PAPERS

Residence near high voltage facilities and risk of cancer in children

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Abstract

Objective—To investigate whether residence before and after birth near 50 Hz high voltage installations increases a child's risk of cancer and whether risk correlates with the strength of the magnetic field.

Design—A population based case-control study.

Setting—Denmark.

Subjects—1707 children under the age of 15 with leukaemia, tumour of the central nervous system, or malignant lymphoma diagnosed in 1968-86 and 4788 children taken from the central population register.

Main outcome measures—Proximity before and after birth to existing or former 50-400 kV electrical transmission connections and substations and associated historical electromagnetic fields calculated on the basis of current load on line, phase ordering of line, and distance from the dwelling.

Results—A significant association was seen between all major types of childhood cancer combined and exposure to magnetic fields from high voltage installations of $\geq 0{\cdot}4$ μT (odds ratio 5·6). At $\geq 0{\cdot}25$ μT no significant association was seen (odds ratio 1·5). A possible association was also seen with cases of Hodgkin's disease separately at $\geq 0{\cdot}1$ μT.

Conclusions—On the basis these results and additional descriptive data on electricity consumption and incidence of childhood cancer in Denmark since the 1940s it was concluded that the proportion of childhood cancer possibly caused by 50 Hz electromagnetic fields must be small.

Introduction

Living near to electric power lines and other high voltage installations has been associated in some studies with an increased risk of cancer in childhood.[1-6] In at least two other studies, however, no such association was seen.[7 8] Extremely low frequency (50-60 Hz) electromagnetic fields from such installations have been implicated as a causal risk factor, although no evidence of a biological link exists.

All inhabitants of Denmark and similar countries are exposed to some extent to magnetic fields in the 50 Hz range. People who live close to certain types of high voltage installations may, however, be exposed to levels 10-20 times above the average.[9] We investigated in a well defined population whether residence before and after birth near high voltage installations increases a child's risk of developing cancer and whether the risk correlates with the strength of the magnetic field. We also describe general trends in electricity consumption in the country and of the incidence of childhood cancer since the 1940s.

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BMJ 1993;307:891-5

Subjects and methods

SUBJECTS

The subjects comprised 1707 children newly diagnosed as having leukaemia, tumour of the central nervous system, or malignant lymphoma during the period from 1 April 1968 to 31 December 1986 who were under 15 years old at time of diagnosis (table I). These types of tumour make up 65% of all reportable neoplasms in childhood in Denmark.[11] They were identified from the files of the Danish cancer registry, which provided the name, sex, and unique identity number. This nationwide cancer registration system, which was set up in 1942, has been described and evaluated in previous publications on cancers in adults[12] and in children.[11] The register also includes histologically benign tumours of the brain and intracranial meninges.

Controls were drawn from the files of the Danish central population register, established in Denmark on 1 April 1968, and were identified by name, sex, and identity number. Two to five controls (table I) were selected at random from among people who had survived without cancer until the date of diagnosis of the case but matched for sex and date of birth (within one year). A total of 4788 children were included as controls.

TABLE I—*Cases of childhood cancer diagnosed in Denmark, 1968-86, and matched controls*

Main diagnostic group*	Cases	Controls	Total	Cases:controls
Leukaemias	833	1666	2499	1:2
Central nervous system neoplasms	624	1872	2496	1:3
Lymphomas and other reticuloendothelial neoplasms	250	1250	1500	1:5
All types combined	1707	4788	6495	

*Based on the International Classification of Diseases for Oncology (ICD-O)[18]

Parents of cases and controls were identified through the files of the central population register.[13] The residential histories of each family were ascertained retrospectively from the date of diagnosis of cancer or a similar date for the matched control children (referred to in the following as date of diagnosis) to nine months before the child's birth. Addresses were provided jointly by the central population registry and the 276 local population registries of Denmark. Each location was identified according to parish, postal code, street, building number, floor, and side of the building. The families were not approached directly.

