



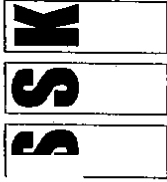
# KiKK研究評価に関する BONN会議(26. Feb.2009)

松原純子

(前原子力安全委員会委員長代理)

2010. 3. 29





Geschäftsstelle der  
Strahlenschutzkommission

SSK-Geschäftsstelle beim  
Bundesamt für Strahlenschutz (BfS)  
Postfach 12 06 29, D-53048 Bonn

Datum: 17.12.2008

## Fachgespräch zur Vorstellung der vollständigen Beratungsergebnisse der Strahlenschutzkommission zur KiKK-Studie am 26. Februar 2009 in Bonn

**Sitzungsort:** Bonn (genauer Ort wird rechtzeitig bekannt gegeben)

**Zeit:** 26. Februar 2009, 11.00 – 16.30 Uhr

### – Vorläufiges Programm –

Zeit	Thema	Berichterstatter
11:00	1. Begrüßung	Prof. Dr. Leitgeb (Graz)
11:10	2. Beratungsauftrag an die SSK	Prof. Dr. Michel (Hannover)
11:20	3. Die KiKK-Studie im Kontext sonstiger epidemiologischer Studien	Prof. Dr. Dr. Wichmann (München)
12:00	4. Strahlenbiologische Grundlagen	Prof. Dr. Müller (Essen)
<i>Mittagspause mit Imbiss von 12.40 Uhr - 13.20 Uhr</i>		
13:20	5. Krebs im Kindesalter nach Strahlenexposition mit niedriger Dosis	Dr. Jacob (München)
14:00	6. Independent Check on the Results of the KiKK-Study	Prof. Dr. Darby (Oxford)
14:40	7. Strahlenexposition der Menschen in der Umgebung von Kernkraftwerken und zusammenfassende Bewertung der KiKK-Studie	Prof. Dr. Michel (Hannover)
15:30	8. Abschlussdiskussion	

*Voraussichtliches Ende des Fachgesprächs ca. 16.30 Uhr*

The logo consists of three vertical rectangular boxes, each containing one letter: 'S', 'S', and 'K'. The boxes are arranged horizontally and are set against a light brown background.

**SSK**

# **Strahlenexposition der Menschen in der Umgebung von Kernkraftwerken und zusammenfassende Bewertung der KiKK-Studie**

**Rolf Michel**

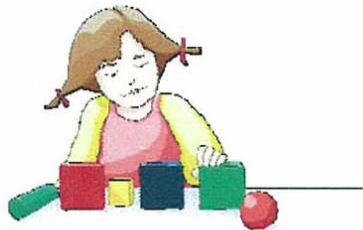
**SSK-Fachgespräch zur Vorstellung der vollständigen Beratungsergebnisse  
der Strahlenschutzkommission zur KiKK-Studie, 26.02.2009**



Deutsches  
Kinderkrebsregister  
Leitung: Dr. Peter Kaatsch

## Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken (KiKK-Studie)

### Abschlussbericht



### Zusammenfassung

Teil 1 (Fall-Kontroll-Studie ohne Befragung)

Teil 2 (Fall-Kontroll-Studie mit Befragung)

Peter Kaatsch, Claudia Spix, Sven Schmiedel, Renate Schulze-Rath, Andreas Mergenthaler, Maria Blettner

Gefördert vom Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit über das Bundesamt für Strahlenschutz (Vorhaben StSch 4334)

JOHANNES  
GUTENBERG  
UNIVERSITÄT  
MAINZ

Institut für Medizinische Biometrie, Epidemiologie und Infor-  
matik (IMBEI) an der Johannes Gutenberg-Universität Mainz  
Direktorin: Prof. Dr. Maria Blettner

