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

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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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The suggestion that childhood leukaemia, specifically acute leukaemia, may have an infectious aetiology is not new.[1] [2] In particular, Kinlen[3] 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.[4] To date, most studies on the topic of population mixing and childhood leukaemia have either been ecological[3] [5–15] or based on a few events.[4] [16]

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 underlying 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.[17–22] Paternal occupation was subsequently bridge coded to one of the 223 jobs described in the 1970 classification of occupations[18] 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)[20] 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

Table 1   *Number of childhood* deaths from cancer and leukaemia registered among the offspring of men with potentially high or medium levels of occupational social contact, England and Wales, 1959–63, 1970–8 and 1979–90*

	Deaths (n)	
Paternal occupation description (occupational code) (1970 revision)	Cancer	Leukaemia
High occupational social contact:		
Railway guards (119)	14	6
Drivers of buses, coaches (120)	128	52
Drivers of other road passenger vehicles (121)	92	32
Bus conductors (131)	29	12
Porters, ticket collectors, railway (132)	26	12
Shop salesmen and assistants (144)	129	53
Roundsmen (bread, milk, laundry, soft drinks) (145)	32	13
Street vendors, hawkers (146)	41	16
Garage proprietors (147)	37	16
Salesmen, services, valuers, auctioneers (150)	114	47
Police officers and men (152)	170	64
Guards and related workers NEC (153)	52	19
Publicans, innkeepers (154)	42	13
Barmen (155)	24	11
Proprietors, managers (hotels), stewards (156-158)	17	7
Restaurateurs, waiters, counter hands (159-161)	91	48
Hairdressers (167)	15	8
Hospital or ward orderlies, ambulance men (170)	24	5
Medical practitioners (qualified) (181)	70	27
Dental practitioners (182)	19	5
Nurses (183)	35	12
Medical workers NEC (191)	11	5
University teachers (192)	31	17
Teachers (193,194)	308	120
Clergy, ministers, members of religious orders (213)	28	11
Social welfare and related workers (215)	32	12
Other occupations (186-190)†	11	5
Medium occupational social contact:		
Radio and radar mechanics (24)	36	17
Installers and repairmen, telephone (25)	107	49
Electricians, electrical and electronic fitters (27,28)	285	115
Motor mechanics, auto engineers (41)	123	52
Plumbers, fitters, heating engineers etc (45,46)	181	67
Shoemakers and shoe repairers (61)	13	6
Tailors, dress, light clothing makers (74)	19	10
Butchers and meat cutters (79)	72	28
Painters, decorators NEC (100)	209	77
Postmen, mail sorters (129)	112	45
Messengers (130)	12	7
Clerks, cashiers, office machine operators (139,140)	637	286
Proprietors and managers, sales (143)	447	189
Commercial travellers, manufacturers' agents (148)	232	112
Fire brigade officers and men (151)	57	22
Valets and related service workers (164)	21	9
Office cleaners, window cleaners (166)	43	12
Launderers, dry cleaners, and pressers (168)	13	6
Proprietors and managers, service and recreation (171)	14	8
Service, sport, and recreation workers NEC (172)	47	21
Stage managers, actors, entertainers, etc (207)	25	12
Judges, barristers, advocates, solicitors (214)	47	25
Other occupations (49,185)†	11	5
Total	4385	1828

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

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 χ^2 distribution, or when the number of observed deaths was <10, from the Poisson distribution.[23]

