Niedrigdosis-Strahlung und Gesundheit

Neues (und Altes) aus der Epidemiologie

Wolfgang Hoffmann

Institut für Community Medicine
Universitätsmedizin Greifswald

Öffentliche Fachkonferenz zur Schachtanlage Asse 2, Ldkrs Wolfenbüttel, Bürgerhaus Remlingen 2.3.2017

WALT DISNEY

Unser Freund das ATOM

VON HEINZ HABER

Knaur

RADIOLOGISCHE PRAKTIKA • BAND X

Röntgentherapie des Schwachsinnes bei Kindern

von

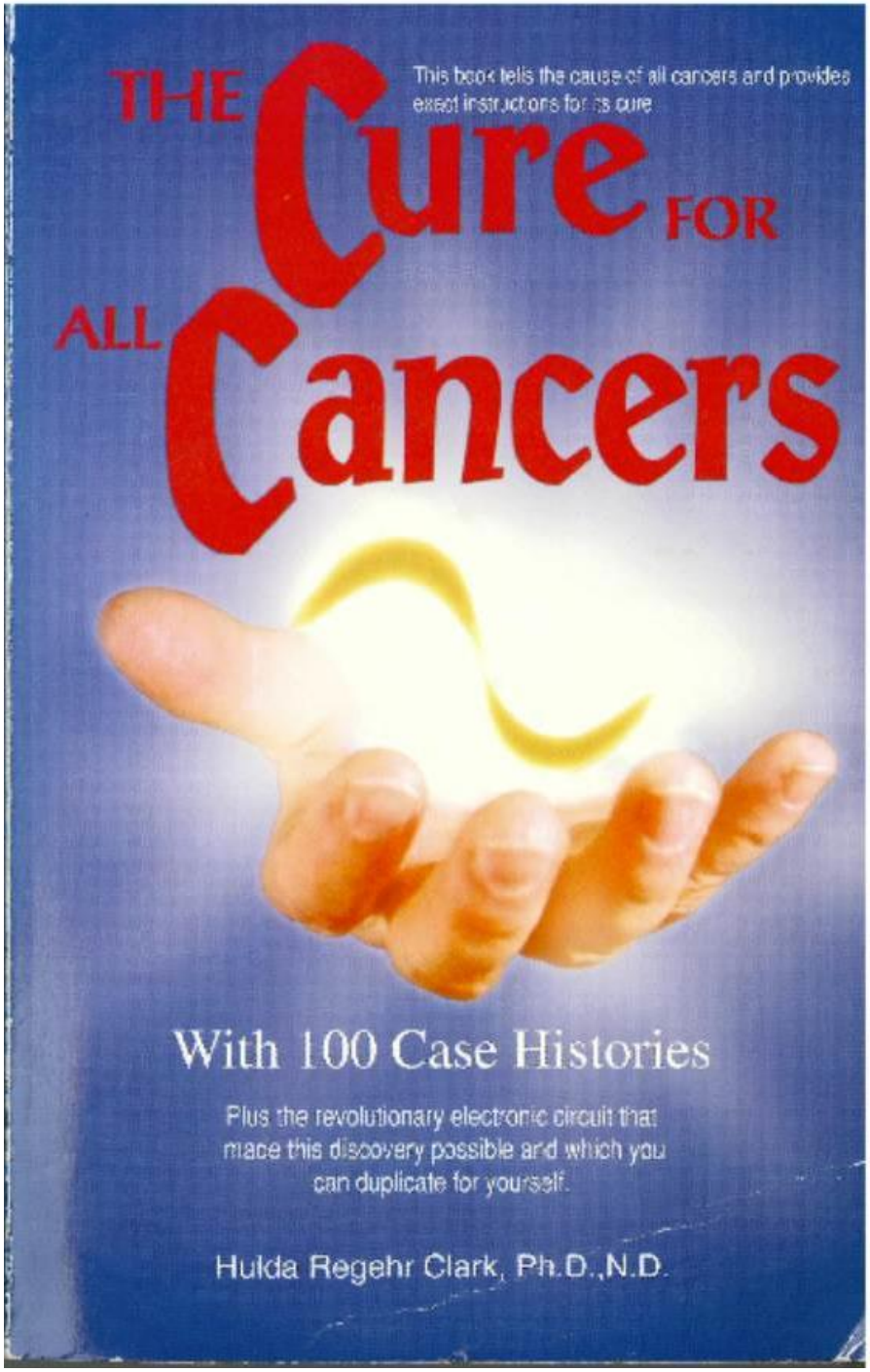
Dr. Wolfgang Freiherr von Wieser

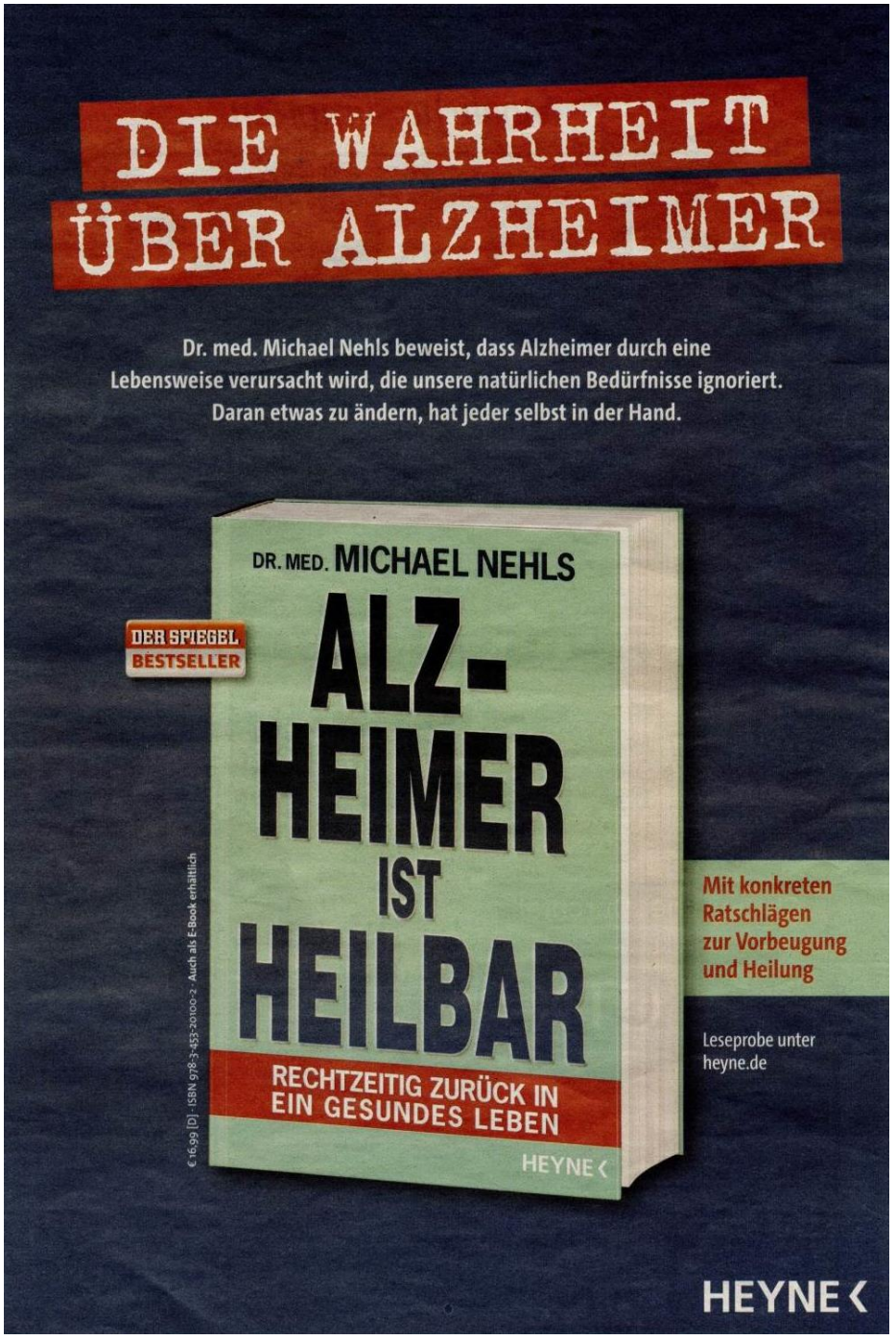

ERNST GROSS
Aviator
So
ging der
Kunde von uns
Passender Schuh
Gerade Zehenlage
Kaum Ballen- und
Hühneraugenbildung
Gesunder Fuß
So
kam der
Kunde zu uns
Zu kurzer Schuh
Verkrümmte
Zehenlage
Starke Ballen- und
Hühneraugenbildung
Kranker Fuß
Lassen Sie sich Ihren Fuß hier kostenlos
durchleuchten