**IMBEI**

**SSK**

## Die KiKK-Studie (2007)

### Aufgabe 1:

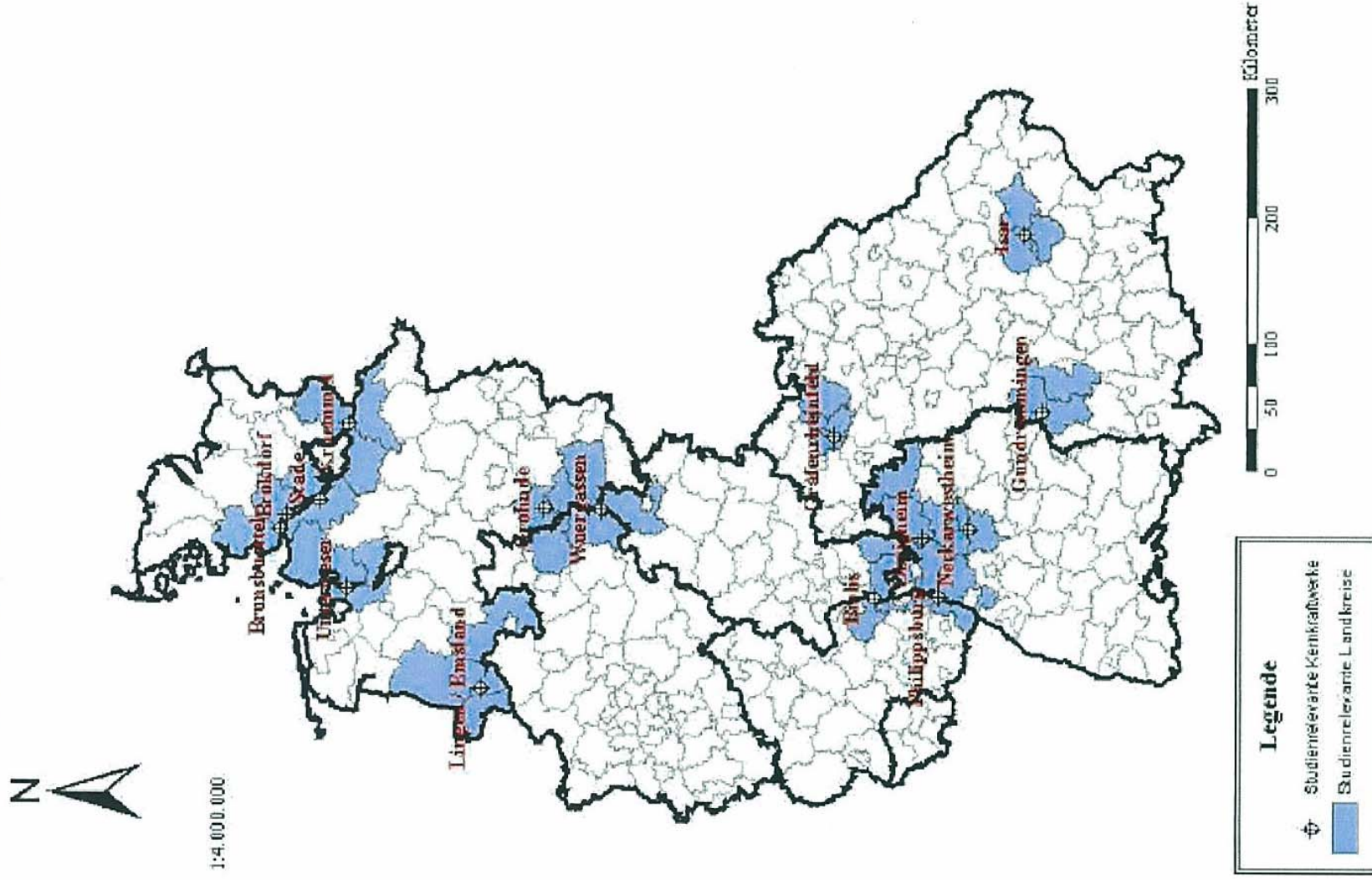
**Es ist eine Fall-Kontroll-Studie  
ohne Befragung zu allen  
malignen Erkrankungen bei  
0 - 4jährigen Kindern  
durchzuführen**

### Aufgabe 2:

**Es ist eine Fall-Kontroll-Studie  
mit Befragung zu Leukämien,  
ZNS-Tumoren und Lymphomen  
bei 0 - 4jährigen Kindern  
durchzuführen.**

# Illustration 2.1: Study region and study-relevant nuclear power stations

Abbildung 2.1: Studienregion und studienrelevante Kernkraftwerke



north south and/or west east direction. In the diagram are different Radii (5km, 10km, 20km, 30km, 40km) as auxiliary lines represented. Particular recognizable amassments are larger places.

Illustration 3.3: Spatial situation of the cases and controls to the nearest in each case nuclear power station, represented are distances to 50km Diagnosis 1980-2003, all illnesses Evaluation data record, 1592 cases and 4735 controls.