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 (chiropodists 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.
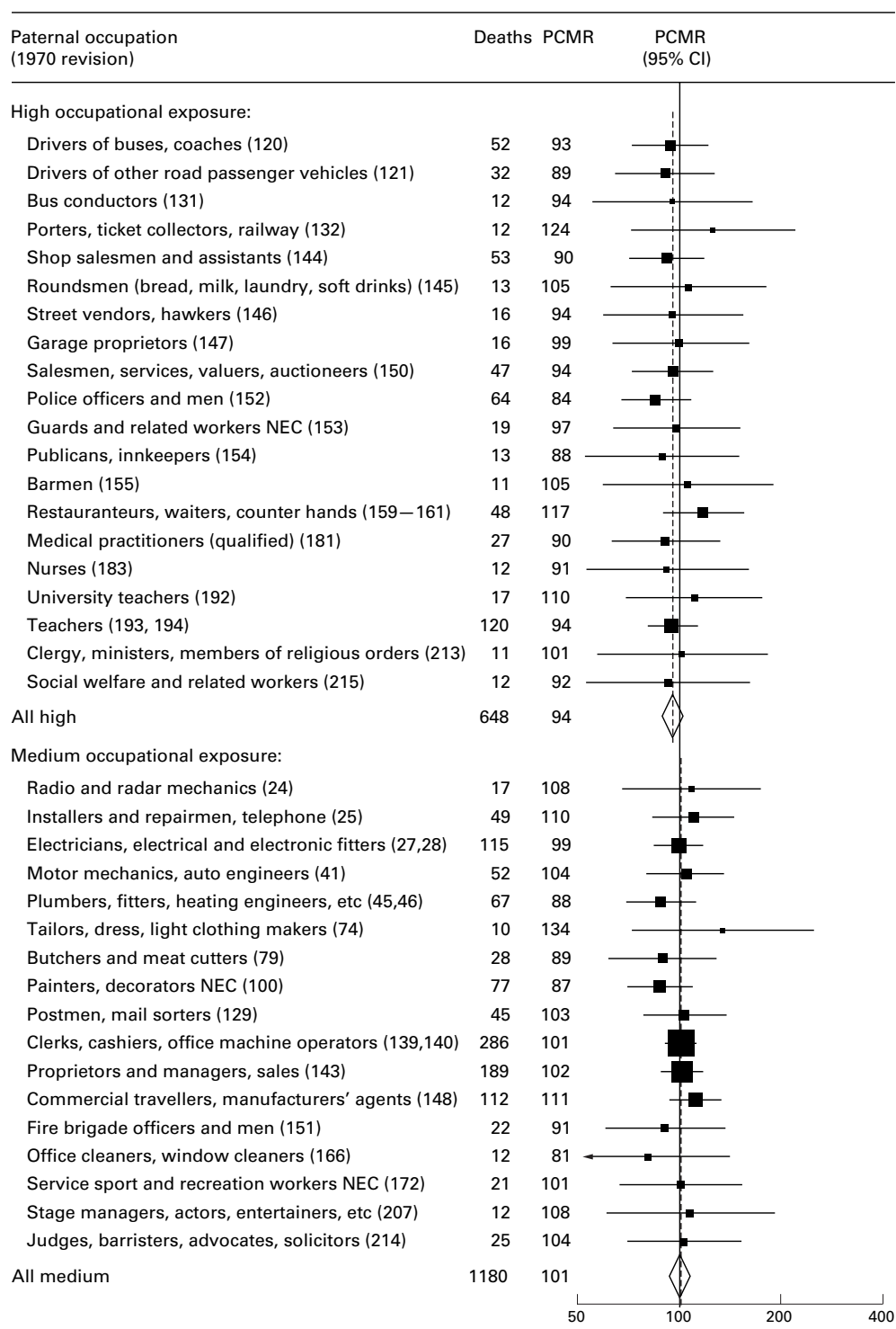
Table 2   *Adjusted proportional cancer mortality ratios (PCMRs)* (95% CIs) for childhood leukaemia deaths† registered among the offspring of men with social contact at work‡, England and Wales, 1959–63, 1970–8, and 1979–90*

	High social contact		Medium social contact		Low social contact	
	Deaths	PCMR* (95% CI)	Deaths	PCMR* (95% CI)	Deaths	PCMR* (95% CI)
All leukaemias (ICD–7:204)	648	94 (87 to 102)	1180	101 (95 to 106)	4062	101 (98 to 104)
Ages (y):						
0–4	212	95 (83 to 108)	426	103 (93 to 113)	1433	100 (95 to 105)
5–14	436	94 (86 to 104)	754	99 (93 to 107)	2629	101 (97 to 105)
Period:						
1959–63	173	101 (87 to 117)	358	98 (89 to 109)	1199	100 (95 to 106)
1970–78	261	90 (80 to 102)	496	102 (94 to 112)	1754	101 (96 to 106)
1979–90	214	95 (83 to 108)	326	100 (90 to 112)	1109	101 (95 to 107)
Subtype:						
Lymphatic leukaemia (ICD–7: 204.0)	321	92 (83 to 103)	565	101 (93 to 109)	1954	101 (97 to 106)
Myeloid leukaemia (ICD–7: 204.1)	137	100 (84 to 118)	209	104 (91 to 119)	716	99 (92 to 106)
Monocytic leukaemia (ICD–7:204.2)	11	75 (42 to 136)	31	109 (76 to 154)	89	101 (82 to 125)
Other and unspecified leukaemia (ICD–7: 204.3–204.9)	179	96 (83 to 112)	375	98 (88 to 108)	1303	101 (96 to 107)

*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.