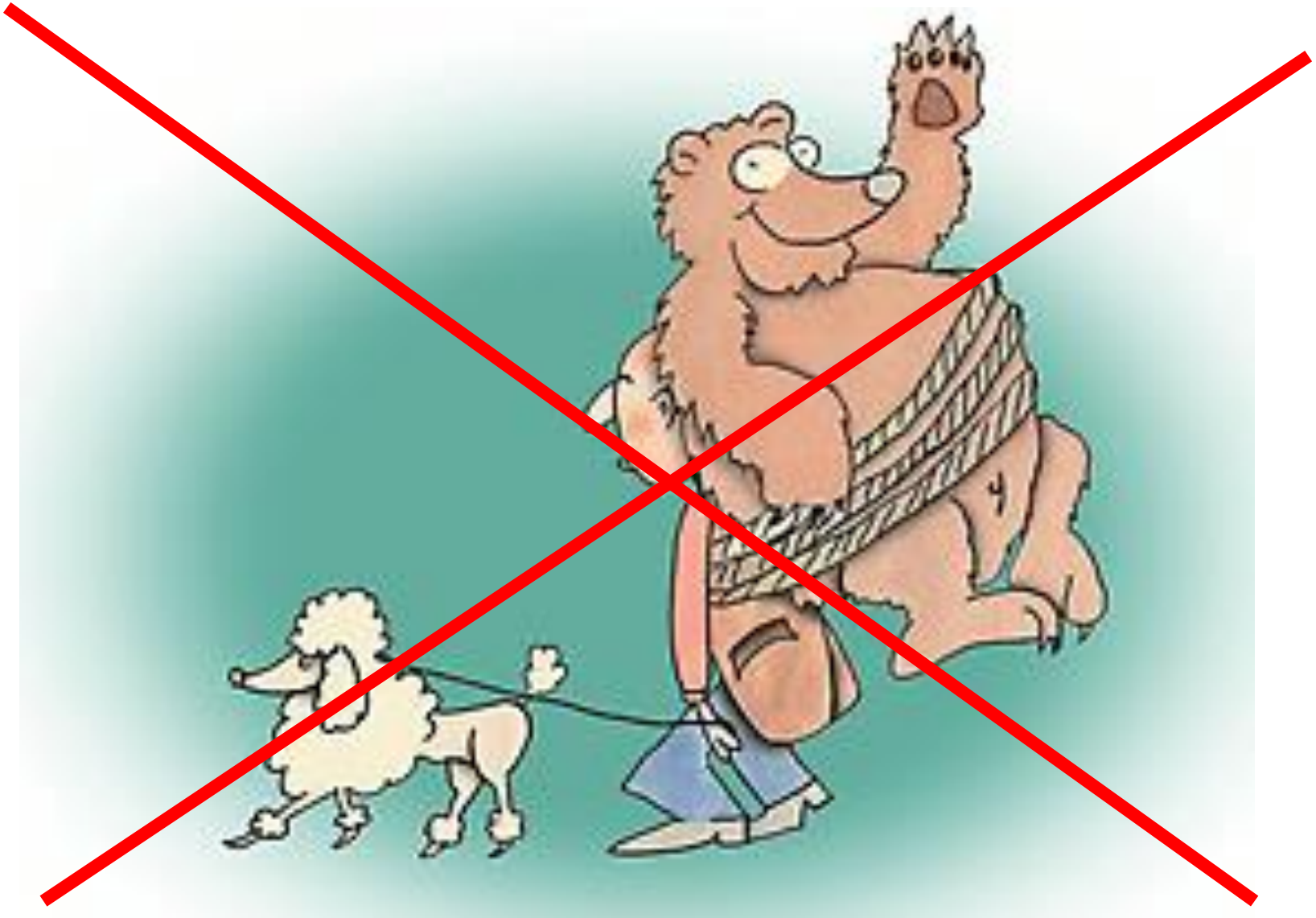
Seit den 20er Jahren kamen in vielen

Abb. 1: Werbung für das Radiumbad Oberschlema um 1938 – allerdings nicht das weltstärkste, denn die Wettinquelle in Bad Brambach liegt mit 160.000 Bq/l noch deutlich höher

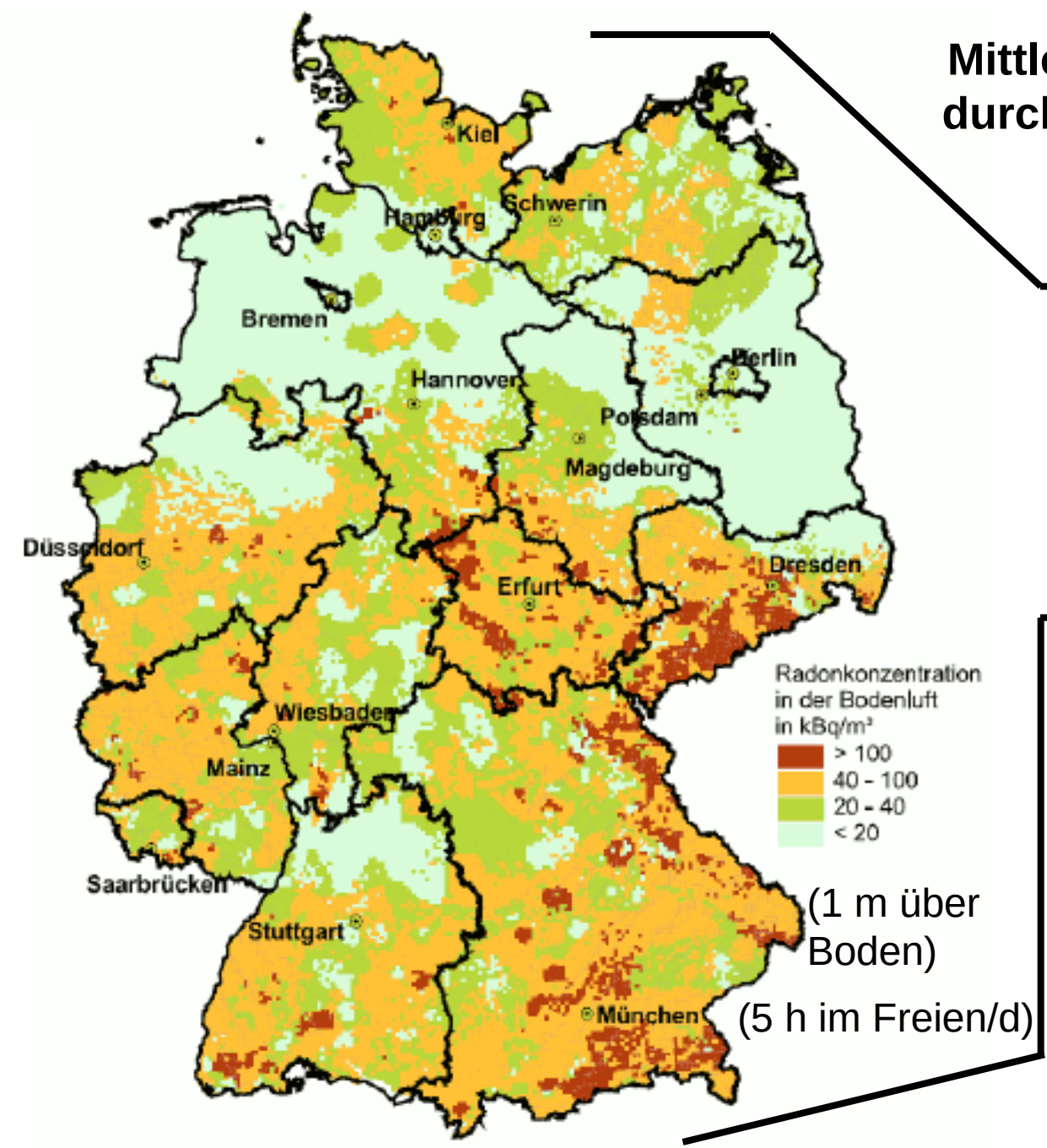
Quelle: Bericht über die 4. Biophysikalische Arbeitstagung vom 22.-24. September 2006 in Bad Schlema in: Strahlenschutz Praxis Heft 1/2007 S. 76-79


THE Cure FOR ALL Cancers
This book tells the cause of all cancers and provides exact instructions for its cure
With 100 Case Histories
Plus the revolutionary electronic circuit that made this discovery possible and which you can duplicate for yourself.
Hulda Regehr Clark, Ph.D.,N.D.


DIE WAHRHEIT ÜBER ALZHEIMER
Dr. med. Michael Nehls beweist, dass Alzheimer durch eine Lebensweise verursacht wird, die unsere natürlichen Bedürfnisse ignoriert. Daran etwas zu ändern, hat jeder selbst in der Hand.
DR. MED. MICHAEL NEHLS
DER SPIEGEL BESTSELLER
ALZ-HEIMER IST HEILBAR
RECHTZEITIG ZURÜCK IN EIN GESUNDES LEBEN
HEYNE
Mit konkreten Ratschlägen zur Vorbeugung und Heilung
Leseprobe unter heyne.de
HEYNE

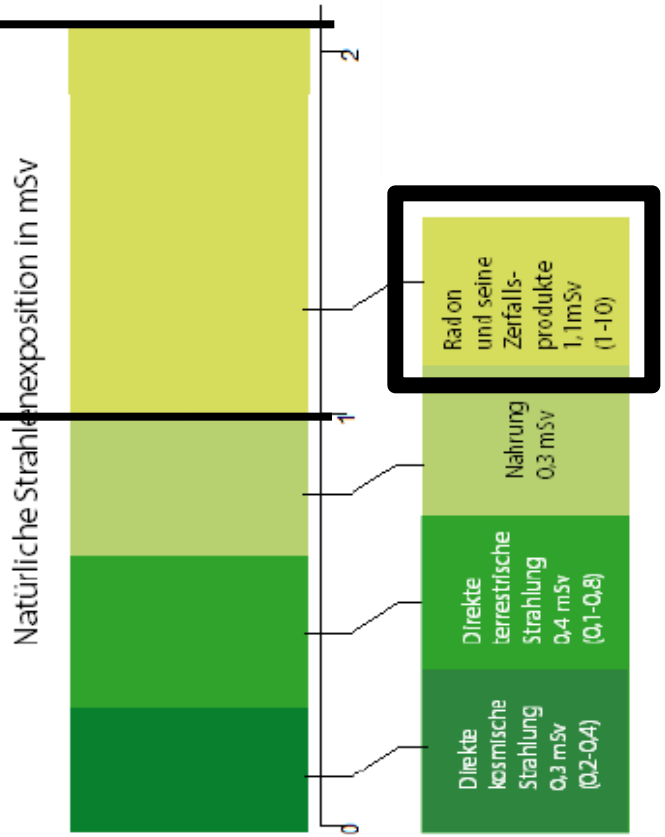


Mittlere effektive Jahresdosis durch ionisierende Strahlung: Radon (2013)



(1 m über Boden)

(5 h im Freien/d)



Karte: Umweltradioaktivität und Strahlenbelastung im Jahr 2011 (Unterrichtung durch die Bundesregierung), Bundestagsdrucksache 17/14395 (2013); rm17297
Grafik rechts: Umweltradioaktivität und Strahlenbelastung im Jahr 2013, Bundestagsdrucksache 18/5565 v. 13.07.2015

