



To the Minister of Housing, Spatial Planning and the Environment

Subject : Advisory letter Power lines and Alzheimer's disease
Your reference : -
Our reference : U-5150/EvR/sl/673-D2 Publication no. 2009/05E
Date : 30 March 2009

Dear Minister:

A Swiss study has recently been published in which the number of deaths with Alzheimer's disease registered as the primary or secondary cause of death was observed to have approximately doubled among people who lived for more than 10 years within a distance of 50 metres from a power line.¹ The Health Council of the Netherlands' Electromagnetic Fields Committee has evaluated this study in consultation with the Knowledge Platform Electromagnetic Fields and Health, taking also into account data from other studies.² This evaluation has been reviewed by the Health Council's Standing Committee on Radiation and Health. In this advisory letter, I report the final findings and conclusions made by the Electromagnetic Fields Committee.

The Committee's opinion

The Committee feels that the Swiss study makes an important contribution to research into associations between exposure to electromagnetic fields and health effects. This is the first study on a possible relationship between living near power lines and death due to or with Alzheimer's disease. The study was carried out carefully, but is subject to a number of – partially inescapable – restrictions, which will be discussed below in more detail. Precisely because of these restrictions,

¹ Huss, A., Spoerri, A., Egger, M., e.a. Residence near power lines and mortality from neurodegenerative diseases: longitudinal study of the Swiss population. *Am J Epidemiol*, 2009; 169(2):167-175.

² This study has generated some public concern, resulting among other things in questions from departments, provinces and municipalities. Therefore, the Knowledge Platform Electromagnetic Fields and Health decided to write a report on this study. In consultation between the Health Council of the Netherlands and the Knowledge Platform, it was concluded that it would be desirable that the Health Council draft an advisory letter concerning this study.



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no conclusion can be drawn from this single study on a causal relationship between residing near power lines and Alzheimer's disease. In general, conclusions on cause and effect can only be drawn from this type of (observational) epidemiological study when the results of more than one study point in the same direction. This is even more the case if the association between exposure and disease is weak. The Committee discusses this methodological problem more extensively in its Annual Update 2008 on electromagnetic fields.³

Previous studies only examined death caused by Alzheimer's disease in relationship to possible occupational exposure.⁴ In the explanatory notes below, the Committee states that the quality of these studies varies. The better studies sometimes show a slightly elevated risk.⁵

On the basis of the epidemiological data currently available, the Committee cannot draw any conclusions on a possible causal relationship between prolonged exposure to low-frequency magnetic fields and an elevated risk of death caused by or involving Alzheimer's disease. Moreover, there are currently no indications for a biological mechanism. However, the Committee does find that the results of the Swiss study, in combination with the data from occupational studies, encourage more detailed studies – regarding both a possible mechanism as well as epidemiological research. With respect to epidemiological research, it is important that a better estimate of the exposure and a better verification of the diagnosis be achieved, and that research into biological mechanisms be intensified. Studies on the relationship between exposure to electromagnetic fields and neurodegenerative diseases will be part of a cohort study done in the Netherlands within the framework of the Electromagnetic Fields and Health research programme

³ In its Annual Update 2008, the Committee states that it considers an association in epidemiological research weak if a relative risk between approximately 0.5 and 2.0 is found. Huss et al. report a relative risk of 2.0 for death caused by or with Alzheimer's disease for the group of people who had resided for more than 15 years at a distance of less than 50 metres from a power line.

⁴ See, for example: Garcia, A.M., Sisternas, A., and Hoyos, S.P. Occupational exposure to extremely low frequency electric and magnetic fields and Alzheimer disease: a meta-analysis. *Int J Epidemiol*, 2008; 37(2): 329-340.

⁵ Relative risks up to 2.3 were found in the large cohort studies. An overall risk of 1.62 has been calculated for these studies, with a 95% confidence interval of 1.16-2.27 (see the paper referred to in footnote 4).



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of the Netherlands Organisation for Health Research and Development (ZonMw). However, it will take some time before the first results of this study are available. The nature of the study means that a considerable length of time is needed.