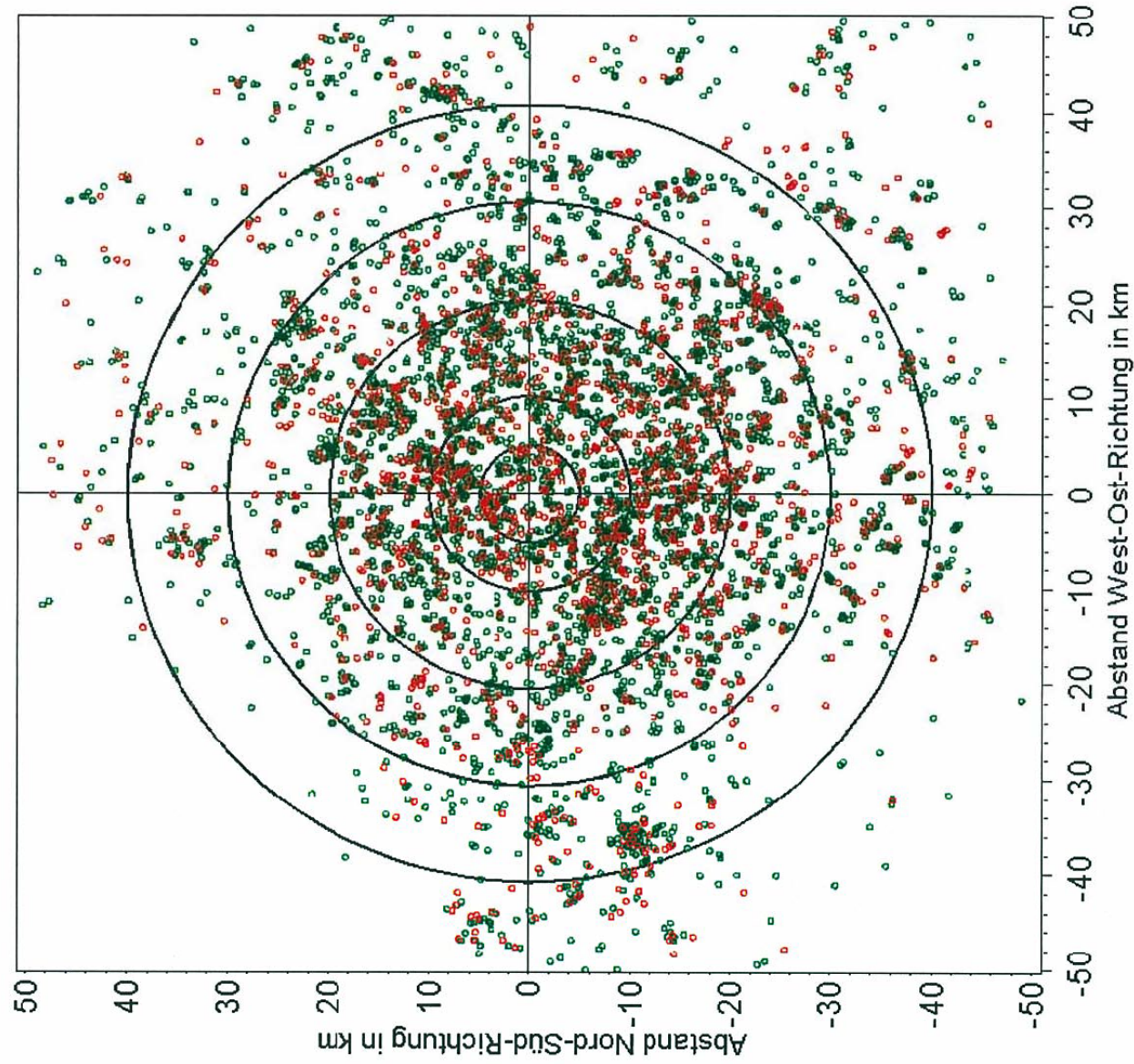
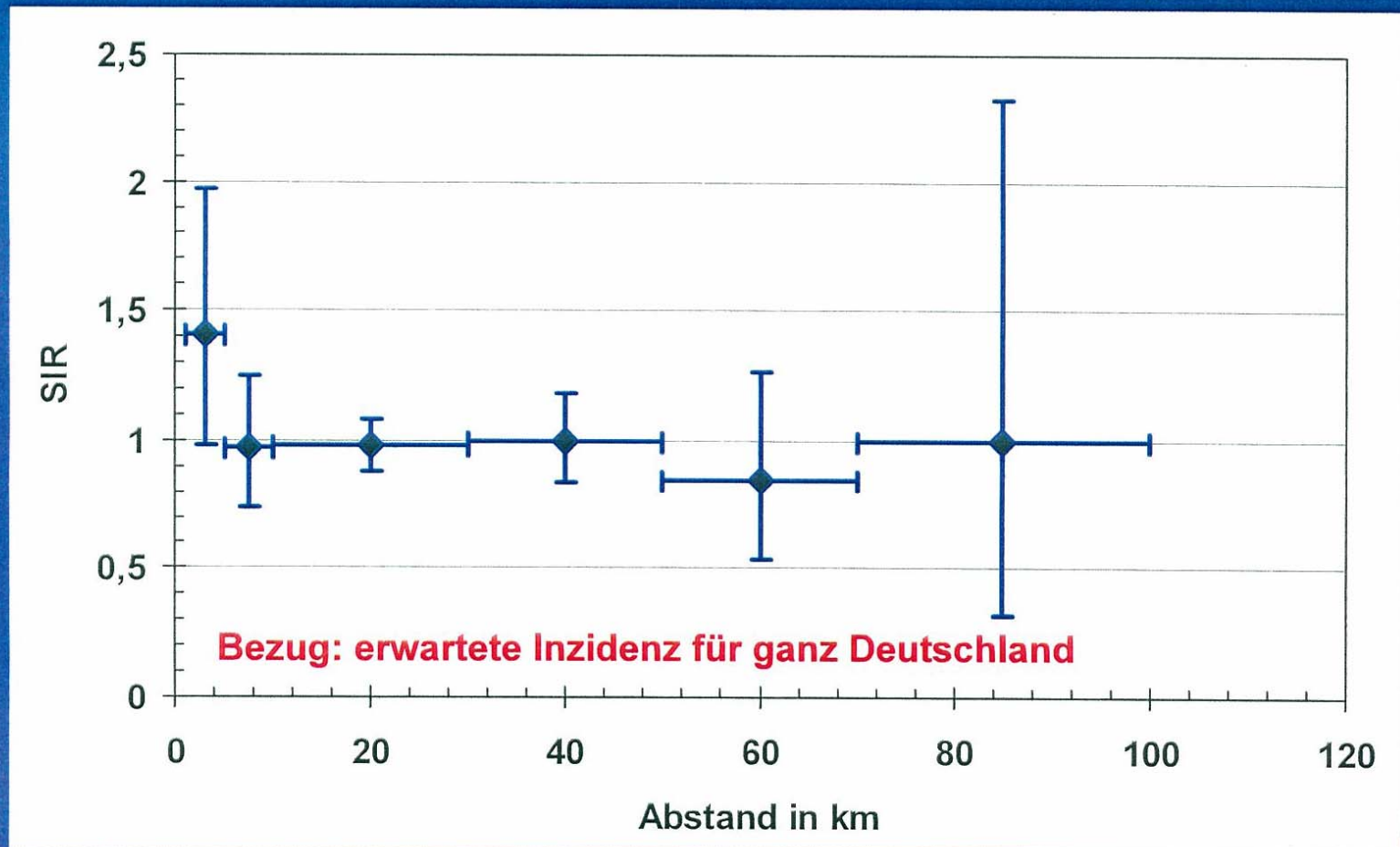
