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Childhood leukemia risk in the California Power Line Study: magnetic fields versus distance from power lines

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Abstract

Pooled analyses have suggested a small increased risk of childhood leukemia associated with distance and with exposure to high magnetic fields from power transmission lines. Because magnetic fields are correlated with distance from lines, the question of whether the risk is due to magnetic fields exposure or to some other factor associated with distance from lines is unresolved. We used data from a large records-based case-control study to examine several research questions formulated to disentangle the relationships among magnetic fields, distance from high voltage lines, and childhood leukemia risk. In models examining an interaction between distance and magnetic fields exposure, we found that neither close proximity to high voltage lines alone nor exposure to high calculated fields alone were associated with childhood leukemia risk. Rather, elevated risk was confined to the group that was both very close to high voltage lines (<50 m) and had high calculated fields (0.4 µT) (odds ratio 4.06, 95% CI 1.16, 14.3). Further, high calculated fields (0.4 µT) that were due solely to lower voltage lines (<200 kV) were not associated with elevated risk; rather, risk was confined to high fields attributable to high voltage lines. Whilst other explanations are possible, our findings argue against magnetic fields as a sole explanation for the association between distance and childhood leukemia and in favor of some other explanation linked to characteristics of power lines.

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HUMAN SUBJECTS REVIEW

The California Power Lines Study was reviewed and approved by University of California, Los Angeles Office for the Protection of Research Subjects.

Keywords

Childhood leukemia; epidemiologic study; magnetic fields; power transmission lines; voltage

1. Introduction

The possibility that the electric power transmission and distribution system could pose a risk for childhood leukemia has been a concern for several decades, beginning with the study of Wertheimer and Leeper (1979) that found an association with electrical wiring configurations. Since that time, over 40 epidemiologic studies have investigated the association of childhood leukemia with residential exposure to magnetic fields or surrogates of magnetic fields (Kheifets and Swanson, 2014; Swanson et al., submitted). Analyses that have pooled data from multiple studies (Ahlbom et al,. 2000; Greenland et al., 2000; Kheifets et al., 2010) report a small but consistent increased risk of childhood leukemia associated with exposures above 0.3 or 0.4 microtesla (μT).

One major source of elevated magnetic fields is high-voltage power lines. The strength of magnetic fields from power lines is strongly related to distance from the lines. A recent comprehensive pooled analysis of childhood leukemia and distance to power lines found a small but imprecise increased risk associated with having a birth residence within 50 m of a 200+ kilovolt power line that was not explained by high magnetic fields (Amoon et al., 2016). There is thus some evidence implicating both magnetic fields and distance from power lines, and the question of whether the risk is due to magnetic fields exposure as opposed to some factor associated with distance from lines remains unresolved. Other factors that have been postulated include socioeconomic status, residential mobility, residence type, viral contacts, environmental tobacco smoke, dietary agents, traffic density (as a proxy for benzene exposure), pesticides and corona ions (Amoon et al., 2018; Kheifets and Shimkhada, 2005; Swanson et al., 2014).

The magnetic field produced by a power line is a function of multiple parameters, including voltage, load, phasing of line, geometry of line, ground clearance and distance, as captured in our directed acyclic graph (Figure 1). The distance at which residences are located may in turn be influenced by parameters of the line such as its size (voltage), line geometry and ground clearance, as these factors may be linked to the width of the right of way and the patterns of housebuilding near the right of way. Distance from the line alone may act as a surrogate for other exposures. Because distance is a key component of the calculated fields from power lines, distance from lines and calculated fields from lines tend to be highly correlated, and analyses using both metrics tend to find similar associations with childhood leukemia risk. Thus analyses that focus solely on magnetic fields or solely on distance from lines are unlikely to resolve the issue of whether one or both of these exposures represents a true risk factor for childhood leukemia.

Although calculated fields are correlated with distance, it is possible to formulate and test hypotheses that would support one versus the other as the causative factor. In particular, if elevated childhood leukemia risk were caused by magnetic fields, it would not matter what combination of parameters had produced the magnetic field. For example, a given magnetic

field strength produced by a high load at a farther distance would produce the same risk as the same magnetic field strength produced by a lower load and a closer distance. Similarly, if another factor correlated with proximity to high voltage lines were the true risk factor, then subjects at equal distance from lines should have the same level of risk, regardless of magnetic field strength.

