Fathers’ occupation and pregnancy outcome

A D MCDONALD, J C MCDONALD, B ARMSTRONG, N M CHERRY, A D NOLIN, D ROBERT
From the Institut de recherche en santé et en sécurité du travail du Québec, Montreal, Quebec H3A 3C2, Canada

ABSTRACT Findings from a survey of 56 067 women in Montreal on maternal occupation and pregnancy outcome have been reported. Paternal occupation recorded in the same survey was analysed for spontaneous abortion in 24 occupational groups retaining the six main sectors of maternal occupation and allowing, by means of logistic regression, for seven potentially confounding variables. In only one of the 24 fathers’ occupational groups was there a statistically significant excess of spontaneous abortions—mechanics, repairers, and certain assemblers (O/E = 1.10, 90% CI = 1.02–1.20); subdivision of this group suggested that this excess was mainly attributable to the large group of motor vehicle mechanics (O/E = 1.17). No significant excess of known chromosomally determined defects was found in any of the 24 occupational groups. An association of developmental defects was found with food and beverage processing (18 defects observed compared with 8.02 expected; p < 0.05); however, there was no specificity in type of food, beverage, or congenital defect, and no obvious explanatory mechanism.

In a survey of occupational factors and outcome of pregnancy 56 067 women were interviewed over a two year period, 1982–4, after delivery or spontaneous abortion in 11 obstetrical units in Montreal. Questions were asked on personal, social, and occupational factors, with detailed information about the mother’s work, for recently completed and all previous pregnancies—104 649 in all. Mothers’ job titles, work demands, conditions of employment, and exposure to chemicals have been analysed in relation to the four main adverse outcomes of pregnancy: abortion, stillbirth (without defect), congenital defect, and prematurity.14

Whereas the primary aim in this survey was to assess the effect of mothers’ work, certain occupational exposures of the father might also have damaged the fetus. The main mechanism by which this could happen would be genetic. Chromosomal abnormalities, presumably the result of mutation in male or female germ cells or in the conjugated zygote, are found in some 50% of spontaneous abortions2 and congenital defects with detectable chromosomal abnormalities are found in about seven per thousand births.6

In studies based on birth defects in Finland7 and Israel8 no association was found with the father’s occupation. In the United States data obtained by interviewing parents of nearly 1000 children with congenital defects showed no convincing association between specific defects and paternal occupation.9 Cleft palate was associated with paternal exposure to freshly printed material and to painting in the construction industry but many comparisons were made without prior hypothesis. In a record linkage study in Finland the frequency of spontaneous abortion was examined in seven large occupational groups entailing exposure to different types of potentially hazardous agent.10 The wives of metal plate and constructional steel workers and of men employed in three small groups (crushers and grinders in chemical processes, sewers, those engaged in the care of fur bearing animals) were at increased risk.

As father’s occupation was recorded for each pregnancy in the Montreal survey, the opportunity was taken to seek evidence of any relation with spontaneous abortion and selected birth defects.

Methods

FATHER’S OCCUPATION Questions on father’s employment at the time of the mother’s first missed menstrual period were asked for all current and past pregnancies. The women were asked the name and description of the job, type of enterprise, and address, much as for the Canadian census. The answers to these questions were coded
which there was tested by subdivision of potential for harmful exposure. 24 occupational groups were classified under the same six main occupational sectors as have been used systematically in our analyses of maternal occupations (see table 1). Within the six main sectors 24 occupational groups were selected as having the potential for harmful exposure. The much greater number of men than women in industrial employment necessitated subdivision of the manufacturing sector into 14 groups instead of six for women. The hypothesis that exposure of men to ionizing radiation might induce chromosomal mutations and so increase the risk of spontaneous abortion in their wives was tested by identifying (1) occupations in which there was probably exposure to ionising radiation and (2) occupations in the health, services, and manufacturing sectors in which there was possibly some such exposure. The exposed occupations were selected on the basis of available information, including that from the Canadian Environmental Health Directorate are listed in table 2. In these occupations the average annual whole body doses reported were mostly low and above 1 MSV only for industrial radiographers, therapeutic radiology technicians, and some occupations in nuclear energy plants.