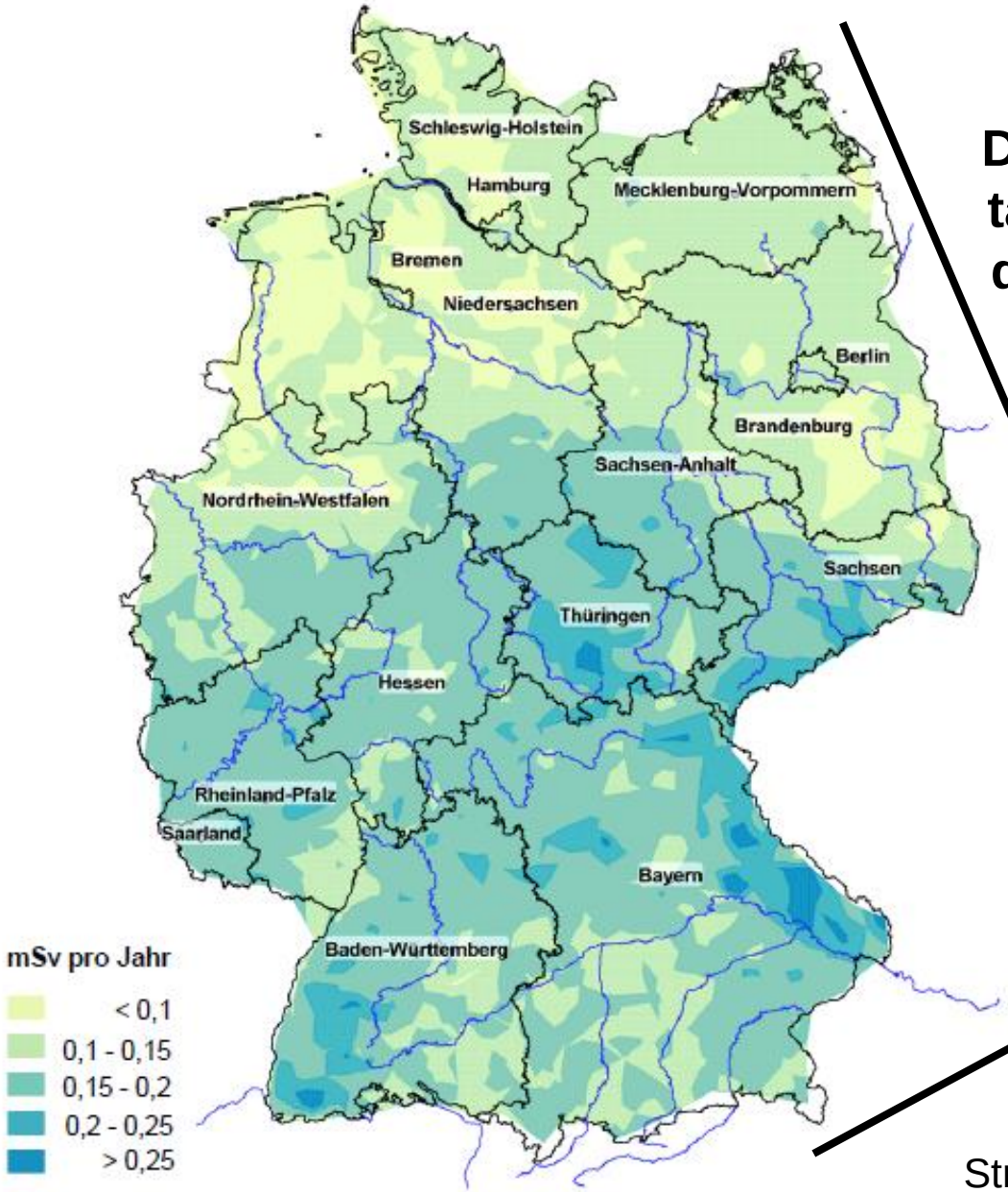
Krebsfälle durch Radon: Bronchialkarzinome

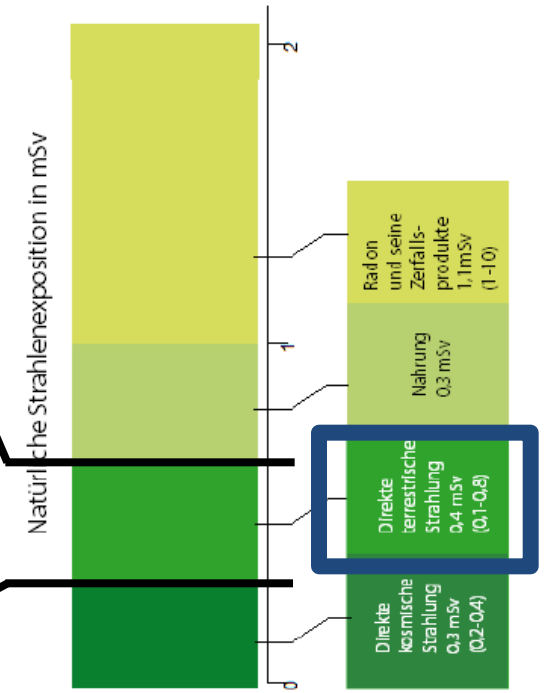
Attributable fraction for lung cancer due to indoor radon in Switzerland and Germany, compared to outdoor air concentrations of 10 Bq/m^3 (Switzerland) and 9 Bq/m^3 (Germany). Based on European indoor model after measurement error correction and likewise corrected radon distribution, calculated separately for gender and smoking.

Gender	Smoking status	PAF in %	95% CI		# cases per year	95% CI	
			Switzerland				
Men	Non-smoker	8.8	3.3	23.2	5	2	14
Men	Smoker	8.2	3.1	21.5	164	62	427
Women	Non-smoker	8.8	3.3	23.2	8	3	21
Women	Smoker	8.6	3.2	22.6	54	20	143
Sum		8.3			231		
			Germany				
Men	Non-smoker	5.2	1.8	13.2	32	11	81
Men	Smoker	5.0	1.7	12.5	1390	478	3484
Women	Non-smoker	5.2	1.8	13.2	127	44	320
Women	Smoker	5.2	1.8	13.0	347	119	874
Sum		5.0			1896		

aus: Menzler S, Piller G, Gruson M, Schaffrath Rosario A, Wichmann HE, Kreienbrock L. Population Attributable for Lung Cancer Due to Residential Radon in Switzerland and Germany. Health Phys 2008, 95 2: 179-189 (modif.)

Externe Strahlenexposition im Freien im Jahr 2013 in Deutschland beim Aufenthalt von täglich 5 Stunden (abgeleitet aus der Gamma-Ortsdosisleistung in Bodennähe)





Quelle: Umweltradioaktivität und Strahlenbelastung im Jahr 2013, Unterrichtung durch die Bundesregierung, Bundestagsdrucksache 18/5565 v. 13.07.2015, S. 9.

Updated estimates of the proportion of childhood leukaemia incidence in Great Britain that may be caused by natural background ionising radiation

Mark P Little[1,4], Richard Wakeford[2] and Gerald M Kendall[3]

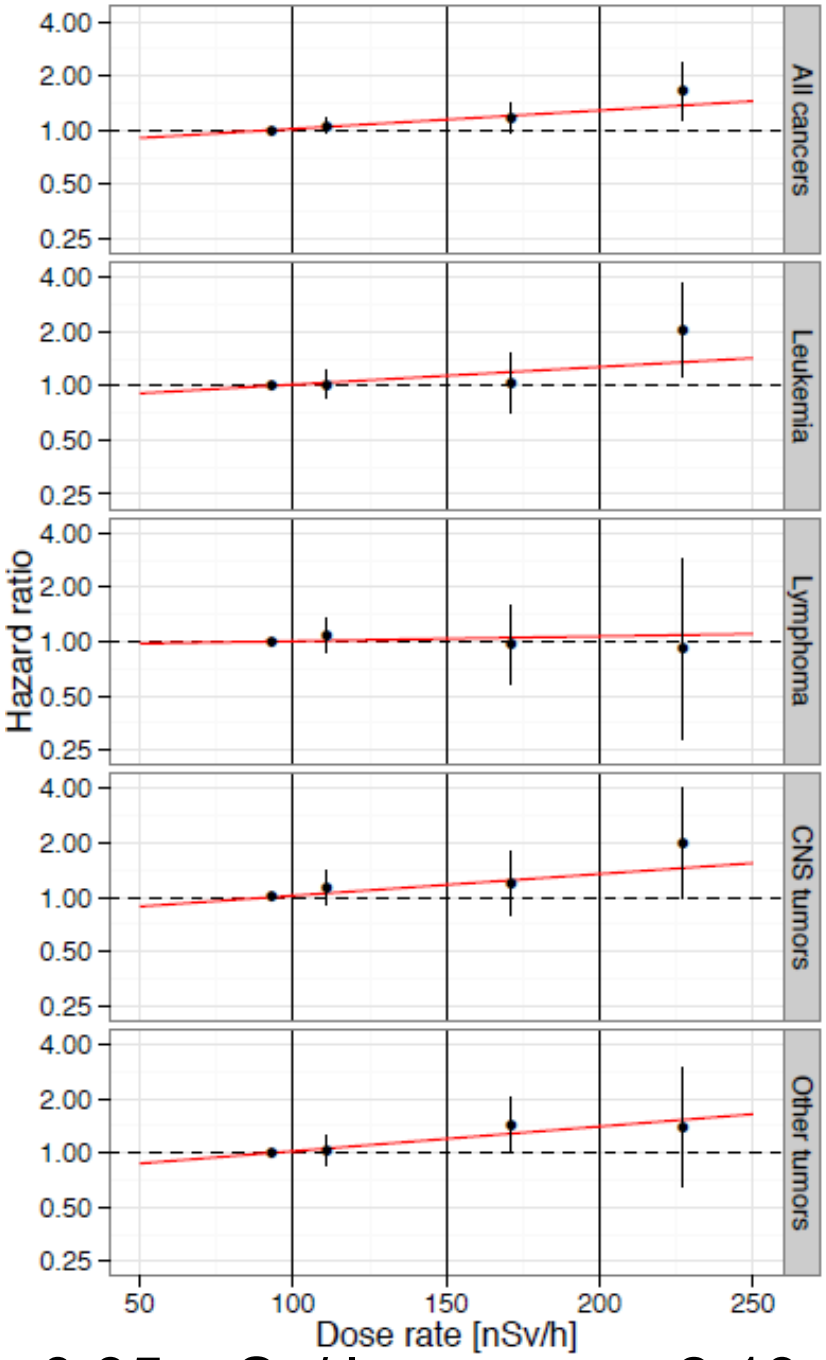
Abstract

The aetiology of childhood leukaemia remains generally unknown, although

Using the newer dosimetry we calculate that the best estimate of the proportion of cases of childhood leukaemia in Great Britain predicted to be attributable to this source of exposure is 15–20%.

this paper we employ the two sets of published leukaemia risk models used previously, but use recently published revised estimates of natural background radiation doses received by the red bone marrow of British children to update the previous results. Using the newer dosimetry we calculate that the best estimate of the proportion of cases of childhood leukaemia in Great Britain predicted to be attributable to this source of exposure is 15–20%, although the uncertainty associated with certain stages in the calculation (e.g. the nature of the transfer of risk between populations and the pertinent dose received from naturally occurring alpha-particle-emitting radionuclides) is significant. The slightly lower attributable proportions compared with those previously derived by Wakeford *et al* (*Leukaemia* 2009 **23** 770–6) are largely due to the lower doses (and in particular lower high LET doses) for the first year of life.