PROXIMITY TO HIGH VOLTAGE FACILITIES

Each address was checked by trained representatives of the local divisions of the Danish electric utilities against detailed typographical maps of existing or former 50-400 kV transmission connections (overhead lines and underground cables) and associated substations in Denmark. All dwellings were categorised according to predefined criteria for distance from the installation (table II). The criteria used to delineate the area of potential exposure ensured that all dwellings with an exposure to magnetic fields of at least 0·1 μT (tesla (T) is magnetic flux density (kg/s²/A); 1 μT = 10

TABLE II—*Distance criteria for grouping dwellings into area of potential exposure to magnetic fields (from high voltage facility) and view distant area. Minimum distance between dwelling and mid-trace line are used*

	Potential exposure area*						View distant area†			
	Overhead lines		Transformer substations		Underground cables		Overhead lines		Transformer substations	
Exposure (kV)	Distance (m)	No of dwellings	Distance (m)	No of dwellings	Distance (m)	No of dwellings	Distance (m)	No of dwellings	Distance (m)	No of dwellings
220-440	≤150	2	<150	0	<20	0	151-300	8	151-300	0
132-150	≤75	28	≤75	0	≤5	1	76-150	23	76-150	3
50-60	≤35	22	≤35	1	≤2·5	3	36-75	29	36-75	3

*Area in which exposures from installations of ≥0·1 μT are likely. †Area in which exposures from installations are <0·1 μT.

milligauss (mG)) would be included (57 dwellings occupied by 55 children). The area classified as view distant covered dwellings close to overhead power lines but not exposed to any measurable extent (66 dwellings occupied by 65 children; table II). These families were assumed to be of the same socioeconomic composition as those in the area of potential exposure.

EXPOSURE ASSESSMENT

We defined exposure as the magnetic field strength that originates from transmission overhead lines, transmission cables, and substations (50-400 kV).

For all dwellings located outside the potential exposure area the magnetic field strength from high voltage facilities was assumed to be zero. For dwellings located inside that area historical magnetic field strengths were determined by using a magnetic field programme developed by the Jutland-Funen Electricity Collaboration.[14] The data necessary for accurate calculation of field strengths at the dwelling included the distance between the dwelling and the installation, the category of line, type of pylons (height of pylons, distance between pylons, distance between phases), ordering of phases, current flow in the line, and date(s) of construction and any reconstructions. The flow of current was determined as the average flow over a full calendar year. As the load in individual installations was not registered systematically in the past all such information was in the form of estimates by people experienced in the planning and operation of the Danish transmission system (J K Jensen and E Folkersen, 1st world congress for electricity and magnetism in biology and medicine, Florida, 1992). The child was considered to have been exposed to the average magnetic field strength calculated at the dwelling for as long as the family occupied the address.

TABLE III—*Descriptive characteristics of cases and controls*

Characteristic	No (%) of cases	No (%) of controls
No	1707 (100)	4788 (100)
No of mothers	1687 (99)	4773 (100)
No of fathers	1601 (94)	4591 (96)
Proportion of residential histories traced	(99·2)	(99·0)
No of addresses before diagnosis:		
1	657 (38)	1663 (35)
2	452 (26)	1253 (26)
3	266 (16)	801 (17)
4	148 (9)	464 (10)
5	80 (5)	267 (6)
≥6	104 (6)	340 (6)
Socioeconomic group*:		
I	145 (8)	440 (9)
II	113 (7)	351 (7)
III	323 (19)	908 (19)
IV	630 (37)	1746 (37)
V	291 (17)	852 (18)
Unclassifiable	38 (2)	107 (2)
Occupation not given	167 (10)	384 (8)
Degree of urbanisation†:		
Large towns	571 (33)	1533 (32)
Suburbs	545 (32)	1558 (33)
Small towns	221 (13)	666 (14)
Rural areas	366 (22)	1018 (21)
Unknown	4 (<1)	13 (<1)
Category of location of dwelling:		
Potential exposure area	14 (0·82)	41 (0·86)
View distant area	16 (0·94)	49 (1·02)
Outside	1677 (98·2)	4698 (98·1)
Distance from high voltage facility:		
Potential exposure area:		
<20 m	5 (0·29)	13 (0·27)
20-39 m	5 (0·29)	16 (0·33)
≥40 m	4 (0·23)	12 (0·25)
Other dwellings	1693 (99·2)	4747 (99·1)

*On basis of father's occupation.
†Address of child in area of highest population density.

