | 271  | 17.3 | 120  | 7.7  | 1.08 | 1.02 to 1.13 |
| 9+  | 114  | 43.7 | 64   | 24.5 | 44   | 16.9 | 39   | 14.9 | 0.97 | 0.70 to 1.34 |

DISCUSSION

We did not find an association between rotating shift work (with or without night) and reduced fecundity. This finding was consistent for all, for nulliparous women, for nurses and nursing assistants, for non-smokers, and for smokers. The median number of working nights per month was only four for rotating shift workers (with or without night). If night shifts have only transient effects (say, few days), we may have limited opportunity for having sexual activity. However, both the Swedish study and the European multicentre study showed that the frequency of sexual intercourse was evenly distributed among daytime workers, rotating shift workers, and fixed night workers. Working time may affect the timing of intercourse, which is more important than frequency for conception.

We do expect that the effect of previous use of contraceptive pills would bias our results since we had limited data on it. We asked the women about the use of oral contraceptives during the past four months before pregnancy and found that among those having TTP 0–2 months, the proportions of the previous use of pills were lower for fixed evening workers (27.9%) and rotating shift (with night) workers (32.2%), but not for fixed night workers (41.3%), and for rotating shift (without night) workers (38.5%), compared with daytime workers (38.8%). However, when we only looked at getting pregnant during 0–2 months of waiting time and performed an analysis after adjusting for the previous use of oral contraceptives and other potential confounders, we obtained similar results. Menstrual cycle characteristics are also known determinants of female fecundity, but we had only limited data to analyse the importance of this factor.

Three previous studies found an association between shift work and women’s fecundity, while three others did not. The differences in working condition for shift workers in different populations and the pregnancy planning bias could...
be major reasons for inconsistent results. Although the European multicentre study concluded that data from the study were in favour of an association between shift work and prolonged TTP, they found no associations between shift work and subfecundity in the population sample with first pregnancies (OR 1.0; 95% CI 0.7 to 1.5) and no effect of shift work on menstrual cycle length and irregular bleedings. They stated “it is likely that shift work is only a risk indicator”.

The DNBC recruited about 60% of invited pregnant women (30–40% of all pregnant women). The response rate could cause selection bias if the decision to participate was associated with both exposure to shift work and TTP. We believe this to be unlikely, since studying determinants of subfecundity was not specified as the aim of the birth cohort.

This study included only women who had a clinically recognised pregnancy and all effects were measured well restricted to pregnancies that survived the first 12–16 weeks of gestation. If the exposures under study lead to an all or none effect or early fetal loss, we had no possibility of detecting such an effect. Most experiences so far show that only few exposures have such an effect.14

We used telephone interviews to obtain information on TTP. Validation studies of TTP have shown that recall of TTP is associated with both exposure to shift work and subfecundity. We therefore controlled in the analyses.

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