J. Radiol. Prot. **29** (2009) 467–482



ehp ENVIRONMENTAL HEALTH PERSPECTIVES
http://www.ehponline.org

Background Ionizing Radiation and the Risk of Childhood Cancer: A Census-Based Nationwide Cohort Study

Ben D. Spycher, Judith E. Lupatsch, Marcel Zwahlen, Martin Röösli, Felix Niggli, Michael A. Grotzer, Johannes Rischewski, Matthias Egger, and Claudia E. Kuehni for the Swiss Pediatric Oncology Group and the Swiss National Cohort Study Group

http://dx.doi.org/10.1289/ehp.1408548

Received: 11 April 2014
Accepted: 28 January 2015
Advance Publication: 23 February 2015

Figure 2. Hazard ratios for cancer by dose rate of external ionizing radiation among children aged <16 years in the Swiss National Cohort. Results from Cox proportional hazards models adjusting for sex and birth year using a categorized exposure (points and bars (95% CIs) placed along the x-axis at mean dose rates within categories; categories delineated by vertical lines) and a linear exposure term (red line). Dose rates <100 nSv/h are the reference category. CNS central nervous system.

0,95 mSv/J

2,19 mSv/J

Umweltforschungsplan des Bundesumweltministeriums (UFOPLAN)

Reaktorsicherheit und Strahlenschutz

Vorhaben StSch 4334:
Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken (KiKK-Studie)

Zusammenfassung/Summary

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

Im Auftrag des Bundesministeriums für Umwelt, Naturschut
Reaktorsicherheit und des Bundesamtes für Strahlenschutz

Bundesamt für Stral

(Jan. 2008)

J_ID: IJC Wiley Ed. Ref. No.: 07-1716.R1 Customer A_ID: IJC23330 Date: 21-NOVEMBER-07 Stage: I Page: 1

Int. J. Cancer 1220(2008), 721-726

Int. J. Cancer: **000**, 000–000 (2007)

AQ1

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

ARTICLE IN PRESS

EUROPEAN JOURNAL OF CANCER XXX (2007) XXX–XXX

available at www.sciencedirect.com

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jo European J. Cancer 44(2008), 275-284

Case–control study on childhood cancer in the vicinity of nuclear power plants in Germany 1980–2003

Claudia Spix[a,], Sven Schmiedel[a], Peter Kaatsch[a], Renate Schulze-Rath[a], Maria Blettner[b]*

[a]*German Childhood Cancer Registry, Institute for Medical Biostatistics, Epidemiology and Informatics, University Mainz, 55101 Mainz, Germany*

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ARTICLE INFO

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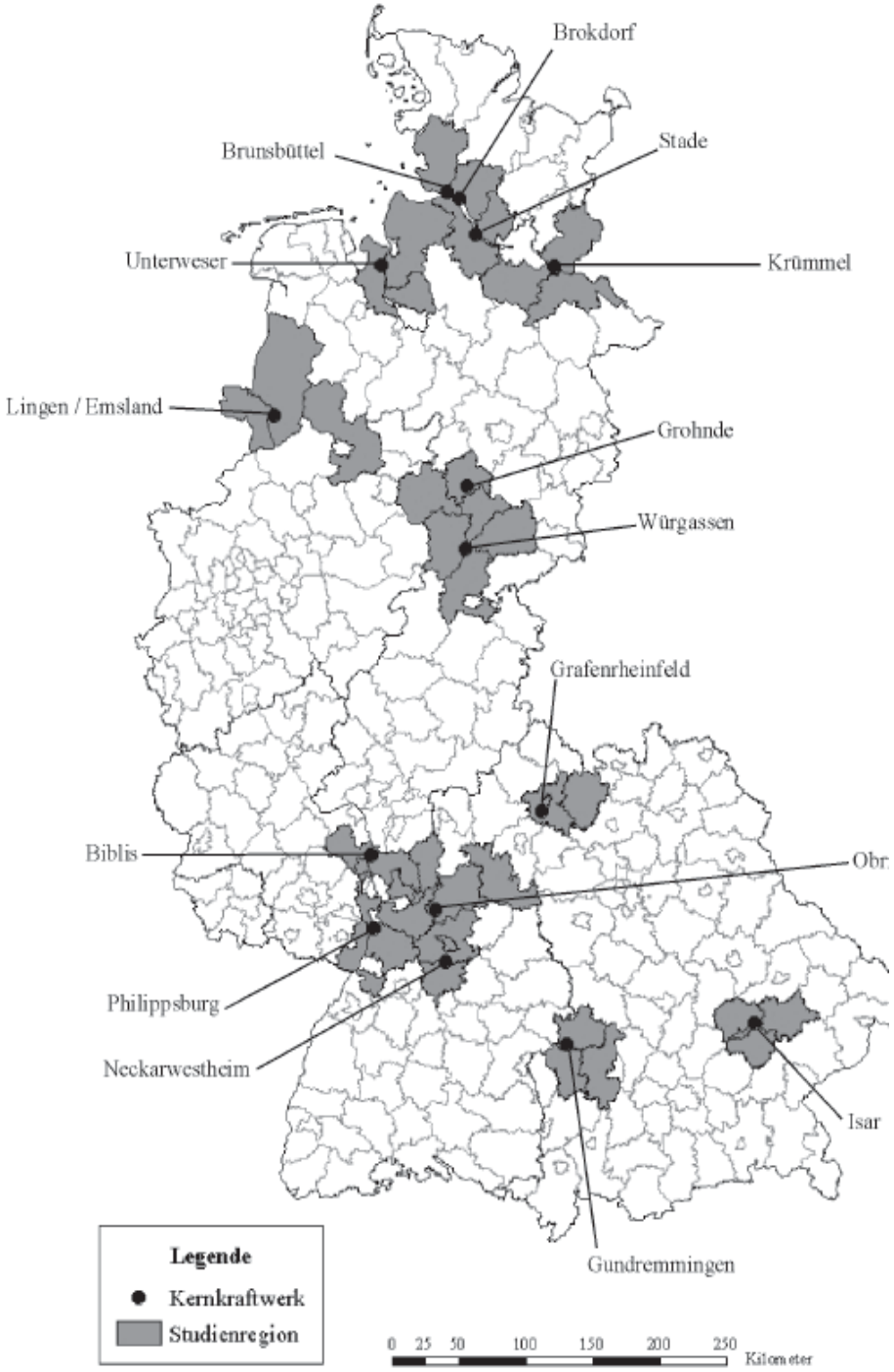
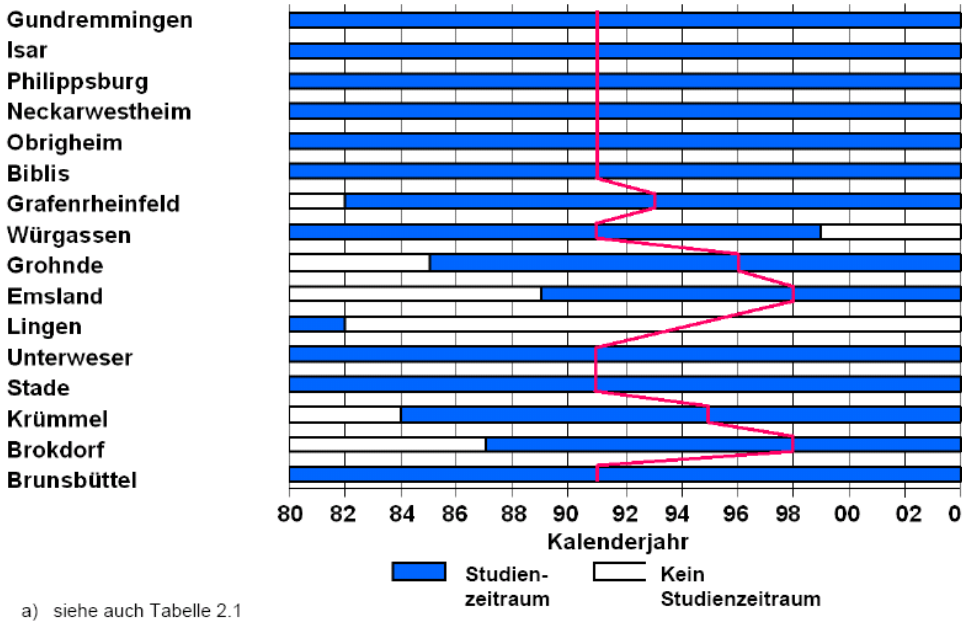
ABSTRACT

The 1984 Windscale study raised concern about a possible association between living in the vicinity of nuclear power plants and childhood cancer. No such effect for all cancers was seen in ecological studies in Germany (1980–1995). Results from exploratory analyses led

Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken (KiKK-Studie), 2003 – 2007