Explanatory notes

The Swiss study

The researchers investigated whether there is a relation between residing near overhead power lines and death involving Alzheimer's disease or other neurodegenerative diseases, such as amyotrophic lateral sclerosis (ALS) or Parkinson's disease, as the primary or secondary cause of death.⁶ The data regarding cause of death were obtained from the national mortality register; the data on the place of residence and the length of time of residing at a certain address were taken from national censuses from 1990 and 2000.

Four corridors were distinguished along both sides of power lines: less than 50 metres, 50-200 metres, 200-600 metres and more than 600 metres. The census data allowed to verify whether a person had resided at the same address for five years prior to the census. Thus address data are known for 1985, 1990, 1995 and 2000. Mortality was examined for the 2000-2005 period. With these data it was possible to link mortality to residing at the same address for more than 5, 10 or 15 years. Ultimately, this resulted in a non-significantly elevated risk of death caused by or with Alzheimer's disease of 1.51 (95% confidence interval: 0.91-2.51) for those who had lived less than 50 metres from a high-voltage power line for longer than 5 years, a significantly elevated relative risk of 1.78 (95% confidence interval: 1.07-2.96) for those who had lived there longer than 10 years, and an equally significant elevated relative risk of 2.00 (95% confidence interval: 1.21-3.33) for those who had lived there at least 15 years (which were only 15 people). The relative risk thus appears to increase as the length of residence increases, but this increase is in itself not significant. A similar relationship was not found for the other neurodegenerative diseases studied.

⁶ The primary cause of death is the cause of death underlying the death, meaning the first in a series of events that resulted in death. Secondary causes of death are consequences or complications of the primary cause of death, but also other diseases the deceased suffered from and that could have contributed to the death.



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This is the first study in which a relationship between the occurrence of a neurodegenerative disease and residing in the vicinity of overhead power lines has been examined (and it is thus implicitly also a study on the associated exposure to low-frequency magnetic fields). The study raises various questions.

1. The exposure to magnetic fields was not measured

The researchers regarded the distance from the residential address to a power line as a measure for exposure to low-frequency magnetic fields. In general, it can be assumed that there would be a difference in average field intensity between the four corridors examined, but Maslanyj et al. stated in a recent publication that, based on measurements and calculations, distance to an overhead power line is a very inaccurate measure for exposure to the magnetic field generated by the line.⁷ Therefore, no relationship can be made between exposure to the magnetic field and the effect being studied, in this case the development of neurodegenerative disorders. This is also indicated by the researchers. Such being the case, the Committee finds that the conclusion of the researchers that the results support the hypothesis that magnetic fields play a role in the development of Alzheimer's disease and senile dementia pushes the matter too far.

2. Uncertainties in the length of residence

The researchers find an elevated risk for the relatively small group of people who had lived for at least 10 years in the same place at a distance of less than 50 metres from a power line. The Committee feels that the period of residence could have been determined more accurately. It would have been better if the researchers had involved the entire residential history in this measurement, and made it a cumulative measurement. After all, what matters is how long a subject lived at a certain distance from power lines, and not only how long he or she resided at a certain address. Someone who first lived within 50 metres from a power line for 4 years and then moved

⁷ Maslanyj, M., Simpson, J., Roman, E., e.a. Power frequency magnetic fields and risk of childhood leukaemia: misclassification of exposure from the use of the 'distance from power line' exposure surrogate. *Bioelectromagnetics*, 2009: DOI: 10.1002/bem.20465.



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to a different place also within 50 metres is currently classified in the category "less than 5 years", and that is incorrect.

3. Possible misclassification of the cause of death

The authors use the national mortality register, in which the relevant neurodegenerative diseases have been entered as the primary or secondary causes of death. The cause of death reported in a mortality register, particularly regarding the secondary cause of death, is not always reliably documented. This is particularly true when medical conditions are involved that are difficult to diagnose, such as Alzheimer's disease and senile dementia. The researchers also state that Alzheimer's disease is probably underreported compared to diseases such as ALS, Parkinson's disease and multiple sclerosis (MS). Due to the absence of physical signs in Alzheimer's disease it is reasonable to assume that this diagnosis is more reliably established as primary cause of death than as a secondary complication. The question is whether the physician who determines the cause of death makes a proper distinction between the different types of dementia, particularly if it is the secondary cause of death. According to Statistics Netherlands (CBS), it is difficult to distinguish mortality as a result of the various types of dementia on the basis of the registration of the cause of death.⁸

In their analysis, the Swiss researchers assume that there is no difference in reliability between the reports of death as a result of Alzheimer's disease and senile dementia as primary and secondary cause of death. They do not state how often Alzheimer's disease is listed as the primary or secondary cause of death. The effect of this significant cause of possible misclassification was not studied in more detail.

