Risk of selected birth defects by maternal residence close to power lines during pregnancy

K G Blaasaas, T Tynes, R T Lie

Aims: To evaluate selected birth outcomes from a published Norwegian cohort study in a nested case-control design with improved exposure data.

Methods: Two controls matched for sex, year of birth, and municipality were selected randomly for children with the following defects: central nervous system (CNS) defects, cardiac defects, respiratory system defects, oesophageal defects, and clubfoot. The distances between maternal addresses, during pregnancy, and power lines were obtained from maps mainly of scale 1:5000. The magnetic fields in the residences were estimated based on distance, current, voltage, and configuration.

Results: The highest increased risks were seen for hydrocephalus (OR 1.73, 95% CI 0.26 to 11.64) and for cardiac defects (OR 1.54, 95% CI 0.89 to 2.68).

Conclusion: This study does not support the hypothesis that residential exposure to electromagnetic fields from power lines causes any of the investigated outcomes.

Several studies of possible effects of low frequency electromagnetic fields on human health have been carried out. Most attention has been given to the occurrence of cancer. A number of studies regarding reproductive outcomes have been reviewed by Robert, but represent no convincing evidence that electromagnetic field exposure of pregnant women or their partners is associated with reproductive outcomes. Two recent studies from California suggest an effect of maximum field exposure on the risk of fetal loss. However, most previous studies are quite small and would not have enough statistical power to detect effects on risks of specific birth defects. Animal models do not indicate that low frequency electromagnetic field exposure has serious reproductive effects.

In an earlier Norwegian study of reproductive outcomes among workers in occupations exposed to 50 Hz magnetic fields, increased risks of selected central nervous system defects were found. Indications of increased risks of clubfoot and respiratory system defects were also seen. Another cohort study indicated an increased risk of oesophageal defects and reduced risks of cardiac and respiratory defects among children whose mothers lived close to power lines during pregnancy, but no effects were seen on the risk of neural tube defects. This study was based on distance measured through geographical information systems (GIS). However, a study comparing GIS based distance measurements and measurements made on maps mainly of scale 1:5000 and on site measurements showed that map based distances correlated better with on site measures than GIS based data. Based on this fact, we have assessed the risk of central nervous system defects, clubfoot, oesophageal defects, cardiac defects, and respiratory system defects by maternal residential exposure to magnetic fields from power lines in a nested case-control study within the previously reported cohort. Our motivation for choosing these sites was the findings in the two previous Norwegian cohort studies. In the present study we used data based on measurements on maps, mainly of scale 1:5000, to determine distances between Norwegian residences and power lines and to calculate the magnetic fields in the houses.

METHOD

The Medical Birth Registry of Norway comprises all Norwegian births with at least 16 weeks of gestation. Notification is compulsory, and is performed by midwives within the first week after birth. Any diagnosis available at that time should be reported. We used the registry as our source of ascertainment. Since the registry only captures diagnoses within the first week after birth, ascertainment is assumed to be poorer for internal defects such as cardiac defects than for external defects like spina bifida with an estimated ascertainment of 80%.

The birth defects included in the analyses were: central nervous system (CNS) defects, cardiac defects, respiratory system defects, oesophageal defects, and clubfoot. These outcomes were selected based on results of earlier investigations regarding magnetic fields and reproductive outcomes. Children could be registered with up to three different types of malformations. We did not consider multiple defects as a separate category. However, when considering spina bifida and hydrocephalus, those with a recorded anencephalus were not included. Similarly, children with hydrocephalus in combination with spina bifida were not counted as hydrocephalus cases.

The Norwegian person identification number is recorded for child and mother of all births in the registry. Through the mothers’ personal identification numbers, Statistics Norway identified all mothers registered in the Medical Birth Registry of Norway who had lived in a corridor around each power line, broad enough to include all potentially exposed houses, on 1 January 1980 or later. The corridor ranged from 25 m on each side of a 25 kV line to 300 m on each side of a 420 kV line. In the period 1986 to 1997, exact new addresses were updated on 1 January annually. Due to the lack of exact address information in the period 1981 to 1985, births during this period were excluded. A woman entered the cohort the first year she was registered in a residence within the corridor and left when she moved out. The child was regarded as exposed if the mother lived in an exposed residence for more than half the pregnancy.