Relevante Betriebszeiträume



a) siehe auch Tabelle 2.1
b) siehe auch Tabelle 2.2

Abbildung 3.3: Räumliche Lage der Fälle und Kontrollen zum jev
genen Kernkraftwerk, dargestellt sind Abstände b
Diagnose 1980-2003, alle Erkrankungen
Auswertedatensatz, 1592 Fälle und 4735 Kontrol

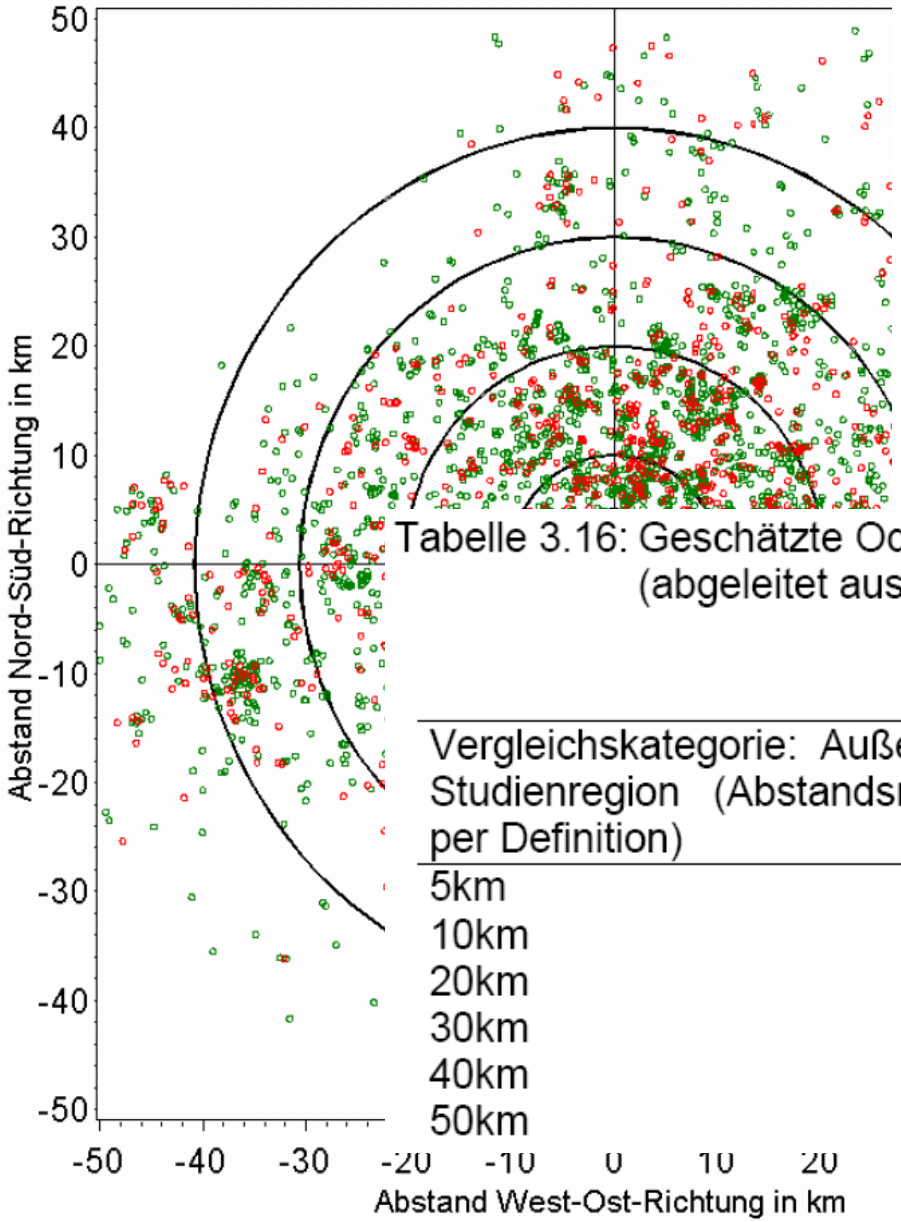


Abbildung 3.2: Verteilung der Fälle und Kontrollen nach Abstand vom jeweils nächstgelegenen Kernkraftwerk
Diagnose 1980-2003, alle Erkrankungen
Auswertedatensatz, 1592 Fälle und 4735 Kontrollen

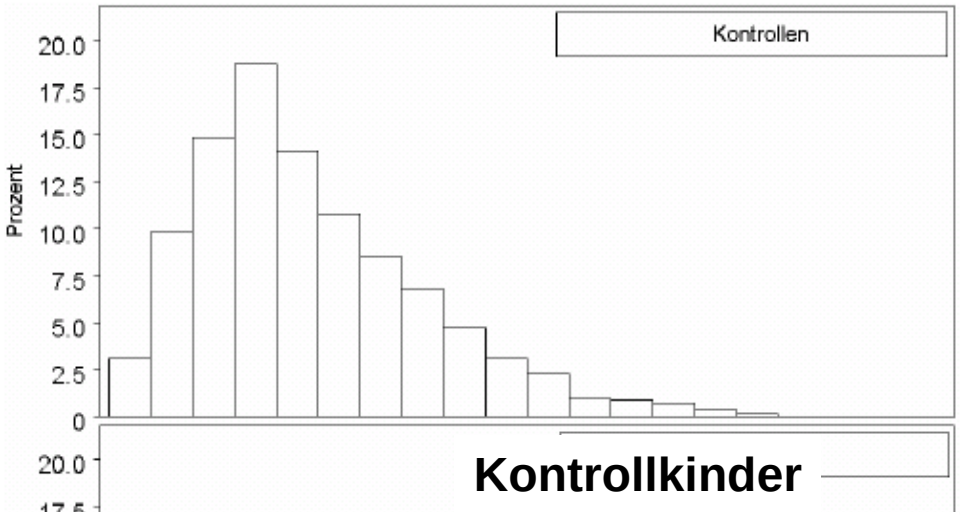


Tabelle 3.16: Geschätzte Odds Ratios (OR) für ausgewählte Abstände (abgeleitet aus der Regressions-Kurve aus Modell (6), Tabelle 3.15)

	OR	Untere eins. 95%-Konfidenzgrenze
Vergleichskategorie: Außerhalb der Studienregion (Abstandsmaß = 0 per Definition)	1	-
5km	1,27	1,10
10km	1,13	1,05
20km	1,06	1,02
30km	1,04	1,02
40km	1,03	1,01
50km	1,02	1,01

Abschlußbericht, S. 47

Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken (KiKK-Studie), 2003 – 2007

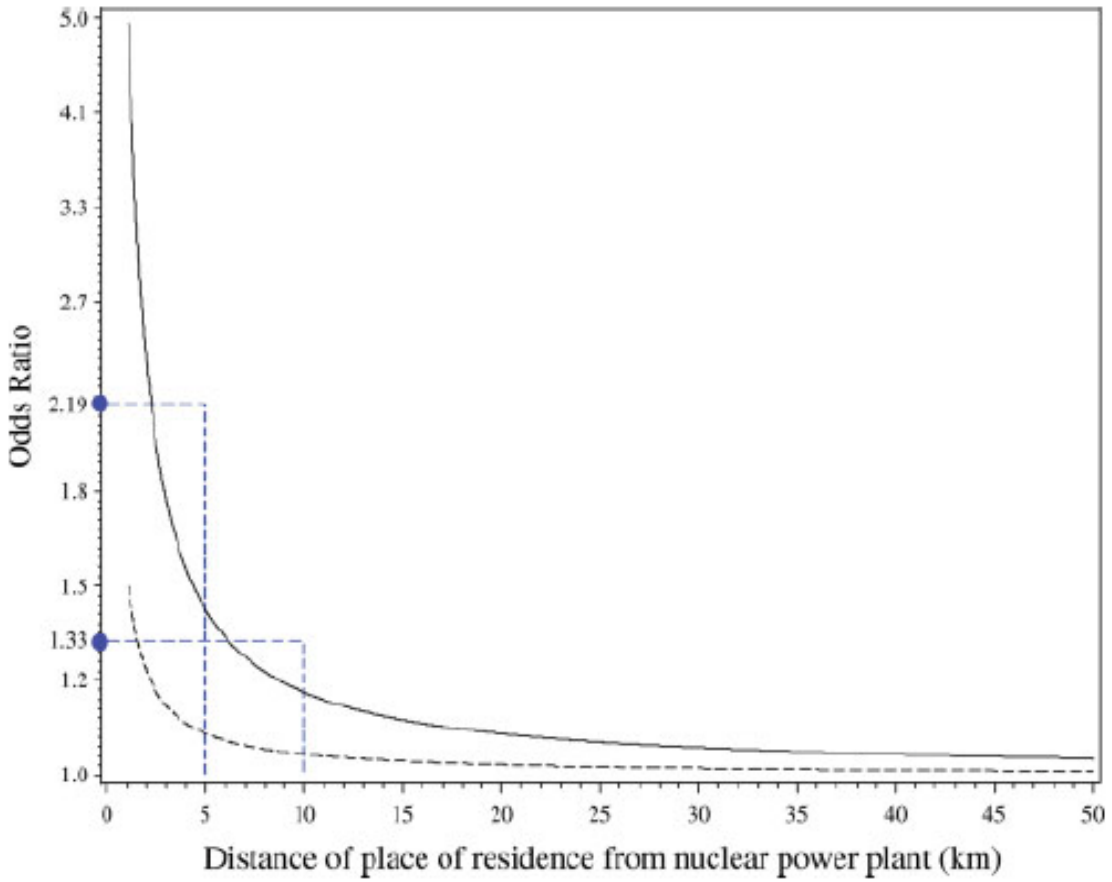


Abb. 2:
Geschätze Dosis-Wirkungsbeziehung für Leukämien (obere Kurve) auf der Basis des Regressionsmodells (593 Fälle, 1766 gematchte Kontrollen, Abstandsbereich abgeschnitten bei 50 km). Untere Kurve: modellbasiertes unteres einseitiges 95% Konfidenzband.
Gestrichelte Linien: Kategorielle Ergebnisse für die 5- und 10-km Region