The Committee considers it unlikely that the accuracy of reporting the cause of death is related to the distance to the power lines. Therefore, any misclassification will be non-differential (i.e., the same for the various distance categories), and according to current epidemiological views this can only result in underestimation of risk. Thus if misclassification has occurred (which the Committee considers likely), the actual risk is probably higher than the reported risk.

⁸ Van der Meulen, A. and Keij-Deerenberg, I. Mortality from dementia. Statistics Netherlands: Bevolkingstrends, 2003; 2nd quarter: 24-28 (in Dutch).



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In addition to possible misclassification due to differences in primary and secondary causes of death, misclassification is also conceivable because it is difficult to differentiate between Alzheimer's disease and other types of dementia using the mortality registry. It would have been useful to also carry out an analysis on a combination of Alzheimer's disease and (senile) dementia.

4. Age dependency was not determined

Alzheimer's disease is probably more accurately diagnosed as a cause of death in elderly people 60-70 years old than in those, for example, older than 75. In the older group, the likelihood that several types of dementia and depression are combined is higher. The researchers did investigate whether the results for coding as primary or secondary cause of death differed for the entire population (30-85 years of age), but it would also have been interesting to investigate this for different age categories. With that, it would be relevant to know the age structure of the group that resided within 50 metres of a power line. If, for example, this group is younger than average it could mean that the diagnosis of Alzheimer's disease is better substantiated and coded more often as the primary cause of death. This could result in an overestimation of risk. An older than average population within 50 metres could mean the opposite.

Previous studies

Previous studies only examined the occurrence of Alzheimer's disease in relation to possible occupational exposure. An overview of these studies is presented by the World Health Organisation⁹ as well as in a recent review paper.¹⁰ After these overviews were published, an extensive study on Swiss railway employees was published; this study is briefly discussed below.

Exposure at the workplace may be higher than in the vicinity of a power line, but the actual degree and duration of exposure was not measured on an individual basis in these studies either. Rather, these values were estimated on the basis of the profession held, assuming that for some professions the likelihood of above-average exposure is higher than for other professions. In some

⁹ WHO - World Health Organization. Extremely low frequency fields. Environmental Health Criteria 238, Geneva: World Health Organization, 2007.

¹⁰ See footnote 4.



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cases, as in the study on Swiss railway employees discussed below, measurements were made in different work situations, thus presenting an overall picture of the exposure in a certain profession. The Committee assumes that the duration of the daily exposure at the workplace would be shorter than if one resided near a power line. And of course the problem of the reliability of the diagnosis is also important in these studies.

The quality of these occupational studies varies. The reliability of the case-control studies in particular is not very high. This is mostly because the exposure metric, the profession, has been obtained second-hand. In addition to this, questions can be raised regarding the selection of the control groups. Also, participation by the controls is often lower than by the cases. The cohort studies are usually of better quality. Some of these show an elevated risk (relative risks up to 2.3, with an overall relative risk of 1.62 and a 95% confidence interval of 1.16-2.27; see the paper in footnote 4).

The recent study on Swiss railway employees¹¹ showed a non-significantly elevated risk of death due to or with senile dementia, including Alzheimer's disease, for the most exposed group – the train drivers (relevant risk 1.96; 95% confidence interval 0.98-3.92), and a somewhat higher, but still not significantly increased risk of death caused by or with Alzheimer's disease (relative risk 3.15; 95% confidence interval 0.90-11.04) in a subgroup with only mortality after 1995. The relation between the calculated cumulative exposure and death caused by or involving senile dementia (including Alzheimer's disease) was statistically significant, however: for every 10 microtesla-years¹², the risk increased by 5.7% (95% confidence interval 1.3-10.4). For the subgroup with Alzheimer's disease alone, the same risk increased by 9.4% (95% confidence interval 2.7-16.4). However, the question is whether cumulative exposure is a relevant metric. This study, incidentally, involves exposure with a different spectral composition than that of power lines: the dominant frequency of the railway network is 16.7 Hz, as opposed to 50 Hz for power lines.