One of the largest single studies on this topic is the California Power Line Study (CAPS), a large records-based case-control study of childhood leukemia risk and exposure to magnetic fields from power lines which investigated both magnetic field and distance from power lines (Kheifets et al., 2015). Strengths of CAPS include its population-based design, a relatively large sample size of 5,788 childhood leukemia cases and 5,788 matched controls, and an improved exposure assessment. CAPS reported an odds ratio (OR) of 1.4 (95% CI 0.7 to 2.7) for childhood leukemia associated with close proximity (within 50 m) of birth address to 200+ kV power transmission lines (Crespi et al., 2016). An odds ratio of this magnitude and precision does not clearly support increased childhood leukemia risk, but could be consistent with a small increased risk associated with close proximity to lines. CAPS also did not provide clear evidence of risk associated with exposure to magnetic fields from power lines (Kheifets et al, 2017); the OR was 1.5 (95% CI 0.7 to 3.2) for the highest exposure group. Both statistical analyses followed an *a priori* developed analysis plan, which specified both main and secondary analyses.

The relatively large size of CAPS presents an opportunity to explore the relationship among magnetic fields, distance to lines, line voltage and childhood leukemia risk. In this paper, we postulate and evaluate several research questions that attempt to disentangle these relationships, focusing on whether magnetic fields are the causative factor. These research questions are:

(1) Is the risk of childhood leukemia associated with exposure to magnetic fields from power lines independent of distance to the closest high voltage transmission line? If the risk is similar for subjects with the same magnetic field exposure who are close versus far from high voltage lines, we may infer that magnetic fields are a risk factor independent of distance.

(2) Is the risk of childhood leukemia associated with exposure to magnetic fields from power lines independent of the voltage of the closest transmission line? Note that the voltage of a line is, in turn, correlated with other factors such as physical size and likely load. If the leukemia risk associated with high fields is similar for subjects with the same magnetic field exposure whose fields are due to high voltage lines (over 200 kV) versus lower voltage lines (under 200 kV), we may infer that magnetic fields are a risk factor independent of voltage.

(3) Does risk decrease at the same rate as magnetic fields decrease with distance, or does it decrease more rapidly or less rapidly? In this study, as the results presented below show, magnetic fields fall roughly as inverse distance (d^{-1}), so a stronger association of risk with d or with d^{-2} or a similarly rapidly decreasing function might indicate that a factor other than magnetic fields is contributing to the observed risk.

2.   Methods

2.1.   Overview

The CAPS study has been described in previous publications (Kheifets et al., 2015; Vergara et al., 2015). Briefly, CAPS included childhood leukemia cases (born in and diagnosed in California 1986-2008, identified from the California Cancer Registry, diagnosed at less than 15 years of age) matched to population-based controls on age and sex, selected from the birth registry. Birth addresses of subjects were geocoded and distance from residence to transmission lines was estimated using geographic information systems, aerial imagery, and additionally site visits for residences sufficiently close to power lines to possibly have elevated magnetic fields exposure. For site-visited residences, we calculated magnetic fields at birth addresses using distance and historical information on load and phasing. Calculated fields accounted for all lines over 100 kV and some lower voltage lines. For all other residences, magnetic fields attributable to power lines were assumed to be <0.1 μT. For this paper, analyses were restricted to childhood leukemia cases and primary controls meeting our threshold for good geocoding accuracy, namely, geocoded to the street segment or parcel level.

2.2.   Statistical Analyses

To characterize the relationship between distance from lines and calculated fields, counts of subjects in distance and calculated fields categories were summarized in a contingency table. We also used penalized regression splines to obtain a nonparametric estimate of the conditional mean of calculated fields as a function of distance from closest 200+ kV line, and compared this curve to regression models that modelled calculated fields as a function of linear distance (d), inverse distance (d^{-1}) and inverse distance squared (d^{-2}) in order to estimate the rate at which calculated fields decreased with distance from lines in our dataset and the proportion of the variation in calculated fields that was attributable to distance from 200+ kV lines.