Kaatsch P. et al.: Leukaemia in young children living in the vicinity of German nuclear power plants. Int. J. Cancer: p.723

Schlußfolgerungen aus der KiKK-Studie

- Statistisch signifikante Assoziation zwischen dem Wohnabstand zum nächstgelegenen AKW zur Zeit der Diagnosestellung und dem Risiko einer Krebserkrankkung vor dem 5. Lj. (insbesondere Leukämie).
- Altersgruppe und Erkrankungsspektrum plausibel unter der Strahlenhypothese
- Ausgeprägte Dosis-Wirkungsbeziehung
- Assoziation stabil im Zeitverlauf, nicht auf eine einzelne Anlage zurückzuführen, keine Hinweise auf Verzerrungen durch fehlende Adressen etc.
- Kein Hinweis auf relevantes Confounding durch bekannte Risikofaktoren für Kinderkrebs

Schlußfolgerung der KiKK-Studie (national)

Schlussfolgerung

(…) kann aufgrund des aktuellen strahlenbiologischen und -epidemiologischen Wissens die von deutschen Kernkraftwerken im Normalbetrieb emittierte ionisierende Strahlung grundsätzlich nicht als Ursache interpretiert werden. **(…)**

Kaatsch et al., Abschlußbericht, Jan. 2008, p XI

Int. J. Epidemiol. Advance Access published January 27, 2012

International Journal of Epidemiology 2012;1–1

CANUPIS study strengthens evidence of increased leukaemia rates near nuclear power plants

From ALFRED KOERBLEIN

Table 1 SIR and RR near Swiss, British and German nuclear power stations

Data set	O	E	SIR	*P*-value*	RR	*P*-value**
Switzerland (CH)						
0–5 km	11	7.87	1.40	0.3431	1.46	0.3334
5–15 km	54	56.40	0.96			
Great Britain (GB)						
<5 km	20	14.74	1.36	0.2216	1.41	0.1715
>5 km	1579	1640.44	0.96			
Germany (D)						
<5 km	34	24.09	1.41	0.0656	1.45	0.0549
>5 km	585	599.58	0.98			
CH + GB + D						
<5 km	65	46.70	1.39	0.0130	1.44	0.0069
>5 km	2218	2296.42	0.97			

*P-value (Poisson distribution).
**P-value (Binomial distribution).

Ionising radiation and risk of death from leukaemia and lymphoma in radiation-monitored workers (INWORKS): an international cohort study

Klervi Leuraud, David B Richardson, Elisabeth Cardis, Robert D Daniels, Michael Gillies, Jacqueline A O'Hagan, Ghassan B Hamra, Richard Haylock, Dominique Laurier, Monika Moissonnier, Mary K Schubauer-Berigan, Isabelle Thierry-Chef, Ausrele Kesminiene

Methods We assembled a cohort of 308 297 radiation-monitored workers employed for at least 1 year by the Atomic Energy Commission, AREVA Nuclear Cycle, or the National Electricity Company in France, the Departments of Energy and Defence in the USA, and nuclear industry employers included in the National Registry for Radiation Workers in the UK. The cohort was followed up for a total of 8·22 million person-years. We ascertained deaths caused by leukaemia, lymphoma, and multiple myeloma. We used Poisson regression to quantify associations between estimated red bone marrow absorbed dose and leukaemia and lymphoma mortality.

Findings Doses were accrued at very low rates (mean 1·1 mGy per year, SD 2·6). The excess relative risk of leukaemia mortality (excluding chronic lymphocytic leukaemia) was 2·96 per Gy (90% CI 1·17–5·21; lagged 2 years), most notably because of an association between radiation dose and mortality from chronic myeloid leukaemia (excess relative risk per Gy 10·45, 90% CI 4·48–19·65).

Interpretation This study provides strong evidence of positive associations between protracted low-dose radiation exposure and leukaemia.

www.thelancet.com/haematology Published online June 22, 2015 http://dx.doi.org/10.1016/S2352-3026(15)00094-0

	Deaths	ERR per Gy	90% CI
Leukaemia excluding CLL*	531	2·96	1·17 to 5·21
Chronic myeloid leukaemia*	100	10·45	4·48 to 19·65
Acute myeloid leukaemia*	254	1·29	−0·82 to 4·28
Acute lymphoblastic leukaemia*	30	5·80	NE to 31·57
CLL*	138	−1·06	NE to 1·81
Multiple myeloma†	293	0·84	−0·96 to 3·33
Non-Hodgkin lymphoma†	710	0·47	−0·76 to 2·03
Hodgkin's lymphoma†	104	2·94	NE to 11·49

ERR estimated with a linear model stratified by country, calendar period, sex, and age. NE lower CI bound could not be estimated because it was on the boundary of the parameter space (−1/maximum dose). 14 deaths were assigned ICD9 code 204.9 (lymphoid leukaemia, unspecified) and one death was assigned ICD9 code 202.9 (other and unspecified malignant neoplasms of lymphoid, haemopoietic, and related tissue) were excluded from the cause-specific analyses. *2-year lagged cumulative dose. †10-year lagged cumulative dose. ERR=excess relative risk. CLL=chronic lymphocytic leukaemia. NE=not estimable.

***Table 2*: ERR per Gy of cumulative red bone marrow dose for causes of death**

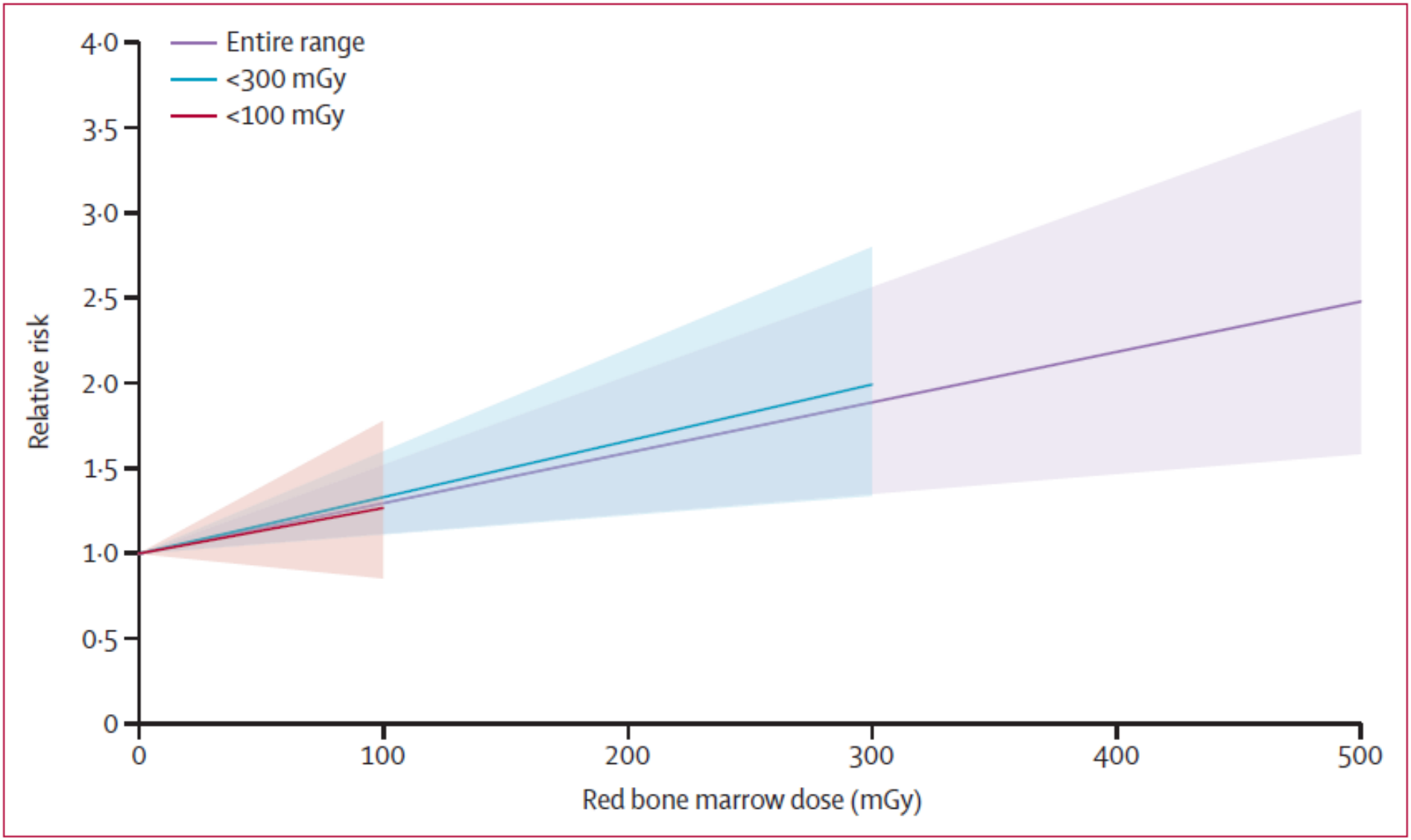


Figure: **Relative risk of leukaemia excluding chronic lymphocytic leukaemia associated with 2-year lagged cumulative red bone marrow dose**

The lines are the fitted linear dose–response model and the shading represents the 90% CIs.

www.thelancet.com/haematology Published online June 22, 2015 http://dx.doi.org/10.1016/S2352-3026(15)00094-0

Implications of all the available evidence

The present study provides strong evidence of a positive association between radiation exposure and leukaemia even for low-dose exposure. This finding shows the importance of adherence to the basic principles of radiation protection—to optimise protection to reduce exposures as much as reasonably achievable and—in the case of patient exposure—to justify that the exposure does more good than harm.

www.thelancet.com/haematology Published online June 22, 2015 http://dx.doi.org/10.1016/S2352-3026(15)00094-0

Radiati… subsequ… a retros…

Mark S Pearce, Jar… Sir Alan W Craft, L… eetha Rajaraman,

THE LANCET

Articles

Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study

Mark S Pearce, Jane A Salotti, Mark P Little, Kieran McHugh, Choonsik Lee, Kwang Pyo Kim, Nicola L Howe, Cecile M Ronckers, Preetha Rajaraman, Sir Alan W Craft, Louise Parker, Amy Berrington de González

Summary

Background Although CT scans are very useful clinically, potential cancer risks exist from associated ionising radiation, in particular for children who are more radiosensitive than adults. We aimed to assess the excess risk of leukaemia and brain tumours after CT scans in a cohort of children and young adults.

