Are the children of fathers whose jobs involve contact with many people at an increased risk of leukaemia?

Nicola T Fear, Eve Roman, Gillian Reeves, Brian Pannett

Abstract

Objectives—To investigate the hypothesis that children of men whose jobs involve contact with many people (particularly children) are at an increased risk of leukaemia.

Methods—A population based dataset obtained from routinely collected death certificates involving 14 168 cancer deaths occurring before the age of 15 years registered in England and Wales between 1959–63 and 1970–90. Associations were assessed with the proportional cancer mortality ratio (PCMR), with all childhood cancer deaths forming the standard for comparison. The PCMRs were adjusted, by stratification, for age and year of death (in 1-year bands) and paternal social class (nine categories). Analyses were performed by estimated level of paternal occupational social contact (high, medium, and low) for all leukaemias, leukaemia subtype, age at death, year of death, and individual occupation.

Results—Out of 223 occupations, 36 (16%) were identified as having potentially high levels of social contact, and 27 (12%) as having potentially medium levels of social contact. No associations were found between paternal occupational social contact and death during childhood from leukaemia (high social contact: PCMR 94, 95% confidence interval (95% CI) 87 to 102; medium social contact: 101, 95 to 106). No associations were found when the data were analysed by leukaemia subtype, age at death, year of death, or individual occupation.

Conclusion—The findings presented here do not support the suggestion that childhood leukaemia is related to the amount of social contact that fathers experience at work.

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Keywords: childhood leukaemia; paternal occupation; social contact

The suggestion that childhood leukaemia, specifically acute leukaemia, may have an infectious aetiology is not new. In particular, Kinlen has proposed that leukaemia in children and young adults can be caused by a specific (but as yet unidentified) infection, the transmission of which is promoted by population mixing. Recently, as an extension of this idea, it has been hypothesised that offspring of men whose jobs involve contact with many people, particularly children, are at an increased risk of leukaemia. To date, most studies on the topic of population mixing and childhood leukaemia have either been ecological or based on a few events.

The findings presented here relate to over 14 000 deaths from childhood cancer occurring in England and Wales between 1959–63 and 1970–90, which is the largest body of data on paternal occupation and childhood cancer ever assembled.

Subjects and methods

Routinely collected death certification data on 360 640 deaths occurring before 15 years of age registered in England and Wales during 1959–63, 1970–78, and 1979–90 were provided for analysis in the form of anonymised individual records by the Office for National Statistics. Data were not routinely coded for 1964–9 and were, therefore, unavailable for analysis. Deaths occurring within the first 28 days of life or which had invalid information on paternal occupation, cause or year of death were excluded. Overall 167 703 childhood deaths (47%) were included and the present analysis is based on 14 168 deaths due to cancer.

Paternal occupation, social class, and underlyng cause of death were coded by the Office for National Statistics with the standard classifications in use at the time of the child’s death. Paternal occupation was subsequently bridge coded to one of the 223 jobs described in the 1970 classification of occupations with a bridge coding program specifically developed for use with routinely collected data. Several occupational codes were subsequently combined to allow complete bridge coding. (Further information available from BP). Cause of death was bridge coded to the 7th revision of the international classification of diseases (ICD) with bridge codes developed at the London School of Hygiene and Tropical Medicine.

Sixty three (28%) of the 223 jobs were classified as having potentially increased levels of occupational social contact by an occupational hygienist (BP): 36 being classified as high and 27 as medium (table 1). For the purposes of the present analysis, the remaining 160 (72%), whose likely social contact was not judged to be unusual, were classified as low.

STATISTICAL METHODS

Associations between death during childhood due to leukaemia and paternal occupational social contact were assessed with the
**Proportional Cancer Mortality Ratios (PCMRs)**

Proportional cancer mortality ratio (PCMR), with all childhood cancer deaths forming the standard for comparison. PCMRs were adjusted, by stratification, for age and year of death (in 1-year bands) and paternal social class (nine categories). For each PCMR, approximate 95% confidence intervals (95% CIs) and two sided tests of significance were estimated from the $\chi^2$ distribution, or when the number of observed deaths was <10, from the Poisson distribution.