TABLE IV—*Adjusted odds ratios and 95% confidence intervals for leukaemia, tumours of central nervous system, malignant lymphoma, and three tumour types combined among children with exposure to magnetic field strengths from high voltage facilities of at least 0·1, 0·25, and 0·4 μT*

Type of cancer	No of cases	No of controls	Odds ratio (95% confidence interval
Combined group:			
Not exposed*	1677	4698	1
Not exposed, view distant	16	49	0·9 (0·5 to 1·6)
Exposed, <0·10 μT	4	21	0·6 (0·2 to 17)
Exposed, ≥0·10 μT	10	20	1·4 (0·7 to 3·0)
Exposed:			
0·10-0·24 μT	4	9	1·3 (0·4 to 4·1)
≥0·25 μT	6	11	1·5 (0·6 to 4·1)
0·10-0·39 μT	4	17	0·7 (0·2 to 2·0)
≥0·40 μT	6	3	5·6 (1·6 to 19‡)
Leukaemia:			
Not exposed†	829	1658	1
Exposed, ≥0·10 μT	4	8	1·0 (0·3 to 3·3)
Exposed:			
0·10-0·24 μT	1	4	0·5 (0·1 to 4·3)
≥0·25 μT	3	4	1·5 (0·3 to 6·7)
0·10-0·39 μT	1	7	0·3 (0·0 to 2·0)
≥0·40 μT	3	1	6·0 (0·8 to 44‡)
Tumours of central nervous system:			
Not exposed†	621	1863	1
Exposed ≥0·10 μT	3	9	1·0 (0·3 to 3·7)
Exposed:			
0·10-0·24 μT	1	3	1·0 (0·1 to 9·6)
≥0·25 μT	2	6	1·0 (0·2 to 5·0)
0·10-0·39 μT	1	8	0·4 (0·1 to 2·8)
≥0·40 μT	2	1	6·0 (0·7 to 44‡)
Malignant lymphoma:			
Not exposed†	247	1247	1
Exposed, ≥0·10 μT	3	3	5·0 (1·0 to 25§)
Exposed:			
0·10-0·24 μT	2	2	5·0 (0·7 to 36)
≥0·25 μT	1	1	5·0 (0·3 to 82)
0·10-0·39 μT	2	2	5·0 (0·7 to 36)
≥0·40 μT	1	1	5·0 (0·3 to 82‡)

*Children who had always lived outside potential exposure area and view distant area.
†Includes children from potential exposure area exposed to less than 0·1 μT.
‡Confidence intervals for risk estimates are unadjusted for multiple testing.
§Exact but unadjusted = 0·7 to 38.

ANALYSIS

The basic measure of exposure was the average magnetic field levels generated from a high voltage installation to which the child was ever exposed. The lower cut off point of the average was set at 0·1 μT because values below that do not clearly outweigh the combined exposure to 50 Hz magnetic fields from other sources in and around a house.[9] An intermediate cut off point was chosen as 0·25 μT. Analyses were done for all types of tumour combined and for the main diagnostic groups separately. Exposure rates within the main groups of cases were compare with the rates in the corresponding matched control groups in all tests. In addition, the cumulative dose of magnetic fields ever received by a child was obtained by multiplying the number of months exposed by the average level of magnetic field at the residence (μT-months).

Odds ratios and 95% confidence intervals were

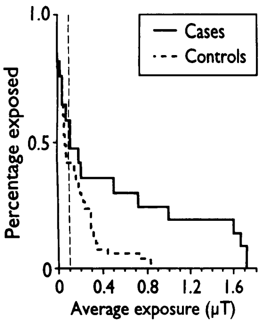

FIG 1—*One minus empirical distribution functions for average magnetic field strength from high voltage installations ever received at home by cases and controls; each line specifies proportion of cases and controls who ever received stated average field strength or more in range 0-1·8 μT*

derived by logistic regression analysis after adjustment for sex, age at diagnosis, and the three types of tumour. For rare events odds ratios and relative risks are effectively identical.[15] Because of the skewed distribution of exposure exact methods for logistic regression were also applied, but the results of logistic regression could not be adjusted for the matching criteria because of numerical problems and are given only if they depart from the results of the adjusted analysis.