To address the first research question (whether the risk of childhood leukemia associated with exposure to magnetic fields is independent of distance to the closest high voltage transmission line), we used logistic regression to model childhood leukemia risk as a function of distance and calculated fields, separately and together. Independence of the effects of magnetic fields and distance on risk implies the absence of an interaction. Therefore, we next examined models including an interaction between distance and calculated fields, focusing on the high exposure categories of each.

For the second research question (whether the risk of childhood leukemia associated with exposure to magnetic fields from power lines is independent of the voltage of the closest high voltage transmission line), we conducted analyses stratified on presence/absence of 200+ kV lines near the residence. In one set of analyses, observations were stratified on whether the line closest to the residence was higher or lower than 200 kV. These analyses included all observations. A second set of analyses was restricted to site-visited residences, which had detailed information collected on line configuration near the residence. For these analyses, we defined two groups, residences with only lines <200 kV nearby and residences

with only lines >200 kV nearby. Thus the second set of analyses exclude residences with nearby lines that included both <200 and >200 kV lines. Both sets of analyses consisted of logistic regression models for childhood leukemia with calculated field categories as predictors, controlling for age, sex, child race and socioeconomic status (SES).

For the third research question (whether risk decreases linearly with distance from lines or more rapidly), we fit and compared logistic models for childhood leukemia that modeled distance (out to 150 m) as d, d^{-1} and d^{-2} The fit of the models was compared using a significance test of the regression coefficient for the distance variable, the Hosmer-Lemeshow goodness of fit test (p-value<0.05 suggests lack of fit), the C-statistic (also known as the area under the ROC curve; higher is better), and AIC and BIC (lower is better). An AIC or BIC difference between two models of less than 2 provides little evidence for one over the other, while an AIC or BIC difference of 10 or more is strong evidence (Dziak et al, 2012).

All logistic regression models controlled for age, sex, child race and SES. SES was coded using a composite index of several variables (Crespi et al., 2016). To avoid dropping subjects in analyses, multiple imputation was used for missing values of child race (n=217, 2.2% of observations) and SES (n=253, 2.6% of observations). Analyses were conducted using Stata/SE 15.1 and R (R Core Team, 2016).

CAPS was reviewed and approved by University of California, Los Angeles Office for the Protection of Research Subjects.

3. Results

After restricting the data to childhood leukemia cases and primary controls with sufficient geocode accuracy, the dataset consisted of 9,714 observations (4,879 cases and 4,835 controls). Table 1 provides a cross-tabulation of calculated field levels and distance to closest power line over 200 kV. We used the same *a priori* cut points as in our previous analyses, chosen to facilitate comparison across published epidemiologic studies. There were a total of 28 subjects (cases and controls) with calculated fields   0.4 µT and a total of 38 subjects within 50 meters of 200+ kV lines. Sixteen subjects were both within 50 meters of 200+ kV lines and had calculated fields   0.4 µT. There were 31 subjects who had calculated fields   0.1 µT but were more than 600 meters from the closest 200+ kV line; for these subjects, the calculated fields were due to proximity to lower voltage lines.

Figure 2 provides a scatterplot of calculated field values and distance to closest 200+ kV line and a nonparametric estimate of the mean calculated fields level as a function of distance, for subjects within 150 meters of 200+ kV lines. A comparison of the spline estimate to regression models using calculated fields as a function of distance, inverse distance (d^{-1}) and inverse distance squared (d^{-2}) is also displayed. The d^{-1} model was closest to the spline model, suggesting that in our data, which included modelling of fields from lower voltages lines, calculated fields were decreasing roughly proportional to inverse distance from 200+ kV line. A linear regression model using d^{-1} as the predictor of calculated fields had an R^2

value of 0.39, indicating that about 39% of the variation in calculated fields values was attributable to (inverse) distance from 200+ kV lines.