¹¹ Rösli, M., Lörtscher, M., Egger, M., e.a. Mortality from neurodegenerative disease and exposure to extremely low-frequency magnetic fields: 31 years of observations on Swiss railway employees. *Neuroepidemiology*, 2007; 28: 197-206.

¹² A microtesla-year is an average occupational exposure of 1 microtesla during one year.



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Conclusions

The Committee considers the study by Huss et al. on residents near power lines to be of interest. The results of this study indicate that there might be an elevated risk of death caused by or with Alzheimer's disease in persons who have resided at a distance of less than 50 metres from an overhead power line for more than 10 years. Due to the restrictions stated above, no conclusion on a causal relationship can be drawn from this single study on the relationship between residing in the vicinity of power lines and Alzheimer's disease: it is not possible to pronounce upon the question of whether this elevated risk is also related to the exposure to the low-frequency magnetic fields generated by the power lines. Even though other studies, such as the one on Swiss railway employees, provide indications of an elevated risk of Alzheimer's disease in relation to exposure to low-frequency magnetic fields, prospective research is required in order to draw any conclusions. Factors that make an unambiguous interpretation more difficult will have to be controlled in these studies. More information is also required on possible biological mechanisms that could play a role in the effect of low-frequency magnetic fields on the initiation or development of Alzheimer's disease.

Sincerely,
(signed)
Professor M. de Visser
Vice-president

The committee

At the time this recommendation was drawn up, the Electromagnetic Fields Committee consisted of the following members:

- Dr G.C. van Rhoon, *chairman*
physicist, Erasmus University Medical Centre, Rotterdam
 - Dr L.M. van Aernsbergen, *adviser*
physicist, Ministry of Housing, Spatial Planning and the Environment,
The Hague
 - Prof. A. Aleman
professor of Cognitive Neuropsychiatry, Groningen University
 - Dr G. Kelfkens, *adviser*
physicist, National Institute for Public Health and the Environment,
Bilthoven
 - Prof. H. Kromhout
professor of Occupational Hygiene and Exposure Characterisation, Institute
for Risk Assessment Sciences, University of Utrecht
 - Prof. F.E. van Leeuwen
professor of Cancer Epidemiology, Free University of Amsterdam
epidemiologist, Netherlands Cancer Institute, Amsterdam
 - Dr H.K. Leonhard, *adviser*
physicist, Ministry of Economic Affairs, Groningen
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- Prof. H.F.J. Savelkoul
professor of Cellular Biology and Immunology, Wageningen University
- Prof. W.J. Wadman
professor of Neurobiology, University of Amsterdam
- D.H.J. van de Weerd, MD
toxicologist and specialist in environmental medicine; Central Gelderland
Municipal Health Services (GGD), Arnhem
- Prof. A.P.M. Zwamborn
professor of Electromagnetic Effects; Eindhoven University of Technology
physicist, TNO (Organisation for Applied Scientific Research), The Hague
- Dr E. van Rongen, *scientific secretary*
radiobiologist, Health Council of the Netherlands, The Hague

The Health Council and interests

Members of Health Council Committees – which also include the members of the Advisory Council on Health Research (RGO) since 1 February 2008 – are appointed in a personal capacity because of their special expertise in the matters to be addressed. Nonetheless, it is precisely because of this expertise that they may also have interests. This in itself does not necessarily present an obstacle for membership of a Health Council Committee. Transparency regarding possible conflicts of interest is nonetheless important, both for the President and members of a Committee and for the President of the Health Council. On being invited to join a Committee, members are asked to submit a form detailing the functions they hold and any other material and immaterial interests which could be relevant for the Committee's work. It is the responsibility of the President of the Health Council to assess whether the interests indicated constitute grounds for non-appointment. An advisorship will then sometimes make it possible to exploit the expertise of the specialist involved. During the establishment meeting the declarations issued are discussed, so that all members of the Committee are aware of each other's possible interests.