Finally, an odds ratio function for the exposure to the average magnetic fields with a step wise increase in the cut off point of exposure from 0·1 to 0·8 μT was established. To adjust for multiple testing in this procedure the corrected p value was derived according to the method of Lausen and Schumacher.[16] Analyses were performed with the SAS system, version 6.07, EGRET, and LogXact.

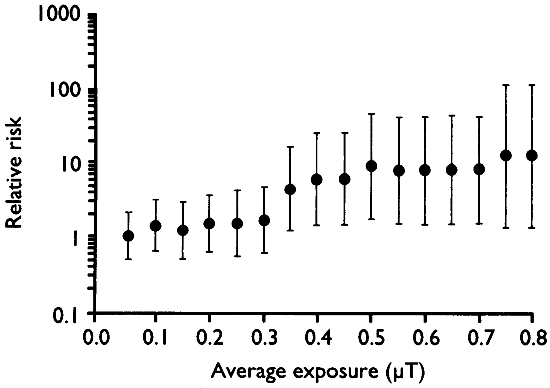

FIG 2—*Odds ratios (95% confidence intervals) for cancer (all three types combined) estimated by odds ratio function with step wise increases in exposure cut off points from 0·1 to 0·8 μT*

Results

At least one parent was identified for each case and for all but two controls, giving a total of 6460 mothers (99·5%) and 6192 fathers (95·3%). Because of multiple changes of address by several families information was collected on 16 420 different locations in which the children had lived during the relevant period, accounting for 99·1% of the sum of tracing periods for all study members—that is, from conception until date of diagnosis. Table III gives the distributions of some characteristics of cases and controls.

Figure 1 shows the proportions of cases and controls who had ever received a stated strength of average magnetic field (generated from a high voltage installation) or above before the date of diagnosis; cases were in general exposed to higher levels than controls.

Table IV gives the adjusted odds ratios and the corresponding 95% confidence intervals for the three main diagnostic groups combined and separately. For the qualitative grouping of children into ever (⩾0·1 μT) *v* never exposed no deviation in risk was seen for either leukaemia (odds ratio = 1·0) or tumours of the central nervous system (1·0), but an increased risk was seen for malignant lymphomas (5·0). At ⩾0·25 μT the risk of leukaemia was increased (1·5; non-significant) whereas the risks of tumours of the central nervous system and lymphoma remained unchanged (1·0 and 5·0, respectively). For the combined group a non-significantly increased risk of 1·4 was observed for exposures above 0·1 μT and of 1·5 for exposures above 0·25 μT. The odds ratio for all three tumour types combined for children in the view distant area was close to unity (0·9). Table V gives further details on the 10 cases with an average exposure of at least 0·1 μT from a high voltage installation. The three cases of lymphoma among the exposed children belonged to the subgroup of Hodgkin's disease, which makes up about 30% of lymphomas in children aged 0-14 years in Denmark. The duration of exposure of the 20 exposed controls ranged from two months to 10 years.

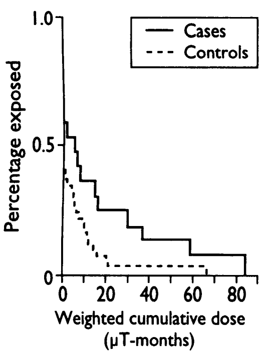

FIG 3—*Empirical distribution functions for cumulative dose of magnetic fields (μT-months) for cases and controls who had ever received stated cumulative dose or more in range 0-90 μT-months*

Figure 2 gives the odds ratio function for the types of tumour combined and shows that the odds ratio increased when cut off points of 0·3-0·4 μT were used. Furthermore, the odds ratios remained significantly raised at cut off points above 0·3-0·4 μT. The lowest p value was observed for the cut off point 0·5 μT (p = 0·02, adjusted for multiple testing). On the basis of this function of the odds ratio a cut off point of 0·4 μT was chosen, above which the risk was raised for each of the tumour types included (see table IV); however, the numbers of exposed cases and controls are small, and the observed increases do not reach significance except for the combined group of tumours (odds ratio 5·6).