Table 2 provides estimates of the odds ratios for childhood leukemia associated with distance and calculated fields categories, separately and together. In the distance-only model, the highest category of exposure (<50 meters of 200+ kV lines) had an odds ratio of 1.47 (95% CI 0.76, 2.82) compared to a reference category of over 600 meters. This OR remained essentially unchanged when controlling for calculated fields (OR 1.44, 95% CI 0.63, 3.29). In the calculated fields-only model, the highest exposure category (0.4 μT) had an odds ratio of 1.50 (95% CI 0.70, 3.23). When controlling for distance, the odds ratio was attenuated to 1.24 (95% CI 0.50, 3.05).

Table 3 provides results from a logistic regression model including an interaction between exposure categories of calculated fields and distance. Exposure groups were formed using the highest exposure categories for distance and calculated fields. In this model, elevated risk was evident only among subjects with high exposure to both calculated fields and distance (OR 4.06, 95% CI 1.16, 14.3). There were 13 cases and 3 controls in this combined high exposure category. There was no indication of elevated risk among subjects with high calculated fields but over 50 meters from 200+ kV lines (OR 0.50, 95% CI 0.15, 1.67) or subjects within 50 meters of 200+ kV lines but with calculated fields less than 0.4 μT (OR 0.81, 95% CI 0.35, 1.88).

Because the exposure group combining higher fields/closer distance (0.4 μT/ <50 m) could exhibit a higher risk than higher fields/further distance (0.4 μT/>50 m) combination group due to higher overall average fields, we repeated the analysis controlling for calculated fields as a continuous variable. The adjustment yielded an attenuated but still elevated risk in the dual high exposure group (OR 2.83, 95% CI 0.22, 37.1, data not shown).

Table 4A presents results stratified by whether the voltage of the closest line was less than or more than 200 kV. Among subjects whose closest line was low voltage, there was no evidence of excess risk associated with high calculated fields (OR 0.31, 95% CI 0.06, 1.54), but numbers of subjects in this cell were small. In contrast, among subjects whose closest line was high voltage (200+ kV), the odds ratio was 3.02 (95% CI 1.09, 8.36). Results for this stratification were similar when restricted to the site-visited subset (data not shown). Detailed information about lines was collected for the site-visited residences, allowing for an analysis restricted to residences with only low or only high line voltages. In these analyses (Table 4B), there was no evidence of elevated risk associated with calculated fields 0.4 μT among subjects with only low voltage lines near the home (OR 0.66, 95% CI 0.10, 4.39), and an elevated OR for subjects with only 200+ kV lines nearby (OR 4.52, 95% CI 1.36, 15.1). However, again, number of subjects in the high calculated field/low voltage line category was small.

Table 5 compares the fit of logistic regression models for the outcome of case-control status using different power transformation of distance as the main predictor. Significance tests of the coefficient of the distance variable indicated that the null hypothesis that the coefficient is zero cannot be ruled out for any of these models. There was no lack of fit indicated by the

Hosmer-Lemeshow test for any of the three models, and the C-statistics were similar, with perhaps a slight advantage of the d^{-2} model over the d^{-1} model. The d^{-2} model had AIC and BIC values 2-3 points lower than the other models, suggesting a possible weak advantage. However, overall, the differences in model fit were small.

4. Discussion

In these exploratory analyses of the relationship of childhood leukemia risk with calculated fields and distance from power lines, we found evidence of an interaction effect. In particular, we found that neither close proximity to high voltage lines alone nor exposure to high calculated fields alone were associated with childhood leukemia risk. Rather, elevated risk was confined to the group that was both very close to high voltage lines (< 50 m) and had higher calculated fields (0.4 μT). When we stratified on the voltage of the nearest line or presence/absence of high voltage lines, only subjects who were both close to high voltage (as opposed to low voltage) lines and had calculated fields 0.4 μT had an elevated odds ratio.

The large size of the CAPS study allowed examination of such interactions. However, unlike our previous results, this analysis was exploratory and thus should be viewed as hypothesis generating. The observed interactions could be spurious findings due to random variation, small number bias, or confounding by an unknown factor.