### STUDY POPULATION

The pregnancies studied were limited to those in which the women were employed 30 hours or more a week at the time of conception. Other pregnancies in which the women were not employed during pregnancy, or for shorter periods, were excluded because the many...
potentially confounding variables for these have not yet been assessed. For the analysis of spontaneous abortion, there were 47 326 such pregnancies (24 711 current and 22 615 previous). The analysis of congenital defects was based on 47 822 pregnancies (27 472 current and 20 350 previous) of women employed 15 hours a week or more at time of conception. This total excluded spontaneous abortions of less than 20 weeks' gestation but included abortions induced for a classifiable congenital defect.

The present study was confined to (a) defects of known chromosomal origin and (b) developmental defects of the neural tube, lip and palate, heart, and of the respiratory, digestive, and urinary tracts. Congenital hernias, musculoskeletal defects, and some miscellaneous anomalies were not included in this study.

**Statistical Analysis**

Expected numbers were calculated for each paternal occupational group after accounting for non-occupational confounding variables (maternal age, gravidity, previous miscarriage, ethnic group, educational level, smoking, and alcohol consumption) by logistic regression, as previously described. Adjustment for possible confounding by maternal occupation was made at a second stage by calculating expected numbers for paternal occupational group cross classified by sector of employment of the mother. The expected numbers by maternal sector were first adjusted by the ratios of observed to expected (O/E) spontaneous abortions in each maternal sector for all pregnancies, and then summed. Ninety per cent confidence intervals for the resulting O/E ratios were calculated on the assumption that the observed number followed a Poisson distribution. The significance of heterogeneity of O/E ratios over the 24 paternal occupational groups was tested by Poisson regression using the GLIM computer package.

As in our previous analyses of congenital defect, no allowance was made for confounding variables because of the different and often unknown
Table 3  Congenital defects by group in selected paternal occupations

<table>
<thead>
<tr>
<th>Congenital defect*</th>
<th>Processing</th>
<th>Agriculture/horticulture (n = 380)</th>
<th>Food &amp; beverage (n = 739)</th>
<th>Wood, textiles, &amp; other (n = 376)</th>
<th>Printing (n = 625)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>E</td>
<td>O</td>
<td>E</td>
<td>O</td>
</tr>
<tr>
<td>Chromosomal</td>
<td>0</td>
<td>0.68</td>
<td>0</td>
<td>1.33</td>
<td>1</td>
</tr>
<tr>
<td>Neural tube</td>
<td>2</td>
<td>0.95</td>
<td>5</td>
<td>1.84</td>
<td>1</td>
</tr>
<tr>
<td>Cleft lip/palate</td>
<td>0</td>
<td>0.32</td>
<td>2</td>
<td>0.62</td>
<td>0</td>
</tr>
<tr>
<td>Digestive respiratory</td>
<td>1</td>
<td>0.55</td>
<td>3</td>
<td>1.06</td>
<td>0</td>
</tr>
<tr>
<td>Cardiac</td>
<td>1</td>
<td>0.41</td>
<td>2</td>
<td>2.75</td>
<td>1</td>
</tr>
<tr>
<td>Renal urinary</td>
<td>5</td>
<td>0.90</td>
<td>6</td>
<td>1.75</td>
<td>1</td>
</tr>
<tr>
<td>All</td>
<td>9</td>
<td>4.13</td>
<td>18</td>
<td>8.02</td>
<td>3</td>
</tr>
</tbody>
</table>

*Excluding musculoskeletal defects and hernias.

epidemiological pattern for each type of defect. The overall rate was used to estimate the number expected in each paternal occupational group. Confidence intervals and p values were calculated as above.

Results

Table 1 shows ratios (O/E) for spontaneous abortion and congenital defect. For spontaneous abortion, a global test of O/E ratios in the 24 occupational groups gave no evidence of heterogeneity (p > 0.20) and, considered individually, the only O/E ratio for which the 90% confidence interval excluded 1.00 was for the group of mechanics and repairers, fabricators, and assemblers of certain products (SOC 8580–8599) for which the O/E ratio was 1.10 (90% CI 1.02–1.20). One subdivision of this group—mechanics and repairers of motor vehicles (SOC 8581)—explained most of this excess with O = 168 and the O/E ratio = 1.17 (90% CI 1.03–1.32). Other subdivisions were too small to give reliable estimates of risk. Ratios were also raised in pregnancies for which the paternal occupation was unknown (O/E = 2.26, 90% CI 1.05–1.28) and in those in which the father was not employed (O/E = 1.14, 90% CI 1.05–1.23).

