Bundesamt für Strahlenschutz

Joint evaluation of international studies on the relationship between childhood leukaemia and distance from power lines

Expert statement

Summary

- Since as early as 2002, the International Agency for Research on Cancer (IARC) has classified low-frequency fields as potentially carcinogenic based on, among other research, two pooled studies (Ahlbom et al., 2000; Greenland et al., 2000) that demonstrated a statistical relationship between childhood leukaemia and magnetic fields stronger than 0.3 and 0.4 microtesla (µT) respectively.
- In a new pooled study and meta-analysis Amoon et al. (2018) have analysed the pooled raw data from 11 case-control studies from 10 countries in order to investigate whether there is a relationship between childhood leukaemia and distance from the nearest power line and, if this is the case, whether this is due to the magnetic field or other factors.
- Overall, the study does not point to a relationship between residential proximity to a power line and the risk of developing childhood leukaemia. Certain indications were found of a slightly higher risk at a distance of less than 50 m between the place of residence and a high-voltage transmission line, albeit only for power lines with a voltage of at least 200 kV.
- However, the study's meaningfulness is severely limited because the magnetic fields were not measured; instead, the residential distance from the nearest power line was used as a substitute. This is, at best, a very inaccurate measure of magnetic field exposure.
- Given that the current state of knowledge regarding environmental risk factors for childhood leukaemia is generally unsatisfactory, the BfS is making every effort to research the causes of childhood leukaemia, including as part of the research programme "Radiation Protection in the Process of Power Grid Expansion".

Background

Since as early as 2002, the International Agency for Research on Cancer (IARC) has classified low-frequency fields as potentially carcinogenic based on, among other research, two pooled studies (Ahlbom et al., 2000; Greenland et al., 2000) that demonstrated a statistical relationship between childhood leukaemia and magnetic fields stronger than 0.3 and 0.4 microtesla (µT) respectively. Two pooled studies conducted at a later stage also identified consistently elevated leukaemia risks in children exposed to magnetic fields stronger than 0.3 or 0.4 µT (Schüz et al., 2007; Kheifets et al., 2010). However, the increases in risk in the four pooled studies were based on small numbers of cases and were not statistically significant in one of the studies (Kheifets et al., 2010). Furthermore, residential exposure to magnetic fields stronger than 0.3 µT is very rare. In Europe, the average residential magnetic field exposure is between 0.025 and 0.07 µT (WHO Monograph 238, 2007). Calculations show that only a small number of children (between 1% and 4%) are exposed to more than 0.3 µT and only some 1–2% to more than 0.4 µT (WHO Monograph 238, 2007). Assuming a causal relationship, researchers have calculated 50 or 60 cases a year due to magnetic field exposure in the EU 27 (Grellier et al. 2014).

Significance of distance from a power line

By examining the distance from a power line, Kheifets et al. (2010) revealed a significantly higher risk (by a factor of 1.59) of leukaemia in children who lived less than 50 m from a power line in comparison with children who lived at least 200 m from a power line, and that the risk increased with decreasing distance. This raised the question whether the leukaemia risk is actually greater in the vicinity of power lines and what could be responsible for the potential increase. Although high levels of magnetic field exposure can occur in the vicinity of power lines, the magnetic field exposure depends on the current electrical load and cannot be reliably predicted by distance (Feychting and Ahlbom, 1994; Maslanyj et al., 2009). It is also conceivable that the leukaemia risk is influenced by factors that are independent of the magnetic field and that relate to proximity to a power line.

New pooled study and meta-analysis

Amoon et al. (2018) have now analysed the pooled raw data from 11 case-control studies from 10 countries in order to investigate whether there is a relationship between childhood leukaemia and

distance from the nearest power line and, if this is the case, whether this is due to the magnetic field or other factors. In doing so, they relied as far as possible on studies conducted without contact with study participants in order to avoid potential distortion of the risk due to selective participation.

In total, their calculations were based on individual data from 29,049 children aged 0 to 17 with a diagnosis of leukaemia and 68,231 control subjects without a diagnosis of leukaemia from the years 1960–2014. In addition to the analyses based on pooled data, they also conducted a meta-analysis bringing together the results of each individual study into a joint result.