Methods In our retrospective cohort study, we included patients without previous cancer diagnoses who were first examined with CT in National Health Service (NHS) centres in England, Wales, or Scotland (Great Britain) between 1985 and 2002, when they were younger than 22 years of age. We obtained data for cancer incidence, mortality, and loss to follow-up from the NHS Central Registry from Jan 1, 1985, to Dec 31, 2008. We estimated absorbed brain and red bone marrow doses per CT scan in mGy and assessed excess incidence of leukaemia and brain tumours cancer with Poisson relative risk models. To avoid inclusion of CT scans related to cancer diagnosis, follow-up for leukaemia began 2 years after the first CT and for brain tumours 5 years after the first CT.

Findings During follow-up, 74 of 178 604 patients were diagnosed with leukaemia and 135 of 176 587 patients were diagnosed with brain tumours. We noted a positive association between radiation dose from CT scans and leukaemia (excess relative risk [ERR] per mGy 0·036, 95% CI 0·005–0·120; p=0·0097) and brain tumours (0·023, 0·010–0·049; p<0·0001). Compared with patients who received a dose of less than 5 mGy, the relative risk of leukaemia for patients who received a cumulative dose of at least 30 mGy (mean dose 51·13 mGy) was 3·18 (95% CI 1·46–6·94) and the relative risk of brain cancer for patients who received a cumulative dose of 50–74 mGy (mean dose 60·42 mGy) was 2·82 (1·33–6·03).

Interpretation Use of CT scans in children to deliver cumulative doses of about 50 mGy might almost triple the risk of leukaemia and doses of about 60 mGy might triple the risk of brain cancer. Because these cancers are relatively rare, the cumulative absolute risks are small: in the 10 years after the first scan for patients younger than 10 years, one excess case of leukaemia and one excess case of brain tumour per 10 000 head CT scans is estimated to occur. Nevertheless, although clinical benefits should outweigh the small absolute risks, radiation doses from CT scans ought to be kept as low as possible and alternative procedures, which do not involve ionising radiation, should be considered if appropriate.

Lancet 2012; 380: 499–505
Published Online
June 7, 2012
http://dx.doi.org/10.1016/S0140-6736(12)60815-0

See **Comment** page 455

See **Perspectives** page 465

Institute of Health and Society (M S Pearce PhD, J A Salotti PhD, N L Howe MSc) **and Northern Institute of Cancer Research** (Sir A W Craft MD), **Newcastle University, Sir James Spence Institute, Royal Victoria Infirmary, Newcastle upon Tyne, UK; Radiation Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD, USA** (M P Little PhD, C Lee PhD, C M Ronckers PhD, P Rajaraman PhD, A B de González DPhil); **Great Ormond Street Hospital for Children NHS Trust, London, UK** (K McHugh FRCR); **Department of Nuclear Engineering, Kyung Hee University, Gyeonggi-Do, South Korea** (K P Kim PhD); **Dutch Childhood Oncology Group—Long-term effects after**

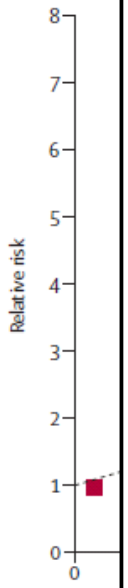


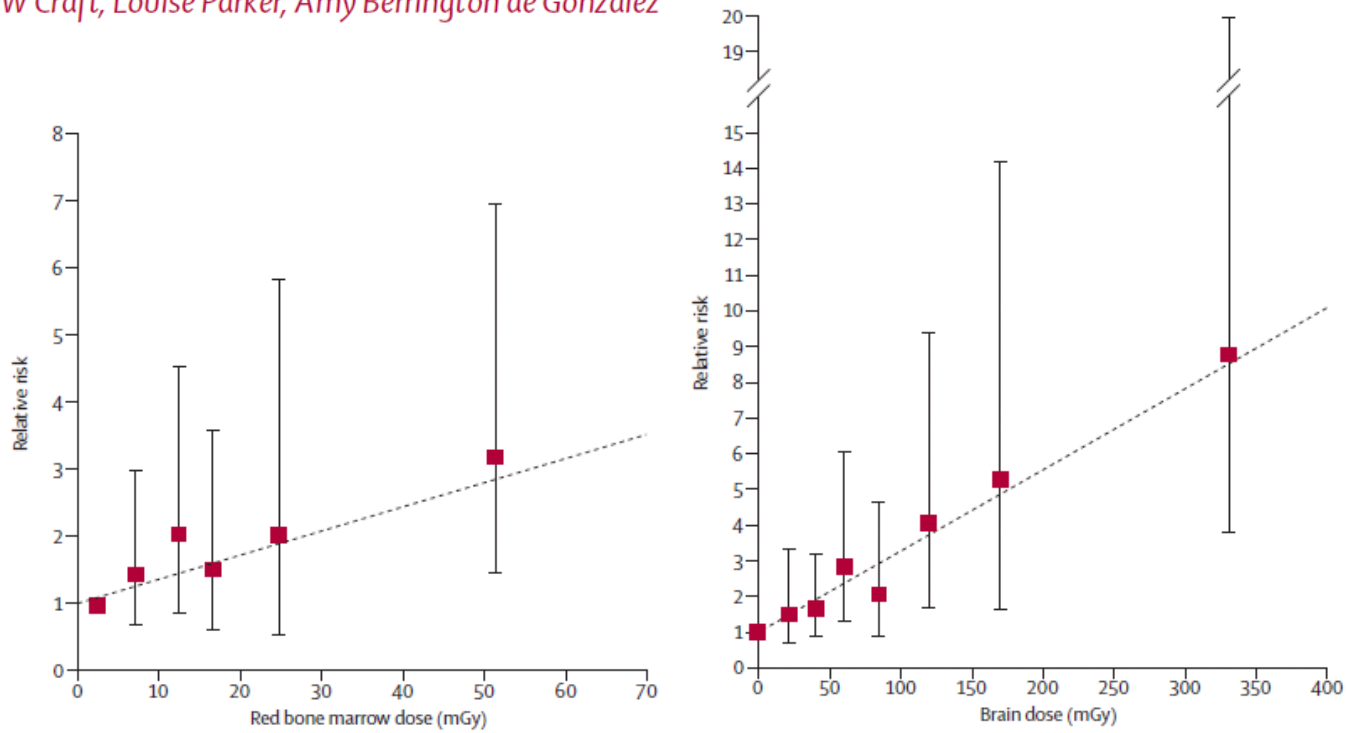
Figure: R… estimated radiatio…
(A) Leuka…
dose-response model (excess relative risk per mGy). Bars show 95% CIs.

Lancet 2012; 380: 499–505
Published Online
June 7, 2012
http://dx.doi.org/10.1016/

rm 16308

Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study

Mark S Pearce, Jane A Salotti, Mark P Little, Kieran McHugh, Choonsik Lee, Kwang Pyo Kim, Nicola L Howe, Cecile M Ronckers, Preetha Rajaraman, Sir Alan W Craft, Louise Parker, Amy Berrington de González



Lancet 2012; 380: 499–505
Published Online
June 7, 2012
http://dx.doi.org/10.1016/

Figure: **Relative risk of leukaemia and brain tumours in relation to estimated radiation doses to the red bone marrow and brain from CT scans**

(A) Leukaemia and (B) brain tumours. Dotted line is the fitted linear dose-response model (excess relative risk per mGy). Bars show 95% CIs.

rm 16308

BMJ

BMJ 2013;346:f2360 doi: 10.1136/bmj.f2360 (Published 22 May 2013)

RESEARCH

Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians

John D Mathews *epidemiologist*[1], Anna V Forsythe *research officer*[1], Zoe Brady *medical physicist*[1 2], Martin W Butler *data analyst*[3], Stacy K Goergen *radiologist*[4], Graham B Byrnes *statistician*[5], Graham G Giles *epidemiologist*[6], Anthony B Wallace *medical physicist*[7], Philip R Anderson *epidemiologist*[8 9], Tenniel A Guiver *data analyst*[8], Paul McGale *statistician*[10], Timothy M Cain *radiologist*[11], James G Dowty *research fellow*[1], Adrian C Bickerstaffe *computer scientist*[1], Sarah C Darby *statistician*[10]

BMJ Helping doctors make better decisions

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Abstract

Objective To assess the cancer risk in children and adolescents following exposure to low dose ionising radiation from diagnostic computed tomography (CT) scans.

Design Population based, cohort, data linkage study in Australia.

Cohort members 10.9 million people identified from Australian Medicare records, aged 0-19 years on 1 January 1985 or born between 1 January 1985 and 31 December 2005; all exposures to CT scans funded by Medicare during 1985-2005 were identified for this cohort. Cancers diagnosed in cohort members up to 31 December 2007 were obtained through linkage to national cancer records.

Main outcome Cancer incidence rates in individuals exposed to a CT scan more than one year before any cancer diagnosis, compared with cancer incidence rates in unexposed individuals.

Results 9074 cancers were recorded, including 3150 in 680 211 people exposed to a CT scan at least one year before any cancer diagnosis. The mean duration of follow-up after exposure was 9.5 years. Overall cancer incidence was 24% greater for exposed than for unexposed at younger ages (P<0.001 for trend). At 1-4, 5-9, 10-14, and 15 or more years since first exposure, IRRs were 1.35 (1.25 to 1.45), 1.25 (1.17 to 1.34), 1.14 (1.06 to 1.22), and 1.24 (1.14 to 1.34), respectively. The IRR increased significantly for many types of solid cancer (digestive organs, melanoma, soft tissue, female genital, urinary tract, brain, and thyroid); leukaemia, myelodysplasia, and some other lymphoid cancers. There was an excess of 608 cancers in people exposed to CT scans (147 brain, 356 other solid, 48 leukaemia or myelodysplasia, and 57 other lymphoid). The absolute excess incidence rate for all cancers combined was 9.38 per 100 000 person years at risk, as of 31 December 2007. The average effective radiation dose per scan was estimated as 4.5 mSv.