**Results**

The PCMRs for leukaemia by estimated level of paternal occupational social contact are shown in table 2. Overall, for leukaemia, the PCMRs were 94 (95% CI 87 to 102, based on 648 deaths) for high social contact, 101 (95% CI 95 to 106, based on 1180 deaths) for medium social contact and 101 (95% CI 98 to 104, based on 4062 deaths) for low social contact. Data were further examined by age (0–4 years and 5–14 years) and period (1959–63, 1970–8, and 1979–90). There was no evidence of a difference between the estimates of risk by either age or period for each level of social contact. Table 2 also shows that no notable patterns emerged when these data were analysed by leukaemia subtype.

The figure shows the job specific PCMRs for leukaemia for children whose fathers’ occupations are listed in table 1. The job specific PCMRs are plotted as black squares, each with an area proportional to the square root of the number of deaths on which it is based with a central horizontal line corresponding to the 95% CI. The overall PCMR for each level of exposure is depicted as a diamond, its height being proportional to the square root of the number of deaths on which it is based and its width corresponding to the 95% CI. Occupations with <10 deaths from leukaemia have not been presented graphically but have been included in the overall estimates. In the high social contact group, two occupations (chiropractors and physiotherapists (occupational codes 187 and 188)) had 0 deaths observed and expected from leukaemia, and therefore did not contribute any information to the overall estimate of risk.

## Table 1

<table>
<thead>
<tr>
<th>Paternal occupational description (occupational code) (1970 revision)</th>
<th>Deaths (n)</th>
<th>Cancer Deaths</th>
<th>Leukaemia Deaths</th>
</tr>
</thead>
</table>

*Excludes deaths occurring within 28 days of birth.
†Those occupations based on <10 cancer deaths.
NCE=not elsewhere classified.

## Table 2

<table>
<thead>
<tr>
<th>High social contact</th>
<th>Medium social contact</th>
<th>Low social contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>PCMR* (95% CI)</td>
<td>Deaths</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>All leukaemias (ICD-7:204)</td>
<td>648</td>
<td>94 (87 to 102)</td>
</tr>
<tr>
<td>Ages (y):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–4</td>
<td>212</td>
<td>95 (83 to 108)</td>
</tr>
<tr>
<td>5–14</td>
<td>436</td>
<td>94 (86 to 104)</td>
</tr>
<tr>
<td>Period:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1959–63</td>
<td>173</td>
<td>101 (97 to 117)</td>
</tr>
<tr>
<td>1970–78</td>
<td>261</td>
<td>90 (80 to 102)</td>
</tr>
<tr>
<td>1979–90</td>
<td>214</td>
<td>95 (83 to 108)</td>
</tr>
<tr>
<td>Subtype:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lymphatic leukaemia (ICD-7:204.0)</td>
<td>321</td>
<td>92 (83 to 103)</td>
</tr>
<tr>
<td>Myeloid leukaemia (ICD-7:204.1)</td>
<td>137</td>
<td>107 (94 to 119)</td>
</tr>
<tr>
<td>Monocytic leukaemia (ICD-7:204.2)</td>
<td>11</td>
<td>75 (42 to 136)</td>
</tr>
<tr>
<td>Other and unspecified leukaemia (ICD-7: 204.3–204.9)</td>
<td>179</td>
<td>96 (83 to 112)</td>
</tr>
</tbody>
</table>

*PCMRs are adjusted for age at death, year of death, and paternal social class. Using all childhood cancer deaths as the standard for comparison.
†Excludes deaths occurring within 28 days of birth.
‡Occupations included within the high and medium social contact groups are shown in table 1, the remaining codes comprise the low social contact group.
Of particular interest are those occupations involving frequent contact with children and young adults—for example, university teachers (occupational code 192) and school teachers (occupational codes 193 and 194)—in which the PCMRs for leukaemia among the offspring of these men were 110 (95% CI 68 to 177, based on 17 deaths) and 94 (95% CI 79 to 113, based on 120 deaths) respectively.

### Discussion

The findings presented here do not support the suggestion that leukaemia in children is related to the amount of social contact that fathers...
experience at work. Of note is the lack of an association for occupations involving frequent mixing with children and young adults—such as school and university teachers—as it has been suggested that the children of such men would have the highest risk.