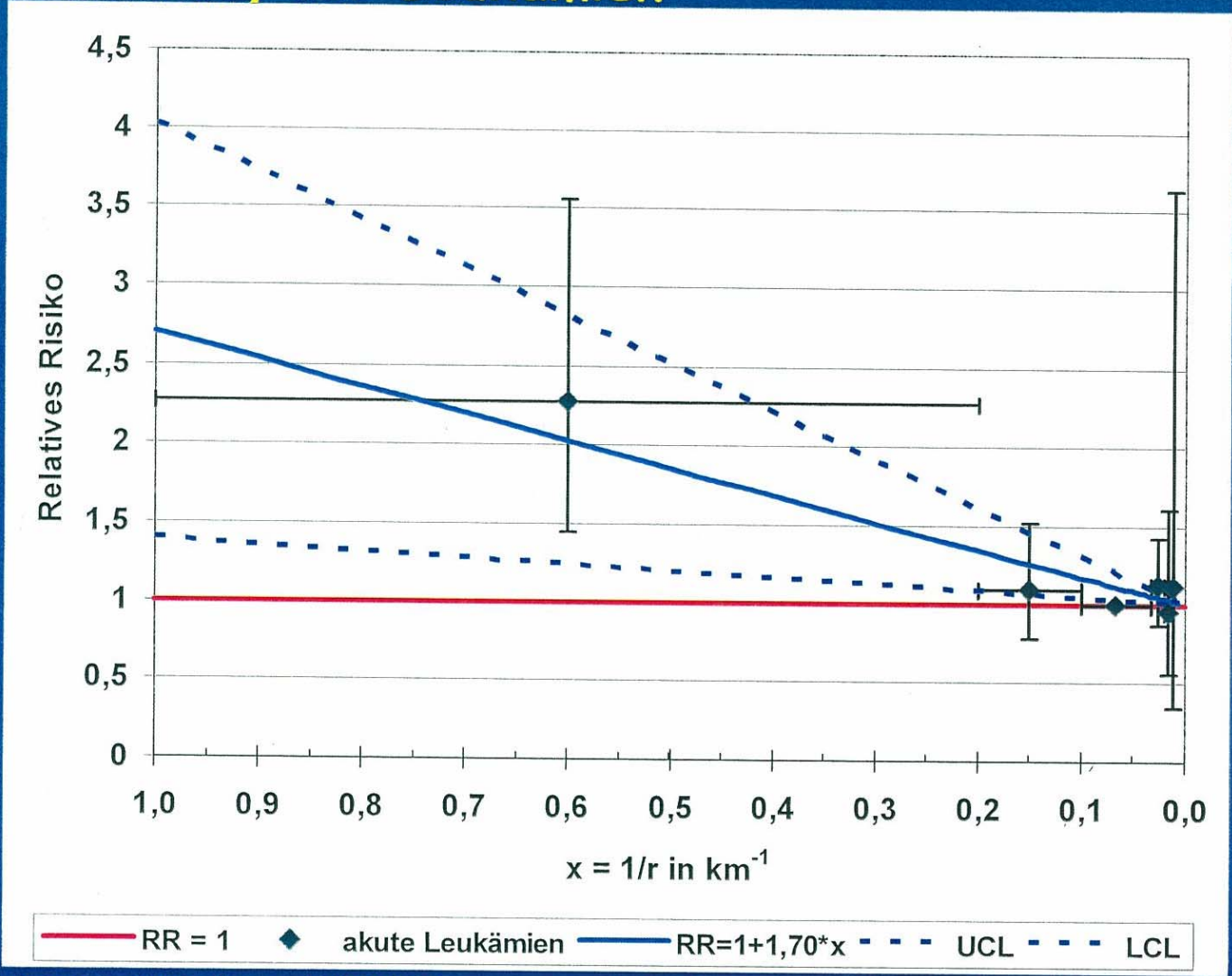