Paternal occupation (1970 revision)	Deaths	PCMR	PCMR (95% CI)
High occupational exposure:			
Drivers of buses, coaches (120)	52	93	
Drivers of other road passenger vehicles (121)	32	89	
Bus conductors (131)	12	94	
Porters, ticket collectors, railway (132)	12	124	
Shop salesmen and assistants (144)	53	90	
Roundsmen (bread, milk, laundry, soft drinks) (145)	13	105	
Street vendors, hawkers (146)	16	94	
Garage proprietors (147)	16	99	
Salesmen, services, valuers, auctioneers (150)	47	94	
Police officers and men (152)	64	84	
Guards and related workers NEC (153)	19	97	
Publicans, innkeepers (154)	13	88	
Barmen (155)	11	105	
Restauranteurs, waiters, counter hands (159–161)	48	117	
Medical practitioners (qualified) (181)	27	90	
Nurses (183)	12	91	
University teachers (192)	17	110	
Teachers (193, 194)	120	94	
Clergy, ministers, members of religious orders (213)	11	101	
Social welfare and related workers (215)	12	92	
All high	648	94	
Medium occupational exposure:			
Radio and radar mechanics (24)	17	108	
Installers and repairmen, telephone (25)	49	110	
Electricians, electrical and electronic fitters (27,28)	115	99	
Motor mechanics, auto engineers (41)	52	104	
Plumbers, fitters, heating engineers, etc (45,46)	67	88	
Tailors, dress, light clothing makers (74)	10	134	
Butchers and meat cutters (79)	28	89	
Painters, decorators NEC (100)	77	87	
Postmen, mail sorters (129)	45	103	
Clerks, cashiers, office machine operators (139,140)	286	101	
Proprietors and managers, sales (143)	189	102	
Commercial travellers, manufacturers' agents (148)	112	111	
Fire brigade officers and men (151)	22	91	
Office cleaners, window cleaners (166)	12	81	
Service sport and recreation workers NEC (172)	21	101	
Stage managers, actors, entertainers, etc (207)	12	108	
Judges, barristers, advocates, solicitors (214)	25	104	
All medium	1180	101	

scale: 50   100   200   400

PCMR = proportional cancer mortality ratio; NEC = not elsewhere classified.

Number of deaths, adjusted proportional cancer mortality ratios (PCMRs) and 95% confidence intervals (95% CI) for deaths from childhood leukaemia by paternal occupation for those paternal occupations with potentially high or medium levels of social contact. Occupations with <10 deaths from leukaemia have not been presented graphically but have been included in the overall estimates.

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

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[4]), England and Wales, 1959–63, 1970–8, and 1979–90*

	Very high social contact		Medium social contact		Low social contact	
	Deaths	PCMR* (95% CI)	Deaths	PCMR* (95% CI)	Deaths	PCMR* (95% CI)
Leukaemia (204)	137	96 (81 to 113)	2298	99 (95 to 104)	3455	101 (97 to 104)
Lymphatic leukaemia (204.0)	75	91 (72 to 114)	11112	98 (93 to 104)	1653	102 (97 to 107)
Myeloid leukaemia (204.1)	32	122 (86 to 172)	438	102 (93 to 112)	592	97 (90 to 106)
Monocytic leukaemia (204.2)	0	—	46	91 (68 to 121)	85	111 (89 to 137)
Other and unspecified leukaemia (204.3–204.9)	30	97 (68 to 139)	702	100 (93 to 107)	1125	100 (95 to 106)

*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.

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.[4]

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).[24][25] 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.[26] 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[4][16] 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 influence of variables such as child's sex and ethnicity could not be examined as this

information was not provided by the Office for National Statistics.

To our knowledge only two, much smaller, studies have published data on childhood leukaemia and parental occupational social contact.[4][16] Both examined data from geographical areas with either higher than average rates of childhood leukaemia or unusual patterns of population mixing. One found no evidence of an association with either paternal or maternal occupational social contact[16] whereas the other reported a significant positive trend (p<0.001) with increasing levels of paternal occupational social contact (adjusted observed to expected ratios of 1.00, 1.75, and 2.17 for medium and low, high, and very high paternal occupational social contact, respectively).[4] This study was based on the re-analysis of five previously published studies.[5][7–9][11] It was unclear what factors were taken into account in the adjustment procedures and it is possible that Kinlen's findings reflect residual confounding by social class or some other factor.

No significant associations were found when data were analysed for the whole of England and Wales for a 26 year period (as shown here) or when a small subset of these data (1970–2) were analysed by rural or urban status.[4] Exclusion of deaths occurring in 1970–2 from the analyses presented here had no effect on the results (data not shown). The data presented here could not be used to examine geographical patterns but it may be possible to do so with data from the United Kingdom childhood cancer study (UKCCS). This is a collaborative case-control study based on several thousand incident cases of childhood cancer diagnosed before 15 years of age within the United Kingdom.

The occupational groupings used in the studies by Roman *et al*[16] and Kinlen[4] 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[4] (table 3). The main difference between Kinlen's classification (which was based on the 1960 classification of occupations[17]) and the one used here, relates to the inclusion of additional occupations in the high social contact group—such as certain administrators and managers, construction workers, the armed forces, and certain transport workers. Kinlen also created a very high social contact group that consisted of occupations involving frequent contact with

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.[4]

Kinlen's hypothesis[4] 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 2] 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.

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