Calculated fields studies such as CAPS attempt to estimate subjects' historical long-term exposure to magnetic fields at their residence, which is a challenging task. When an exposure is rare, even a small number of false positives (unexposed subjects who are identified as exposed) can swamp the true positives and attenuate risk estimates. The exposure assessment in CAPS was specifically designed to achieve high specificity (i.e., a low false positive rate), using a tiered approach in which subjects tentatively identified as highly exposed were subjected to increasing levels of scrutiny (Vergara et al., 2015). We also conducted extensive sensitivity analyses to confirm high specificity. Nevertheless, an alternative explanation for our findings here is that magnetic fields are indeed the causative factor, that calculated higher fields are less prone to error when produced by closer distances or higher voltage lines, but that CAPS did not achieve high enough specificity for calculated higher fields in other situations. We cannot verify whether or not this is the case. Future work on exposure assessment could help to settle this issue.

Magnetic fields depend on distance from power lines. When we controlled for distance in the logistic regression model predicting case-control status based on calculated fields, the odds ratio for calculated fields was attenuated. This could be expected since distance from lines is a key contributor to calculated fields; others have found it explains more than 62% variation (Feychting and Ahlbom, 1994). We found that only about 39% of the variation in calculated historic field was explained by (a function of) distance to closest 200+ kV line. Thus calculated fields are not synonymous with distance, but rather also depend on load, configuration of lines and proximity to lower voltage lines, and although they are substantially correlated, they are not perfectly collinear and theoretically it should be possible to disentangle their effects.

On the other hand, when we controlled for calculated fields in the logistic regression model predicting case-control status based on distance, the odds ratio for distance remained unchanged. Calculated fields might be better predictors of retrospective magnetic fields exposure, while distance might be a better predictor of some other risk factor relevant to the development of childhood leukemia. We discuss two such factors below.

Renting rather than owning one's home is often used as a surrogate for lower SES and apartment buildings might be more common closer to large power lines, leading to confounding. Interestingly, two studies report stronger associations for single family homes than for apartments: in Sweden, the magnetic fields risk for childhood leukemia was limited to single family homes, although calculated magnetic fields were somewhat higher in apartments. In CAPS we observed a slightly higher risk for single family homes in the highest exposure group (Kheifets et al., 2017). Unfortunately, information on dwelling type was available only for a subset of subjects who were site-visited because they lived close to the power lines. We are currently collecting additional data on type of dwelling for a larger subset of subjects.

Some studies have found links between parental pesticide use or proximity to large agricultural crops and childhood leukemia (Vinson et al., 2011). In California, commercial plant nurseries, which could be a source of pesticide exposure, are often located underneath high voltage power lines. We are currently collecting data on distance to plant nurseries and use of pesticide by them to evaluate it as a risk factor for childhood leukemia and as an effect modifier for childhood leukemia.

Residential mobility has been considered a potential confounder in studies of childhood leukemia (Kheifets et al., 2017). We were not able to control for mobility in this study because CAPS has information on residential mobility only for cases. For cases, both birth address and diagnosis address were collected, whereas for controls, which were selected from birth records, only birth address was collected. However, in a case-only analysis, we found that residential mobility was not associated with distance to nearest power line or calculated magnetic fields (Amoon et al., 2018). Thus mobility is unlikely to be an important confounder in CAPS.

While the magnetic fields from a single line typically decrease with inverse distance squared from power lines (Maddock 1992), in our data which incorporates field and distance values from multiple lines, magnetic fields decreased more slowly with distance, on the order of d^{-1}. Our calculated magnetic fields incorporated not just high voltages lines but also the contributions of lower voltages lines. However, when we repeated the modelling after excluding residences with nearby low voltage lines, the relationship was similar (data not shown). A possible alternative explanation could be that subject residences are differentially distributed at larger distances from lines producing larger fields compared to lines producing smaller fields.

Magnetic fields in our data decreased roughly proportional to d^{-1}. When we compared models for childhood leukemia risk that included d, d^{-1} and d^{-2} as predictors, there was a

slight suggestion that the model with d^{-2} was a better fit for the data; however, we did not find that one model was clearly better than the others, and the findings were inconclusive.