Table 3.14 lists in different spacer categories to respective number of cases and controls.

Anzahl beobachteter und erwarteter Leukämie-Erkrankungsfälle < 5 Jahren sowie SIR mit 95%-KI (zweiseitiger Test zum Niveau 5%) in Abhängigkeit vom Abstand der jeweiligen Ortsmittelpunkte aller in die Studienregion einbezogenen Gemeinden zum nächstgelegenen Kernkraftwerk



# Nachrechnung durch S. Darby und S. Read (2008): Kategorielle und kontinuierliche Auswertung der Leukämien



S. Darby und S. Read (2008)



3

## **Die KiKK-Studie im Kontext sonstiger epidemiologischer Studien**

**Wichmann, H.-Erich**

Institut für Epidemiologie, Helmholtz-Zentrum München  
IBE, Ludwig Maximilians Universität München

Fachgespräch zur Vorstellung der vollständigen Beratungsergebnisse der  
SSK zur KiKK-Studie am 26. Februar 2009 in Bonn

# Inhalt

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1. Die KiKK-Studie
2. Kontext sonstiger epidemiologischer Studien



Deutsches  
Kinderkrebsregister  
(Leitung: Dr. P. Kaatsch)

**GUTENBERG**  
UNIVERSITÄT

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# Die KiKK-Studie

Kaatsch et al. 2007 KiKK-Bericht  
Kaatsch et al. 2008 Int J Cancer  
Spix et al. 2008 Eur J cancer

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HelmholtzZentrum münchen  
German Research Center for Environmental Health

 HELMHOLTZ  
ASSOCIATION

## FAST TRACK

# Leukaemia in young children living in the vicinity of German nuclear power plants

Peter Kaatsch\*, Claudia Spix, Renate Schulze-Rath, Sven Schmiedel and Maria Blettner

Institute for Medical Biostatistics, Epidemiology and Informatics, German Childhood Cancer Registry, Obere Zahlbacher Strasse 69, 55131 Mainz, Germany

(24 年刊)

A case control study was conducted where cases were children younger than 5 years (diseased between 1980 and 2003) registered at the German childhood cancer registry (GCCR). Population-based matched controls (1:3) were selected from the corresponding registrar's office. Residential proximity to the nearest nuclear power plant was determined for each subject individually (with a precision of about 25 m). The report is focused on leukaemia and mainly on cases in the inner 5-km zone around the plants. The study includes 593 leukaemia cases and 1,766 matched controls. All leukaemia combined show a statistically significant trend for 1/distance with a positive regression coefficient of 1.75 [lower 95%-confidence limit (CL): 0.65]; for acute lymphoid leukaemia 1.63 (lower 95%-CL: 0.39), for acute non-lymphoid leukaemia 1.99 (lower 95%-CL: -0.41). This indicates a negative trend for distance. Cases live closer to nuclear power plants than the randomly selected controls. A categorical analysis shows a statistically significant odds ratio of 2.19 (lower 95%-CL: 1.51) for residential proximity within 5 km compared to residence outside this area. This result is largely attributed to cases in previous studies of the GCCR (especially in the inner zone) as there is clearly some overlap between those studies. The result was not to be expected under current radiation-epidemiological knowledge. Considering that there is no evidence of relevant accidents and that possible confounders could not be identified, the observed positive distance trend remains unexplained.

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Key words: childhood; leukaemia; nuclear power plants; population-based; cancer registry

To date, the aetiology of childhood leukaemia has remained inconclusive even though numerous epidemiological studies have addressed this question. There are some risk factors discussed as possibly causal or protective include lifestyle, genetic disposition, course of pregnancy and perinatal development, the immune system and environmental hazards.<sup>1–5</sup> One generally accepted risk factor for leukaemia is exposure to ionising radiation.<sup>6,7</sup> Whether there is a threshold level at which any higher level of exposure will be associated with occurrence of leukaemias, however, is subject to controversy. Internationally, currently used estimates of cancerogenic radiation effects in the low-dose range are based on linear no-threshold extrapolation regarding leukaemia, a quadratic model is also applicable.<sup>8,9</sup> Other authors work on the assumption that these models overestimate the effects in a dose range of <10 mSv. Sievert considers published reports or data are reported to be insufficient for any conclusions to be drawn.<sup>8</sup>

For many years, there has been controversy over whether or not the emission of ionising radiation during routine operation of nuclear plants will already increase the risk of leukaemia in children. Such an effect is not too likely as present-day emissions of ionising radiation from nuclear power plants in routine operation are several magnitudes lower than the value of 0.3 mSv/year not to be exceeded according to the guidelines for the operation of nuclear power plants.<sup>11,12</sup>