Methodology

Main analysis

The relationship between childhood leukaemia and residential distance from a power line was quantified using a logistical regression model, and odds ratios (ORs) were calculated with accompanying 95% confidence intervals. An OR approximately corresponds to a relative risk and, in this instance, indicates the factor by which the leukaemia risk increases if a place of residence near a power line is considered instead of one further away (reference category). An OR of 1 means there is no increase in risk. An OR of greater than 1 means there is an increased risk. An OR of less than 1 means there is a decreased risk. Four distance categories were considered:

- “less than 50 m”
- “50 m to less than 150 m”
- “150 m to less than 300 m”
- “at least 300 m”

The category “at least 300 m” was defined as the reference category. All ORs are adjusted for age at the time of diagnosis (in categories), gender and socioeconomic status. Amoon et al. determined the ORs in two ways: they referred in one case to the distance from the nearest high-voltage power line with a voltage of at least 200 kV and in another to the distance from the nearest power line with any voltage. Some of the included studies determined the distance based on the place of residence at the time of the child’s birth and some based on the place of residence at the time of diagnosis.

Subgroup analysis

The calculations for the main analysis were repeated for individual subgroups based on the pooled data. Here, only the distance from high-voltage power lines with a voltage of at least 200 kV was considered. For the subgroups, a distinction was drawn based on the type of leukaemia (acute lymphoblastic leukaemia, acute myeloid leukaemia), the age at diagnosis (under the age of 5, aged 5 or over) and the year of diagnosis (1960–1980, 1980–2000, 2000–2014). In addition, a further subgroup analysis was carried out excluding children with Down’s syndrome.

Confounder analysis

For the following potential confounders, i.e. possible risk factors for childhood leukaemia, information was available for part of the pooled analysis:

- individual socioeconomic status
- socioeconomic status in a person’s milieu
- mobility (never moved house or moved at least once between birth and diagnosis)
- type of dwelling
- pollution due to road traffic
- urban/rural
- magnetic field exposure (calculated)
- magnetic field exposure (calculated or measured)

Looking at each of these factors separately, Amoon et al. (2018) first examined whether there is a relationship with childhood leukaemia, again with adjustment for age at the time of diagnosis, gender and socioeconomic status. Secondly, they examined whether leukaemia risk varies depending on distance from the nearest high-voltage power line with a voltage of at least 200 kV, with and without adjustment for the individual factors. This allowed them to ascertain whether one of these factors influences the relationship between leukaemia risk and distance from the nearest power line (so-called confounding). Of particular importance here was the factor of magnetic field exposure, which was available in eight of the 11 studies. However, the magnetic field had only been measured in one study.

In the other seven studies, the magnetic field was calculated, with the distance from the nearest power line playing a central role.

Results

Main analysis

In principle, there were no appreciable differences between the results of the pooled study and those of the meta-analysis. The results shown below are therefore limited to those of the pooled study.

No relationship was observed between childhood leukaemia and residential distance from a power line at “any voltage”. For example, the leukaemia risk for children who lived less than 50 m from a power line of any voltage is approximately the same as that for children who lived at a distance of at least 300 m (OR = 1.01; 95% confidence interval (CI): 0.85–1.21).

If only high-voltage power lines with a voltage of at least 200 kV are considered, the leukaemia risk in the “less than 50 m” category, based on 50 cases of leukaemia and 123 controls, is greater by a factor of 1.33 (95% CI: 0.92–1.93) compared with that at “at least 300 m”, but this increase in risk is not statistically significant. In addition, there is no apparent relationship between exposure and effect, as the ORs do not successively increase with decreasing distance.

Subgroup analysis

The main analysis identified an increased leukaemia risk in the vicinity of a high-power voltage line with a voltage of at least 200 kV (less than 50 m) compared with that for children living further away, but this is limited to the acute lymphatic leukaemia subtype and to children under the age of five at the time of diagnosis. In this age group, the ORs for the distance categories “less than 50 m”, “50 m to less than 150 m” and “150 to less than 300 m” compared with “at least 300 m” were 1.65 (95% confidence interval (CI): 1.02–2.67), 0.9 (95% CI: 0.69–1.17) and 1.14 (95% CI: 0.94–1.38) respectively. The subgroup analysis with regard to year of diagnosis showed that the ORs tended to be greater in the period between 1960 and 1980 than in the other periods.