5. Conclusions

In summary, our key finding is that, in this study, neither distance nor magnetic field alone predict risk, but only the combination of both, and risk is likewise confined to magnetic fields produced by higher voltage lines, not by lower voltage lines. While potentially informative, we suggest cautious interpretation of this observation as the analysis was exploratory. Furthermore, despite the relatively large size of CAPS, some cell counts were low. Further investigation of potentially important factors, including ground clearance and geometry, might be informative. For instance, ground clearance might impact calculated fields only at close distances with no impact at further distance. Moreover, we recognize the potential from uncontrolled residual confounding from an unknown or combination of unknown factors in our directed acyclic graph (Figure 1).

Given the correlation between magnetic fields and distance and the small numbers of highly exposed in both exposure categories, it is difficult to fully disentangle the influence of these exposures on risk of childhood leukemia, if any. Nevertheless, within the confines of the limitations, our results argue against magnetic fields as a sole explanation for the observed association between distance to high voltage power lines and childhood leukemia, and in favor of some other explanation linked to such lines.

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Highlights

- Magnetic field strength and power line proximity are related but distinguishable

- Childhood leukemia risk was higher only when highly exposed to both

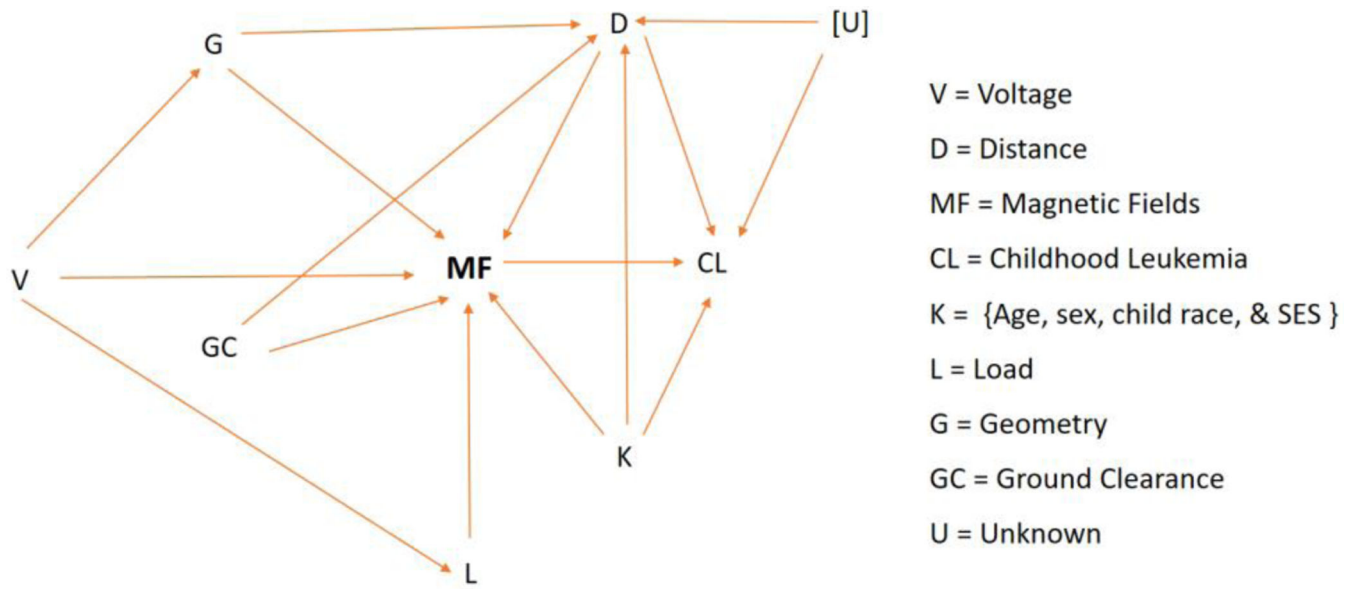- Factors other than magnetic fields may explain higher leukemia risk near lines

Figure 1.
Directed acyclic graph of magnetic fields and distance.