In 1987 and 1989, British studies reported a statistically significant increased rate of leukaemia in under 15-year-olds within a 10-mile zone of nuclear plants in England and Wales.<sup>13,14</sup> These

reports prompted a study of almost identical design that was based on the data of the German Childhood Cancer Registry (GCCR) and was conducted in the late 1980s. This was an ecological study comparing disease rates within 15 km (roughly 10 miles) of German nuclear plants with those seen in specified control areas. The study period extended from 1980 through 1990 (Study 1). An increased rate of all cancer or, more specifically, leukaemia in children younger than 15 years within a 15-km zone of West German nuclear plants was not confirmed. However, exploratory analyses indicated that, for example, in children younger than 5 years living within the inner 5-km zone, the increase in leukaemia rate was statistically significant.<sup>15</sup> As these results gave rise to controversial discussion and as at the same time a statistically significant leukaemia cluster was seen near the North German nuclear power plant of Krümmel,<sup>16</sup> the study period was extended to cover the years 1991 through 1995 (Study 2).

Study 2 failed to reproduce statistically significant results regarding the subgroup for which results were significantly increased in the exploratory analysis of Study 1. Nevertheless, a tendency was seen towards an increased relative risk (RR) for leukaemia to occur in under 5-year-olds within the 5-km vicinity.<sup>17</sup>

Even after these results had been published, discussions on a potential relationship between the occurrence of childhood leukaemia and close proximity to nuclear plants in routine operation have not ceased. For this reason, a case control study was initiated by the Federal government and started at the GCCR in 2003. In this investigation, residential proximity to the nearest nuclear power plant was determined for each subject individually. This case control study was limited to children younger than 5 years. As in Studies 1 and 2, not only leukaemia, but all childhood malignancies were included. Its scope extends well beyond the 15-km zone defined in the first 2 studies.<sup>18</sup> Some features regarding the design of all 3 GCCR studies are given in Table I.

The present report is focused on leukaemia and mainly on cases with place of residence in the inner 5-km zone around the nuclear power plants. Other results are published elsewhere.<sup>19</sup> As in most radiation-epidemiological studies, the leukaemia cases are subdivided for analysis into acute lymphoid and acute non-lymphocytic leukaemias. Considering that some leukaemia cases of the previous studies (Studies 1 and 2), and especially those from the inner zone, are identical with those included in the recent study, and data are thus not independent, this aspect will be given particular attention.

**Abbreviations:** CL, confidence limit; GCCR, German Childhood Cancer Registry; GPOH, German Society of Paediatric Oncology and Haematology; ICC, International Classification of Childhood Cancer; NPP, nuclear power plants; OR, odds ratio; RR, relative risk.

Grant sponsors: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety via the Federal Office for Radiation Protection; Grant number: StSch 4334.

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DOI 10.1002/ijc.23330

Published online 7 December 2007 in Wiley InterScience (www.interscience.wiley.com).

SSK

**Die Antwort ist richtig,  
aber die Frage ist falsch gestellt.**

**Ein wichtiger Aspekt:**

**Diejenigen, die an der Überlegung festhalten, dass die von den Kernkraftwerken ausgehende Strahlenexposition für die Erhöhung der Leukämiefälle verantwortlich ist, sollten bedenken, dass für den Fall, dass sie sich irren, der eigentliche/die eigentlichen Verursacher nicht identifiziert werden!**

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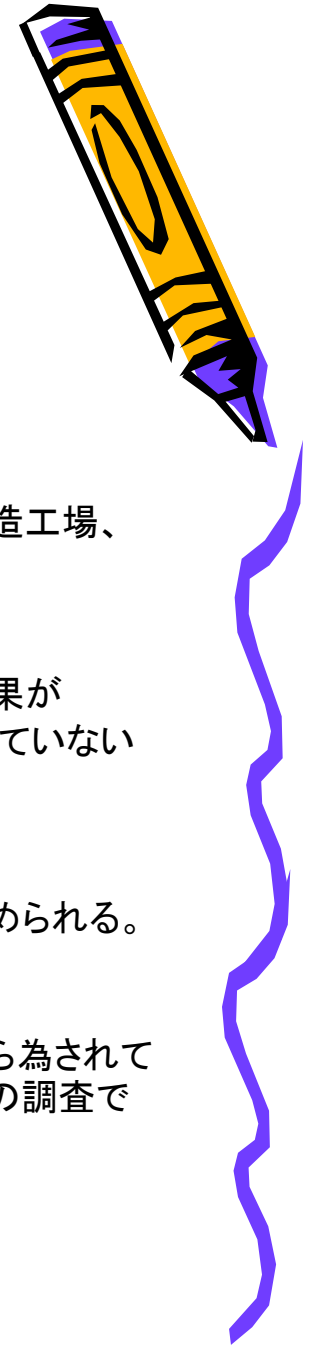
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# KiKK研究におけるデザインの欠点