Children under 1 year at the onset of exposure to ⩾0·25 μT had a higher risk of cancer (odds ratio 3·4; 95% confidence interval 0·9 to 13) than children first exposed at a later age (0·4; 0·0 to 3·0). No variation in risk was seen with latent period (time between onset of exposure and diagnosis) or with a period free of exposure immediately before diagnosis.

The distribution functions of cumulative doses of magnetic fields (μT-months) among cases and controls are shown in figure 3. Higher doses were generally found among cases than among controls. The dose category above 9·7 μT-months (median exposure value among exposed), however, was not significantly associated with an increase in risk (1·8; 0·6 to 4·5).

No association was observed between the distance of a child's residence from a high voltage installation and the risk of cancer (see table III).

All analyses were repeated after inclusion of data on population density, socioeconomic class, and family's mobility to adjust for potential confounding effects. No effect on the risk estimates was observed which would change the results.

ELECTRICITY USE AND CHILDHOOD CANCER

Figure 4 shows the radical changes in electricity consumption since 1945 and the concurrent changes in the incidence of childhood cancer and of leukaemia in particular. While electricity consumption in Denmark has increased 30-fold over this time, incidence rates of cancer have changed hardly at all.

Discussion

Our main findings were that exposures in the order of 0·4 μT (chosen empirically) of density of magnetic

TABLE V—*Magnetic field levels and time sequences of exposure and tumour diagnosis among cases exposed to average density of 0·1 μT or more*

Case No	Tumour diagnosis	Average magnetic field level (μT)	Age at onset of exposure (years, months)	Period of exposure* (years, months)	Age at diagnosis (years, months)	Latent period (years, months)	Exposure free period (years, months)
1	Acute lymphatic leukaemia	1·72	Conception	3,5	2,8	3,5	None
2	Acute lymphatic leukaemia	1·66	0,6	2,3	3,1	2,7	0,4
3	Acute lymphatic leukaemia	0·51	1,10	3,3	5,1	3,3	None
4	Stem cell leukaemia	0·12	Conception	4,9	4,0	4,9	None
5	Hodgkin's disease	0·20	Conception	0,11	11,4	12,1	11,2
6	Hodgkin's disease	0·73	0,0	0,11	9,9	9,9	8,10
7	Hodgkin's disease	0·21	2,9	9,11	12,8	9,11	None
8	Medulloblastoma	1·00	Conception	3,0	3,3	4,0	1,0
9	Medulloblastoma	0·12	1,7	7,11	13,1	11,6	3,7
10	Malignant glioma	1·59	Conception	5,6	4,9	5,6	None

*Includes exposures during fetal life.

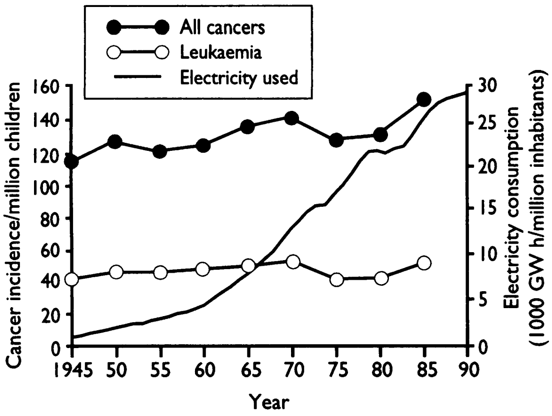

FIG 4—*Electricity consumption in Denmark, 1943-90, per one million inhabitants and incidences of childhood cancer and leukaemia, 1943-86, per one million children aged 0-14 years*

fields from high voltage installations increase the risk for all three tumour types combined and that exposures of at least 0·1 μT increase the risk for malignant lymphoma separately. The risk estimates, however, were based on only nine and six exposed children, respectively, and are therefore highly unstable, as reflected in the size of the associated 95% confidence intervals (table IV). Higher cumulative doses of magnetic fields (μT-months) were found among cases compared with controls, but the difference was smaller (non-significant) than for the density of magnetic fields. This result contrasts with what might be expected—that is, that the exposure accumulated over a lifetime would be the most important determinant of risk. No significant association was seen, however, between all major types of childhood cancer combined and exposure to magnetic fields of defined average density of 0·25 μT or more (defined at the beginning of the study).