For every child in the corridor registered in The Medical Birth Registry of Norway with one of the defects to be included in the analyses, born in 1980 or between 1 January 1986 and 31 August 1997, two controls matched for sex, year of birth, and municipality were selected randomly. The

Abbreviations: GIS, geographical information systems; CNS, central nervous system
Main messages

- The Medical Birth Registry of Norway provides a good opportunity to evaluate birth outcomes in offspring of mothers residing near high voltage power lines.
- Residential exposure to magnetic fields had no impact on the outcomes evaluated.

Policy implications

- The present results do not call for any efforts towards mothers living close to power lines.

Comparing these results with our findings in the earlier residential cohort study, the excess risk of oesophageal defects and the reduced risks of cardiac and respiratory defects was not reproduced in the present study. Neither do the present results support earlier findings regarding maternal occupational exposure and birth defects.

For spina bifida, oesophageal defects, and clubfoot there is a shift from increased to decreased risk, in the present study compared to the previous residential cohort investigation, although only the risk of oesophageal defect was significant in the previous study. For hydrocephalus and cardiac defects we observed a shift from decreased to increased risk, significant only for cardiac defects in the previous study. For respiratory system defects, the reduced risk was closer to unity compared to the previous study. The distance measurements in this study are more accurate than in the previous study. We therefore consider the results in this study more reliable.

Information of the mothers' addresses only once a year in the study period was one important limitation in this study. Another critical problem was the limited number of cases and subsequent limited statistical power.

Residential exposure based on calculated magnetic fields from power lines only with no personal measurements, may have introduced some exposure misclassification, but a previous dosimeter study among children living close to a power line in Norway, showed that the magnetic fields from the line is the major source of exposure. The case for adults too. In comparison with other countries, like Sweden, the contribution of ground currents to magnetic fields in homes is minor in Norway because of a different grounding system.

The Norwegian birth registry only includes birth defects identified at the maternity ward in the hospital during the first week after birth. The majority of birth defects are probably detected shortly after birth. However, defects diagnosed later, such as cardiac defects, are less likely to be detected and might therefore be seriously underreported in the registry.

In the present population based, nested case-control study, we took advantage of the population registration system in Norway. Furthermore, by defining the study population as adults who had lived in geographical areas crossed by high voltage power lines, we could assume these lines to be the main source of exposure. The design made it possible to

<table>
<thead>
<tr>
<th>Category of birth defects</th>
<th>Crude</th>
<th>Adjusted*</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>No. cases</td>
<td>OR</td>
</tr>
<tr>
<td>All CNS defects</td>
<td>51</td>
<td>0.87</td>
</tr>
<tr>
<td>Anencephalus</td>
<td>13</td>
<td>1.00</td>
</tr>
<tr>
<td>Spina bifida</td>
<td>19</td>
<td>0.43</td>
</tr>
<tr>
<td>Hydrocephalus</td>
<td>14</td>
<td>1.88</td>
</tr>
<tr>
<td>Cardiac defects</td>
<td>103</td>
<td>1.54</td>
</tr>
<tr>
<td>Respiratory system defects</td>
<td>40</td>
<td>0.84</td>
</tr>
<tr>
<td>Oesophageal defects</td>
<td>40</td>
<td>0.84</td>
</tr>
<tr>
<td>Clubfoot</td>
<td>270</td>
<td>0.84</td>
</tr>
</tbody>
</table>

*Adjusted for highest family educational level and mother's age.
control for factors associated with area of residence and socioeconomic status.

In conclusion, this study does not support the hypothesis that residential exposure to electromagnetic fields from power lines causes any of the investigated outcomes.

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7 Blaasaas KG, Tynes T, Lie RT. Risk of birth defects by residence near power lines; a population-based study. Epidemiology 2003;14:95–8.
8 Blaasaas KG, Tynes T. Comparison of three different ways of measuring distance between residences and high voltage power lines. Bioelectromagnetics 2002;23:288–91.
Occupational exposure of midwives to nitrous oxide on delivery suites

In our opinion, the article “Occupational exposure of midwives to nitrous oxide on delivery suites” is in need of some remarks.

Many years ago, when $N_2O$ in urine was first evaluated, we frequently observed “exceeding concentration of $N_2O$ in urine of exposed and unexposed subjects. The phenomenon was kept under control and disappeared when urine samples were treated with a small quantity of $H_2SO_4$ (0.2 ml). For this reason, we suggested the following. ...” Approximately 10 ml of urine were collected from all the subjects at the end of the exposure period in 120 ml gastight glass vials with airtight plugs. Caps were rapidly replaced in the vials to prevent any significant loss of dissolved anaesthetic. The vials contained 0.2 ml of a strong acid in order to avoid the in vitro production of $N_2O$ (probably due to microbial activity). ...”