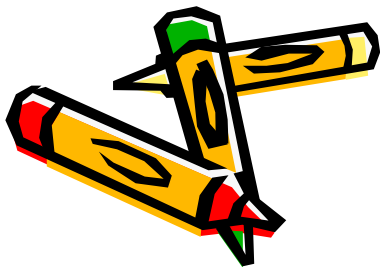
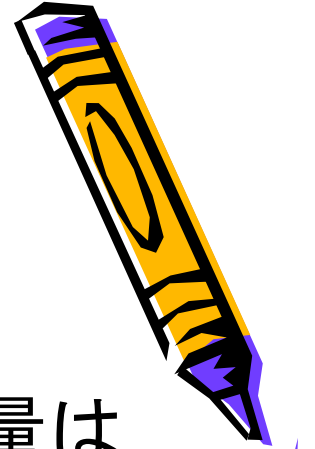


- ①:「古い」データの混入  
→ データの約3分の2は、古い(エコロジー)研究によるもので、これらのデータから5キロ圏内の5歳児以下の発症が多いことは、すでに知られていた。
- ②:居住地は、必ずしも主たる滞在地とは一致しない。  
→ 小児は居住地以外の場所で過ごす時間が長い。例えば幼稚園など。
- ③:原子力発電所以外の場所については調査されていない。  
→ 他のいくつかの研究もKiKK研究と類似する結果を出しているが、それらは精油所、自動車製造工場、自動車修理工場、溶剤メーカーなども調査している。
- ④:交絡因子が考慮されていない。  
→ KiKK研究の第2部は、交絡因子が追求されてしかるべきなのに実行されておらず、有益な結果が得られていない。とりわけ5キロ圏内の症例の両親は、きわめて乏しい数しか調査用紙を返送していないために、第2部は役に立たない。
- ⑤:住民の移動が考慮されていない。  
→ KiKK研究の当事者自身が確認しているとおり、当該地域では頻繁に転入(および転出)が認められる。
- ⑥:デザイン  
→ 通常の放射線被曝、および原子力発電所による放射線被曝を把握する試みが、端緒的にすら為されていない。KiKK研究の第2部の結果はあまりにも統計的有意差の検出力不足なので、もし第2部の調査で交絡因子について信頼するに足る情報は得られなかっただろう。



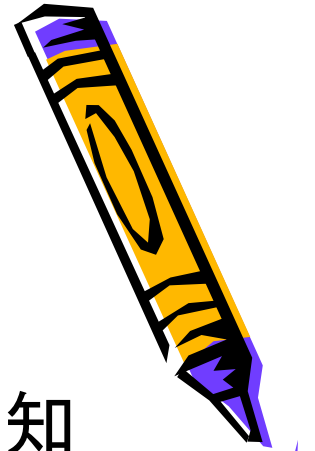
# 結語

- 原子力施設周辺の標準人への年間被曝線量は年間 $1.9 \mu\text{Sv}$ である。
- この被曝は、施設5km以内で観察されたリスクを説明する1000分の1の量である。
- このリスクを示すためには12–30mSv必要。
- LNT仮説に基づいて逆の推論をすれば、自然放射線が年間10万人あたり5人の白血病の自然発生に寄与しているかもしれない。



# SSKの提言

- 白血病の病因や発症のメカニズムは学術的知見が少なすぎる。
- 小児白血病を理解するには、疫学調査だけではなく、小児白血病に関するさらに基礎的研究が必要である。
- そのためには、さらなる学際的研究は不可欠である。
- 疫学、遺伝学、免疫学、分子生物学、放射線医学の連携をしよう。