Our cases were drawn from a high quality national cancer registry and controls were taken at random from a complete list of people in Denmark and were thus unselected. Residential histories were known from the time of conception until date of diagnosis. The records were assembled without knowledge of the child's status as case or control and were completed before notification of the cases, implying that any observational or recall bias is unlikely.

CONFOUNDING

If the positive associations were caused by confounding, the observation of no significant link between distance of dwelling from the source of electromagnetic fields and risk of cancer indicates that any unknown confounder would be one that correlates better with the level of the field generated from the power lines than with inverse distance to the line. Few risk factors for childhood cancer have been described—for instance, ionising radiation and certain rare genetic diseases—and none is suspected to be more prevalent in families living near high voltage installations than in other families. Socioeconomic class, traffic density at place of residence, and air pollution are suspected risk factors; however, neither socioeconomic class nor population density in the area of residence varied between cases and controls (table III). The distribution of cases and controls by number of changes of address was nearly the same.

OTHER STUDIES

A recent survey has shown that the average domestic exposure to 50 Hz magnetic fields in Danish dwellings distant from high voltage installations is 0·06 μT.[9] The survey also indicated, however, that field levels from all electric installations of 0·1 μT or higher are prevalent inside about 15% of normal dwellings. This implies that our results, which are based on the lower limit of 0·1 μT for fields generated from power lines, may be influenced by a considerable degree of misclassification of the exposure variable, which, however, gradually diminishes as higher cut off points—for example, 0·25 and 0·40 μT—are used. Any such misclassification of exposure would tend to bias the estimated odds ratio towards 1·0[17]; in our study such bias would mean that the true odds ratios were underestimated, particularly at the lower end of the exposure range.

In 1979 Wertheimer and Leeper first reported an association between the wire configurations at children's homes and the risk for cancer.[1] They observed a twofold to threefold increase in risk of childhood cancers combined and of leukaemia, lymphoma, and tumours of the central nervous system separately in children from homes with "high current configurations" above that in children from homes with "low current configurations." At least seven other studies have investigated the relation between electromagnetic fields from power lines and other domestic electrical wiring and childhood cancer.[2-8] Most of these were summarised in a meta-analysis by the United Kingdom's national radiological protection board.[18] For the studies that included a classification of domestic and nearby wire configurations[3 4 7] the meta-analysis showed a closer and more general association with childhood cancers than did the analysis of the studies that included direct measurements close to or inside the residence.[2-4] That a surrogate measure of magnetic field strength seems to be more strongly associated with risk of cancer than measured fields may give rise to concern. Wire configurations may be a better estimate of historical exposure to magnetic fields originating from high voltage installations than direct measurements at a single, recent point in time. Biases in the studies that were included in the meta-analysis, however, may be another explanation for the observed associations. In most of the studies which found an association the method of control selection tended to result in controls who had had fewer changes of address than cases,[2-4] suggesting that controls were selected from among a subset of people who were more content than average with their place of residence and possibly with a smaller chance of living near a high voltage installation. This would result in overestimates of the odds ratio for cancer.

Although such biases in selection of controls is overcome in our study we also found indications of a link between exposure to magnetic fields and childhood cancer.

In a recent study from Sweden a significant 2·7-fold increase in risk of leukaemia was observed in relation to calculated historical fields closest in time to the diagnosis of 0·2 μT or more.[5] Their results, however, are not fully compatible with ours. Firstly, the main effect in our study was not on leukaemia separately but rather on the mixed group of leukaemia, tumours of the central nervous system, and lymphoma; and the effect was not at an exposure of 0·2 μT or more but at 0·3-0·4 μT and higher. Secondly, any effect of lower exposures that can be discriminated from random variation in our study concerns malignant lymphoma rather than leukaemia. A confusion of the diagnosis of lymphomas and acute lymphatic leukaemia in the two studies is unlikely as the three cases of lymphoma among exposed children in our study belonged to the well defined subgroup of Hodgkin's disease.