Confounder analysis

Adjustment for each of the potential confounder variables did not result in a significant change in leukaemia risk depending on the distance from a high-voltage power line with a voltage of at least 200 kV for any of these variables. The same applied when the results were adjusted for magnetic field exposure. The data from the studies for which information on (calculated or measured) magnetic field exposure was available was used to calculate an unadjusted OR of 1.32, while the OR adjusted for magnetic field exposure was equal to 1.47 (neither of which represents a statistically significant difference from one).

The pairwise relationship analyses between the respective potential confounder variables and the leukaemia risk showed no association for most variables. In particular, the leukaemia risk for a calculated magnetic field exposure of at least 0.4 µT, compared with less than 0.1 µT, was not significantly higher (OR = 1.07; 95% confidence interval (CI): 0.65–1.76). Only the variable “mobility” showed a statistically significant increase, by a factor of 1.9, in the risk of leukaemia (OR = 1.89; 95% CI: 1.50–2.38) for children who had moved house at least once between birth and diagnosis compared with those who had never moved.

Authors’ summary

Amoon et al. (2018) conclude that there is practically no relationship between childhood leukaemia and distance from the nearest power line if all voltages are considered together and that there is only a small, not significantly increased risk at a short distance (less than 50 m) from a high-voltage power line with a voltage of at least 200 kilovolts (kV). In the authors’ view, the weak observed relationship cannot, however, be explained by magnetic field exposure: firstly, their study revealed no relationship between the calculated magnetic field exposures and the leukaemia risk. Secondly, adjusting for magnetic field exposure did not lead to a reduction in the OR.

The authors also point out that the relationship was weaker and less precise in their study than in the earlier studies, although they only included studies that were less prone to distortion because they were conducted without contact with the study participants.

Evaluation by the BfS

Overall, this pooled study shows that the factor “residential proximity to a power line” has no influence on the risk of developing leukaemia in childhood. A slightly higher leukaemia risk was identified only for high-voltage power lines with a voltage of at least 200 kV at a distance of less than 50 m between the place of residence and the high-voltage power line. Consideration of the risk for various types of leukaemia and for various age groups at diagnosis showed that this increase derives primarily from the increased risk of acute lymphatic leukaemia and the significantly increased risk in children aged under five at the time of diagnosis.

Overall, the findings of the study by Amoon et al. (2018) do not confirm the observation by Kheifets et al., (2010) of a general increase in leukaemia risk with decreasing distance and a significantly increased risk at a distance of no more than 50 m from the nearest power line . However, for acute lymphatic leukaemia and for children under the age of five at the time of diagnosis, the study by Amoon et al. reports an increased risk in the lowest distance category. The reason for this increase is unclear.

Given that the current state of knowledge regarding environmental risk factors for childhood leukaemia is generally unsatisfactory, the BfS is making every effort to research the causes of childhood leukaemia, including as part of the research programme “Radiation Protection in the Process of Power Grid Expansion”.

Strengths and weaknesses of the study

The pooled analysis by Amoon et al. (2018) is very comprehensive and considers all of the available and relevant studies on the subject. In view of the low incidence of childhood leukaemia, pooling provides relatively large numbers of cases and thus allows subgroup analysis. Basic confounders were considered and sensitivity analyses were conducted.

The meaningfulness of the study with regard to the relationship between magnetic field exposure and childhood leukaemia risk is severely limited by the fact that, rather than taking primary measurements of the magnetic field exposure itself, the study relied on the residential distance from the nearest power line. This distance is, at best, a very inaccurate measure of magnetic field exposure (Feychting and Ahlbom, 1994; Maslanyj et al., 2009). Although the authors examined the relationship between magnetic field exposure and leukaemia risk as a possible confounder in an additional analysis, almost all of the information available to them for this analysis related to calculated magnetic fields. In turn, this information was essentially based on distance from power lines. The meaningfulness of these results is therefore questionable.

References

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Further information at

- https://www.bfs.de/EN/bfs/science-research/bfs-research-programme/grid-expansion/grid-expansion_node.html
- https://www.bfs.de/EN/topics/ion/effect/cancer/childhood-leukaemia/childhood-leukaemia.html

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