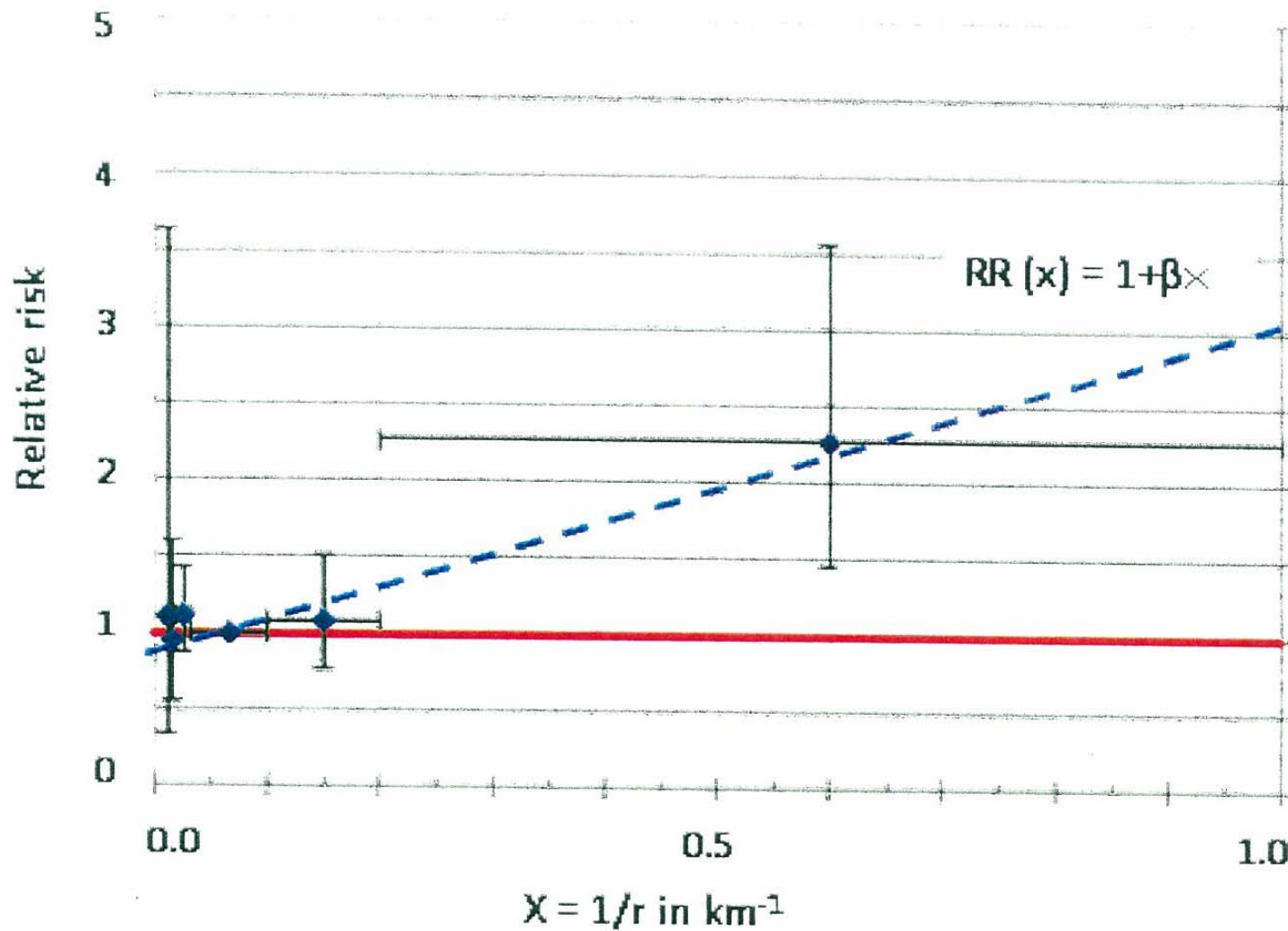


図 2.1-1 SSK 報告書の Fig.2 を左右反転させ、回帰直線を引いた場合  
(緒方による)

(別添)

## KiKK 研究とその後

松原メモ (2010.3.29)

### KiKK 研究 : Epidemiologischen Studien zu KinderKrebs in der Umgebung von Kernkraftwerken

#### 経過

- 1.1980-1995 ecological study で 原子力施設周辺 5 km 以内で小児白血病の発生リスク大。特に初期に顕著であった。
2. 2007. 12, BfS は、以前ガブリエル連邦環境相が依頼した KiKK 研究の検証を行いその評価報告を発表。……①
3. 2008. 5. ICNIRP/WHO/BfS 主催の Berlin 会議で小児白血病のリスク要因について議論した。変異性 B リンパ球前駆細胞に由来する ALL は、社会的接触の少ない免疫不全の子供に多いらしい。故に疫学のほかに、免疫学や遺伝学や環境との相互作用に関する研究が必要と主張。
4. 2008. 10. ドイツ連邦 BMU から「SSK による KiKK 研究の評価」が発表された。すなわち、SSK 文書 Heft 57 (2008)、および Heft 58 (2009)..... ②
5. 2009. 2.26. SSK 主催で Bonn にて専門家会議開催。

#### KiKK 研究とボン会議の結論

DKKR (ドイツ小児がん登録) に基づき、原子力発電所周辺に居住する小児癌の症例 1592 人と、性、年齢と地域をマッチさせた対照 4725 人につき症例対照研究法(case-control study)で分析したところ、住居と最も近い原子力発電所との距離と 5 歳未満の白血病リスクとの関連が確認された。5km 圏内での初期の 5 歳未満児の白血病増加が全体の結果に大きく影響していた。発電所との距離だけを問題にし、被曝放射線量や交絡因子について調べられていないので、関連性の説明やリスク因子の推定は不可能。今後、小児白血病と環境要因、遺伝要因を含むより幅広い学際的研究が必要である。

#### 資料

- ①「原子力安全・放射線防護にかんする—UFOPLAN StSch 4334」  
334 ページ  
—BMU,BfS により委託された KiKK 研究 P.Kaatsch ら、  
第 1 部症例対照研究 (質問紙なし)、  
第 2 部同 (一部質問紙発送)
- ②SSK による「KiKK 研究の評価」  
Heft 57 (2008) 約 40 ページ  
Heft 58 (2009) 約 300 ページおよび約 200 頁の資料