CONCLUSIONS

In conclusion, we observed a positive association between all major types of childhood cancer combined and exposure to an empirically defined average density of 0·4 μT or more of magnetic fields from high voltage installations. At 0·25 μT or more, however, chosen before the study, no significant association was seen. A possible association was also seen with malignant

Public health implications

- Children living near high voltage installations have above normal exposure to electromagnetic fields in the 50 Hz range
- About 0·5% of Danish children are exposed to measurable levels from such installations
- A positive association was observed in this study between all major types of childhood cancer combined and exposure to average magnetic field strengths of 0·3-0·4 μT or more, which were measured in distances of up to 50 metres from an overhead power line
- Data indicate that the proportion of childhood cancers caused by electromagnetic fields must be small
- A possible biological mechanism behind the observed associations still needs to be determined

lymphoma separately at 0·1 μT or more; the subgroup most affected was children with Hodgkin's disease, which is not normally regarded as being aetiologically related to childhood leukaemias. If the observed associations are causal, as indicated by the case-control analysis, descriptive data on electricity consumption and incidence of childhood cancer in the national population indicate that the aetiological fraction must be small. It may be that severe exposure occurs only rarely—for example, in infants and small children residing near powerful, high voltage installations who have prolonged, uniform exposure to electromagnetic fields in the 50 Hz range. It must be kept in mind, however, that no agreement has yet been reached on any cellular process that would induce or facilitate a carcinogenic response to extremely low energy fields.

We thank Jytte Kaad Jensen and Erik Folkersen for help in assessing exposure; Andrea Bautz and Visti Larsen for help with computing; and Jørgen Skotte for measuring electromagnetic field strengths.

This study was funded by the Danish Cancer Society and the Association of Danish Electric Utilities.

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(Accepted 20 July 1993)

Risk of cancer in Finnish children living close to power lines

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BMJ 1993;307:895-9

Abstract

***Objective*—To investigate the risk of cancer in children living close to overhead power lines with magnetic fields of ⩾0·01 microteslas (μT).**

***Design*—Cohort study.**

***Setting*—The whole of Finland.**

***Subjects*—68 300 boys and 66 500 girls aged 0-19 years living during 1970-89 within 500 m of overhead power lines of 110-400 kV in magnetic fields calculated to be ⩾0·01 μT. Subjects were identified by record linkages of nationwide registers.**

***Main outcome measures*—Numbers of observed cases in follow up for cancer and standardised incidence ratios for all cancers and particularly for nervous system tumours, leukaemia, and lymphoma.**

***Results*—In the whole cohort 140 cases of cancer were observed (145 expected; standardised incidence ratio 0·97, 95% confidence interval 0·81 to 1·1). No statistically significant increases in all cancers and in leukaemia and lymphoma were found in children at any exposure level. A statistically significant excess of nervous system tumours was found in boys (but not in girls) who were exposed to magnetic fields of ⩾0·20 μT or cumulative exposure of ⩾0·40 μT years.**

***Conclusions*—Residential magnetic fields of transmission power lines do not constitute a major public health problem regarding childhood cancer. The small numbers do not allow further conclusions about the risk of cancer in stronger magnetic fields.**

Introduction

The possible carcinogenic effect of electric power lines was raised in the late 1970s when an epidemiological study reported a twofold to threefold risk for childhood cancer close to power lines.[1] Magnetic fields have been regarded as the possible causative agent because, unlike electric fields, they penetrate normal building materials.

In residential surroundings one of the sources of extremely low frequency magnetic fields is the power lines used for transmission (high voltage power lines) or distribution of electricity. Other sources of magnetic fields at home include wiring and grounding systems within the buildings as well as various electrical appliances.

Since the original report seven other case-control studies have been published on the risk of cancer in children living close to power lines or exposed to residential magnetic fields.[2-8] Altogether four of six studies on overall cancer risk in children found some