The findings described in this paper have the advantage of being based on individual records obtained from a very large population based dataset derived from routinely collected childhood death certification data. Furthermore, cause of death and paternal occupation would have been recorded without bias, as the registrar and parents would have been unaware of the use of these data at the time of registering the death. Also, the classification of occupations by their potential level of social contact was constructed before the start of the study in collaboration with an occupational hygienist (BP).

However, as this study is based on cancer deaths, as opposed to incident cancers, it is important to consider the influence of changes in survival. Over the past few decades survival rates for all types of childhood cancer have improved particularly for acute lymphocytic leukaemia, for which the 5 year survival rate has risen from 2% (1954–63) to 73% (1986–88). Under such circumstances, mortality data are not ideal for determining risk factors of childhood cancer. As the estimates of risk were similar for each period considered it seems unlikely that changes in survival have influenced the results.

In all proportional analyses, the estimates of risk may be unduly influenced by the most common causes of death. The PCMR removes the influence of these causes as the standard for comparison is restricted to cancer deaths only. In these data the other causes of death were shown to unduly influence the estimates of risk for this exposure group (data not shown), therefore making it inappropriate to use proportional mortality ratios (where the standard for comparison is based on all causes of death).

The use of occupational title as a proxy measure of potential exposure is controversial but is the only approach available for use with these data. The two previously conducted studies used a similar approach. It is important to note that father’s occupation at the time of the child’s death rather than that held before conception, during pregnancy, or at the time of birth has been examined in this study. Also, the classification of occupations by their potential level of social contact was constructed before the start of the study in collaboration with an occupational hygienist.

The occupational groupings used in the studies by Roman et al and Kinlen differed from each other and from the one presented here; this difference being partly due to the occupational coding schemes used. The application of these schemes to our data had no effect on the observed results. This is particularly important for Kinlen’s study (table 3).

Table 3 Adjusted proportional cancer mortality ratios (PCMRs) (95% CIs) for childhood leukaemia deaths registered among the offspring of men with social contact at work (Kinlen’s classification), England and Wales, 1959–63, 1970–8, and 1979–90

<table>
<thead>
<tr>
<th></th>
<th>Very high social contact</th>
<th>Medium social contact</th>
<th>Low social contact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deaths</td>
<td>PCMR* (95% CI)</td>
<td>Deaths</td>
</tr>
<tr>
<td>Leukaemia (204)</td>
<td>137</td>
<td>96 (81 to 113)</td>
<td>2298</td>
</tr>
<tr>
<td>Lymphatic leukaemia</td>
<td>75</td>
<td>91 (72 to 114)</td>
<td>11112</td>
</tr>
<tr>
<td>Myeloid leukaemia</td>
<td>32</td>
<td>122 (86 to 172)</td>
<td>438</td>
</tr>
<tr>
<td>Monocytic leukaemia</td>
<td>0</td>
<td>—</td>
<td>46</td>
</tr>
<tr>
<td>Other and unspecified leukaemia (204.3–204.9)</td>
<td>30</td>
<td>97 (68 to 139)</td>
<td>702</td>
</tr>
</tbody>
</table>

*PCMRs are adjusted for age at death, year of death, and paternal social class, with all childhood cancer deaths as the standard for comparison.
†Excludes deaths occurring within 28 days of birth.
children or young adults. The analyses presented in this paper had already been completed for a doctoral thesis (NTF) before the publication of Kinlen’s paper.1

Kinlen’s hypothesis1 that the offspring of men whose jobs involve contact with many people are at an increased risk of leukaemia assumes that these men expose their children to a specific leukaemogenic agent acquired within the working environment. Although infectious agents may indeed be involved in leukaemogenesis,1, 7 the lack of an association in these analyses is reassuring and leads us to think that there is no relation between childhood leukaemia and the amount of social contact that fathers experience at work.

We thank the Office for National Statistics for supplying the childhood death certification data for epidemiological analysis, Leslie Styles from the Medical Research Council Environmental Epidemiology Unit in Southampton for the development of the occupational recording program, Paul Appleby for producing the figure and Krys Baker for help with the occupational recording, both from the Imperial Cancer Research Fund, Cancer Epidemiology Unit in Oxford. NTF carried out this work as part of her doctoral thesis while based at the Imperial Cancer Research Fund, Cancer Epidemiology Unit in Oxford.