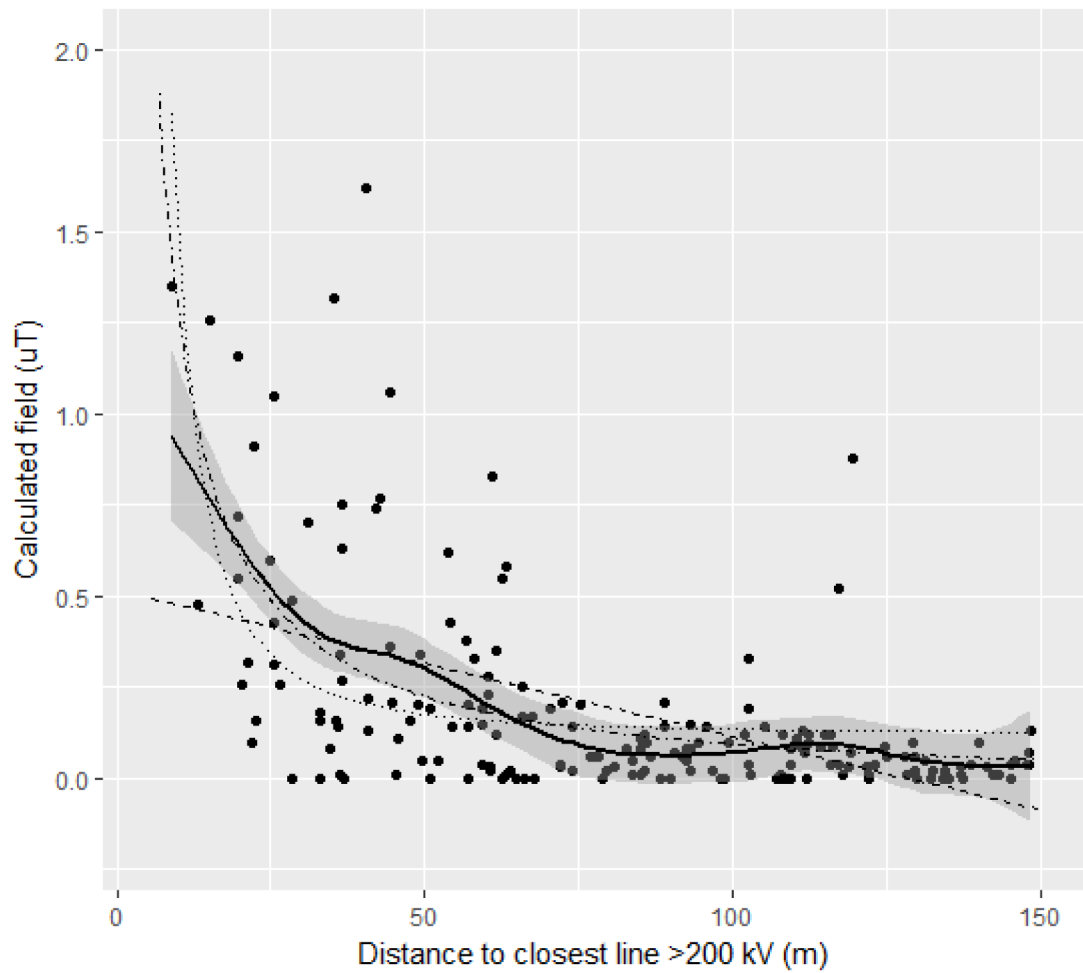**Figure 2.**
Scatterplot of calculated field values and distance to closest power line over 200 kV. Solid black line is conditional mean estimated from penalized regression spline model; gray indicates standard error bar for the spline model. dashed, dot-dash and dotted lines are from linear regression models fitted using distance, distance^{-1} and distance^{-2} as predictor, respectively.

Table 1.

Number of observations in categories of calculated field and distance to closest power line over 200 kV. Childhood leukemia cases and controls (n=9714)

	<0.1 µT	0.1-0.2 µT	0.2-0.4 µT	0.4 µT	Total
0-50 m	4	9	9	16	38
50-100 m	31	14	9	3	57
100-200 m	106	14	2	1	123
200-300 m	130	0	0	0	130
300-400 m	132	0	0	0	132
400-500 m	115	0	0	0	115
500-600 m	122	0	0	0	122
600 m	8966	14	9	8	8997
Total	9606	51	29	28	9714

Table 2.