In the group of occupations with probable exposure to ionising radiation there were 18 abortions (O/E = 0.87, 90% CI 0.56–1.29). For the three groups with possible exposure to ionising radiation, 235 abortions were observed in the health sector (O/E = 1.0, 90% CI 0.93–1.15), 89 abortions in the service sector (O/E = 0.99, 0.82–1.17), and 76 abortions in manufacturing (O/E = 0.93, 90% CI 0.76–1.11).

Table 1 also shows the ratios of chromosomal and developmental congenital defects observed to those expected on the basis of the rates in all working women. In none of the 24 paternal occupational groups was there an excess of chromosomal defects statistically significant at a 5% level and there was no evidence of heterogeneity in the 24 occupational groups (p > 0.20). There was significant heterogeneity of the O/E ratios for developmental defects (p = 0.01). Three O/E ratios for developmental defects had confidence intervals which excluded one: processing of food, beverages, wood and textiles, agriculture and horticulture, and the large occupational group of clerical workers in which the 90% confidence interval only just excluded one. This latter group was not investigated further.

Table 2 shows in the other two occupational groups numbers of developmental defects by type compared with those expected from rates for all working women. For agriculture and horticulture the excess was attributable to renal urinary defects (polycystic kidney (1), hydrenephrosis (1), hypospadias (3)). Because a large occupational group was engaged in processing food, beverages, wood and textiles the substances handled were diverse, it was subdivided. The excess of developmental defects was confined to processing of food and beverages (18 developmental defects compared with 8.02 expected). Raised O/E ratios were found in four of the five types of developmental defects (table 3); there were no chromosomal defects. Table 4
Father's occupation and pregnancy outcome

shows 12 four digit SOC occupations comprising different sections of the food and beverage industry; the excess appeared to be distributed fairly evenly between them.

Comment

The 10% increase in risk of spontaneous abortion found in the paternal occupational group of mechanics and repairers may have occurred by chance in the large number of occupations analysed. On the other hand, an association between the paternal occupation of automobile mechanic and infantile cancer has been suspected; if confirmed this might also suggest the possibility of mutation in the fetus leading to spontaneous abortion. Congenital defects known to be caused by chromosomal abnormalities—in this survey trisomies and sex chromosome anomalies—were not found to be increased in any of the 24 paternal occupational groups analysed. An excess of trisomy 18 has been reported with maternal leatherwork; in our survey leatherworkers were too few to confirm or refute this association with a rare chromosomal defect (~1:3000 births).

There is no obvious genetic mechanism for the occurrence of the developmental defects selected for analysis. Some features of the associations observed with three paternal occupational groups appear to merit mention. The large group of male clerical workers was not obviously exposed to any biologically active agent. The excess in agricultural and horticultural workers potentially exposed to chemical agents was mainly attributable to three cases of hypospadias observed compared with 0.26 expected. It is difficult to interpret the excess in food and beverage workers, the magnitude of which is not easily dismissed. It is not impossible that employees in the food industry are exposed to biologically potent agents, perhaps used for food preservation; on the other hand, there is lack of specificity in type of defect or in type of employment (table 4) and it is unlikely that any environmentally induced genetic factor could be common to them all. The significance of this finding must therefore depend on whether it finds independent support from other studies.

We failed to detect an increase in spontaneous abortion in the wives of men whose work entailed possible exposure to ionising radiation. The small group (65) of pregnancies in the wives of constructional steel workers had no significant excess of abortions (O = 14, O/E = 1.24, 90% CI 0.75–1.95), by contrast with the finding reported from Finland. No increased risk of cleft palate was observed in printing (shown in table 3)—contrary to a finding in the United States. The high O/E ratios for spontaneous abortion in the wives of men whose occupation was unknown and those who were unemployed merit comment. Perhaps there were unidentified confounding variables in these groups. Overall, we conclude that this survey provided no convincing evidence that fathers' occupations had any adverse effect on their progeny.

References