Another point we consider very important is that the subjects must void the bladder rapidly in areas known to be free of nitrous oxide, otherwise a significant contamination of samples can occur. In conclusion, we think that among the simple precautions that should be taken to avoid significant errors (avoiding collection of urine samples in places contaminated with $N_2O$, carrying out collection rapidly, and using airtight collection vials in order to avoid any major loss of dissolved anaesthetic), one point should be emphasised in view of its importance: storage of urine before analysis can produce an endogenous formation of $N_2O$ originating from the oxidation processes of the nitrogen compounds present in biological liquids. Experiments performed to study this phenomenon have shown that the process is inhibited if the urine is kept acid. If, as a precaution, a few drops of strong acid are added to each collection vial before urine samples are collected, neof ormation of nitrous oxide will be avoided and the urine samples may then be stored as long as required prior to the analysis.


doi: 10.1136/oem.2003.012534
Comments on article by Koh and Aw

Quoting both dictionary definitions and statutory requirements, Koh and Aw’s education article limits the definition of occupational “health surveillance” to the detection of adverse health effects resulting from occupational exposures. In doing so, they exclude international and national requirements for occupational health and medical surveillance to assess fitness for work.

Looking at the hazard of ionising radiation, international recommendations, European Directives, and UK National Legislation all identify a requirement for surveillance where the primary purpose is an assessment of the individual’s fitness for work. On a more general level, both in the public and in the occupational setting, systems of health surveillance exist for drivers where it is clearly nonsense to suggest that this is aimed at the detection of adverse effects resulting from time behind the wheel. It is therefore suggested that the authors’ conclusion needs to be expanded to identify a requirement for periodical examination of individuals, not only to detect irreversible ill health, but also to assess fitness for work.

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References
4 The Ionising Radiations Regulations 1999 (UK statutory instrument).

BOOK REVIEW

Tolley’s managing stress in the workplace

Carole Spiers (£60.00). Croydon, UK: Lexis-Nexis UK. ISBN 07545-1269-X.

“Not another book about workplace stress”—emanating in this case, from the “stress industry” would be an understandable reaction. Carole Spiers, the author, unequivocally describes herself as an “occupational stress consultant” and head of the Carole Spiers Group: “International Corporate Well-being Consultants”.

She faces up to the implications immediately by asking “Why indeed another book about stress? What makes it different from the others?” Well, this is intended to be practical and user-friendly—a handbook that can sit on your desk and act as a reference manual to be dipped into whenever required. It is aimed primarily at employers, employees, and their representatives rather than occupational health practitioners or researchers; this is not a criticism—many occupational health practitioners will appreciate the way in which the subject of workplace stress is assiduously presented in all its complexity.

Far from being all about the practicalities of managing stress in the workplace, there are chapters which go into some detail about the nature of stress, current legislation, and the health and safety framework in the UK and, to some extent, Europe. Naturally there has to be constant reference to health and safety and employment law but also to civil litigation, and here comes one of the problems: very few cases of work induced stress have in fact been litigated and those that have, have not, in many people’s view, been very typical. Moreover, this is a fast changing field and the useful synopsis of appeal cases heard in 2002 and act as a reference manual to be dipped into whenever required. It is aimed primarily at employers, employees, and their representatives rather than occupational health practitioners or researchers; this is not a criticism—many occupational health practitioners will appreciate the way in which the subject of workplace stress is assiduously presented in all its complexity.

The book does, however, deserve to be “dipped into” because there is a wealth of descriptive material on which to build.

D Snashall

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NOTICE

CORRECTION

With reference to the paper “Risk of selected birth defects by maternal residence close to power lines during pregnancy” (Blaasaa KS, Tynes T, Lie RT. Occup Environ Med 2004;61:174–6), the authors state: “The total number of births inside the specified corridor given as 128 680 in the Results was wrong. We verified, however, that only 42 223 pregnancies were completed on specific addresses inside the corridor. These 42 223 births represented the cohort from which we identified the 465 cases and selected 930 controls. This should have been specified in the paper. The error gave a wrong impression of the prevalence of defects but had no implications for the results of the paper.”

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