Logistic regression modeling of childhood leukemia risk as function of distance to power lines over 200 kV, calculated fields or both

	Distance only		Calculated fields only		Distance and calculated fields
Distance, m	OR (95% CI)	Ca/Co	OR (95% CI)	Ca/Co	OR (95% CI)
>600	1.0 (Ref)	4879/4835			1.0 (Ref)
500-600	1.12 (0.78, 1.60)	65/57			1.12 (0.78, 1.60)
400-500	0.86 (0.59, 1.25)	54/61			0.86 (0.59, 1.25)
300-400	1.11 (0.79, 1.57)	71/61			1.11 (0.79, 1.57)
200-300	0.86 (0.61, 1.22)	61/69			0.86 (0.61, 1.22)
100-200	0.75 (0.53, 1.08)	53/70			0.77 (0.53, 1.09)
50-100	0.94 (0.55, 1.58)	28/29			0.98 (0.55, 1.74)
<50	1.47 (0.76, 2.82)	23/15			1.44 (0.63, 3.29)
Calculated fields,μT					
<0.1			1.0 (Ref)	4824/4782	1.0 (Ref)
0.1-0.2			0.84 (0.48, 1.47)	24/27	0.85 (0.46, 1.57)
0.2-0.4			0.97 (0.47, 2.02)	14/15	0.88 (0.39, 2.00)
0.4			1.50 (0.70, 3.23)	17/11	1.24 (0.50, 3.05)

Models control for age, sex, child race and SES. Multiple imputation was used for missing values of child race and SES.

Table 3.

Odds ratios for childhood leukemia from logistic regression model with interaction between calculated fields and distance to closest 200+ kV line. Estimates control for age, sex, race and socioeconomic status (SES). Multiple imputation was used for missing values of race and SES.

	Risk factors			
	Line proximity	Calculated fields	OR (95% CI)	Ca/Co
>600 m and <0.1 µT	No	No	1.00 (Ref)	4509/4457
<50 m and <0.4 µT	Yes	No	0.81 (0.35, 1.88)	10/12
>50 m and 0.4 µT	No	Yes	0.50 (0.15, 1.67)	4/8
<50 m and 0.4 µT	Yes	Yes	4.06 (1.16, 14.3)	13/3

Table 4.

Odds ratios for childhood leukemia associated with calculated fields exposure stratified by voltage of lines near residence. Estimates control for age, sex, race and socioeconomic status (SES). Multiple imputation was used for missing values of race and SES.

A. All observations

Calculated fields category	Closest line <200 kV		Closest line >200 kV	
	OR (95% CI)	Ca/Co	OR (95% CI)	Ca/Co
<0.1 µT	1.00 (Ref)	1563/1598	1.00 (Ref)	3261/3184
0.4 µT	0.31 (0.06, 1.54)	2/6	3.02 (1.09, 8.36)	15/5

B. Restricted to site-visited residences.

Calculated fields category	Only lines less than 200 kV nearby		Only lines more than 200 kV nearby	
	OR (95% CI)	Ca/Co	OR (95% CI)	Ca/Co
<0.1 MT	1.00 (Ref)	29/36	1.00 (Ref)	30/38
0.4 µT	0.66 (0.10, 4.39)	2/6	4.52 (1.36, 15.1)	14/5

Table 5.

Comparison of logistic regression models predicting childhood leukemia case-control status using different transformations of distance to nearest line >200 kV. Distance out to 600 m.

	Linear distance (d)	Inverse distance (d⁻¹)	Inverse squared distance (d⁻²)
P-value, test of coefficient equal to zero	.47	.27	.10
P-value, Homser-Lemeshow goodness of fit test	.65	.45	.59
C-statistic	.528	.521	.532
AIC	1010.04	1009.18	1007.06
BIC	1051.21	1050.36	1048.23