Conclusions The increased incidence of cancer after CT scan exposure in this cohort was mostly due to irradiation. Because the cancer excess was still continuing at the end of follow-up, the eventual lifetime risk from CT scans cannot yet be determined. Radiation doses from contemporary CT scans are likely to be lower than those in 1985-2005, but some increase in cancer risk is still likely from current scans. Future CT scans should be limited to situations where there is a definite clinical indication.

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RESEARCH

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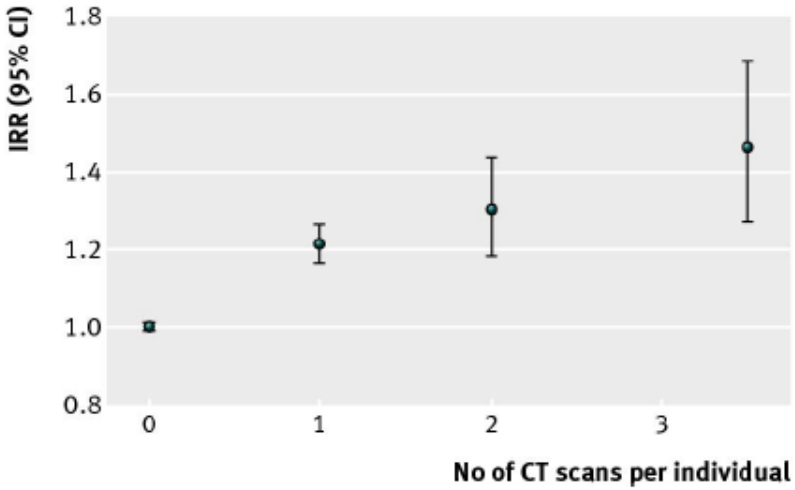

Fig 2 Incidence rate ratios (IRR) for all types of cancers in exposed versus unexposed individuals based on a one year lag period, by the number of CT scans. The IRR increased by 0.16 (95% confidence interval 0.13 to 0.19) for each additional CT scan, calculated after stratification for age, sex, and year of birth (χ^2=131.4 and P<0.001 for trend). If unexposed people were excluded, the trend remained significant (χ^2=5.79 and P=0.02 for trend). The average number of scans among individuals exposed to three or more scans was 3.5. (Web figure A shows corresponding results based on lag periods of five and 10 years)

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RESEARCH

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What is already known on this topic

CT scanning rates have risen substantially since the 1980s. Although large doses of ionising radiation are known to cause cancer, there is uncertainty about the risks following the lower doses from CT scans (5-50 mGy per organ)

A recent study of 180 000 young people exposed to CT scans in the United Kingdom found an increasing risk of leukaemia and brain cancer with increasing radiation dose

What this study adds

Among 680 000 Australians exposed to a CT scan when aged 0-19 years, cancer incidence was increased by 24% (95% confidence interval 20% to 29%) compared with the incidence in over 10 million unexposed people. The proportional increase in risk was evident at short intervals after exposure and was greater for persons exposed at younger ages

By 31 December 2007, with an average follow-up of 9.5 years after exposure, the absolute excess cancer incidence rate was 9.38 per 100 000 person years at risk

Incidence rates were increased for most individual types of solid cancer, and for leukaemias, myelodysplasias, and some other lymphoid cancers

individuals exposed to three or more scans was 3.5. (Web figure A shows corresponding results based on lag periods of five and 10 years)

Projected Cancer Risks From Computed Tomographic Scans Performed in the United States in 2007

Amy Berrington de González, DPhil; Mahadevappa Mahesh, MS, PhD; Kwang-Pyo Kim, PhD; Mythreyi Bhargavan, PhD; Rebecca Lewis, MPH; Fred Mettler, MD; Charles Land, PhD

Background: The use of computed tomographic (CT) scans in the United States (US) has increased more than 3-fold since 1993 to approximately 70 million scans annually. Despite the great medical benefits, there is concern about the potential radiation-related cancer risk. We conducted detailed estimates of the future cancer risks from current CT scan use in the US according to age, sex, and scan type.

Methods: Risk models based on the National Research Council's "Biological Effects of Ionizing Radiation" report and organ-specific radiation doses derived from a national survey were used to estimate age-specific cancer risks for each scan type. These models were combined with age- and sex-specific scan frequencies for the US in 2007 obtained from survey and insurance claims data. We estimated the mean number of radiation-related incident cancers with 95% uncertainty limits (UL) using Monte Carlo simulations.

Results: Overall, we estimated that approximately 29 000 (95% UL, 15 000-45 000) future cancers could be related to CT scans performed in the US in 2007. The largest contributions were from scans of the abdomen and pelvis (n=14 000) (95% UL, 6900-25 000), chest (n=4100) (95% UL, 1900-8100), and head (n=4000) (95% UL, 1100-8700), as well as from chest CT angiography (n=2700) (95% UL, 1300-5000). One-third of the projected cancers were due to scans performed at the ages of 35 to 54 years compared with 15% due to scans performed at ages younger than 18 years, and 66% were in females.

Conclusions: These detailed estimates highlight several areas of CT scan use that make large contributions to the total cancer risk, including several scan types and age groups with a high frequency of use or scans involving relatively high doses, in which risk-reduction efforts may be warranted.

Arch Intern Med. 2009;169(22):2071-2077

The NEW ENGLAND JOURNAL of MEDICINE

Perspective

JULY 1, 2010

Is Computed Tomography Safe?

Rebecca Smith-Bindman, M.D.

„. . . We found that the risk of cancer from a single CT scan could be as high as 1 in 80 — unacceptably high, given the capacity to reduce these doses. . . .“

„. . . Evidence suggests the radiation dose from CT could be reduced by 50% or more without reducing diagnostic accuracy.[4]

„. . . We need to establish diagnostic reference levels, on the basis of clinically relevant outcomes and safety, not the creation of the greatest-quality images, if such quality does not improve outcomes. . . .“

„. . . the FDA could take the lead in creating standards and assessing compliance. Facilities that could not meet the standards should not be certified to conduct CT. . . .“

Ärzte Zeitung, 08.06.2012 05:00

Studie bestätigt: Krebs auch durch niedrige Strahlendosis beim CT

Eine große retrospektive Studie bestätigt, dass auch durch die niedrige Strahlenbelastung, die während der CT-Untersuchung auftritt, das Krebsrisiko leicht erhöht ist. Analysiert wurden Daten von fast 180.000 Patieten, die im Kindesalter eine CT bekamen.

NEWCASTLE UPON TYNE (ple). Bereits vor mehr als einer Dekade ließen Modellrechnungen aufgrund der Erkenntnisse, die von Überlebenden der Atombombenexplosionen in Japan gewonnen wurden, vermuten, dass auch in der Medizin genutzte niedrige Strahlendosen das Krebsrisiko erhöhen.

Auch für Niedrigdosis-CT gilt strenge Indikationsstellung!

Jetzt liefert eine britische retrospektive Kohortenstudie erstmals Daten von fast 180.000 Patienten, die Kinder eine CT-Untersuchung bekamen, und zwar zwischen 1985 und 2002 (Lancet 2012; online 7. Juni). Keines der Kinder war an Krebs erkrankt.

Für die Auswertung nicht genutzt wurden die Daten von Patienten, die innerhalb von zwei Jahren nach der CT-Untersuchung an Leukämie oder innerhalb von fünf Jahren nach der Untersuchung an einem Hirntumor erkrankten.

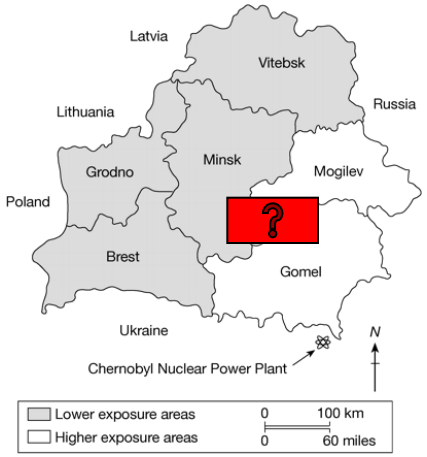
Bei insgesamt 74 von 178.604 Patienten wurde nachfolgend eine Leukämie diagnostiziert, bei 135 von 176.587 ein Hirntumor.

Bodyscan-Lastwagen: *Wanderheiler vor der Dorfkirche*

Der Spiegel 30/2002

Thyroid cancer in children in Belarus after Chernobyl

Republic of Belarus with oblast regions:



"IAEA's 1991 assessment of the health consequences of the Chernobyl accident found no health disorders that could be attributed directly to radiation, ruling out reports of widespread illnesses. What the investigators did find was substantial negative psychological consequences and stress-related illnesses attributed to uncertainty and fear extending beyond contaminated villages and towns."

Rojas- Burke, J. The Journal of Nuclear Medicine Vol.33. 11, 1992

Thyroid cancer in children in Belarus after Chernobyl

"This study documents marked increases in the incidence of thyroid cancer among residents of both "higher Exposure" areas within in the Republic of Belarus."

"…it appears likely that (…) radioiodine (…) served as a cancer-initiating event."

Mahoney, M. C et al. Int. J. Epidemiol. 2004, 33, Thyroid Cancer incidence trends in Belarus: examining the impact of Chernobyl , 1026 pp.

Table 3 Rate ratios by sex and age at diagnosis for thyroid cancer incidence rates per 100 000 among residents of 'lower exposure'[a] areas in Belarus, 1980–1999

0–14 years at diagnosis

Year of diagnosis	Males				Females			
	n[b]	Rate	RR[c]	(95% CI)	n	Rate	RR	(95% CI)
1980–1986	2	0.09	1.00	–	5	0.20	1.00	–
1987–1991	23	1.40	15.63	(66.29, 3.68)	23	1.27	6.31	(2.40, 16.59)
1992–1995	75	22.96	255.75	(1041.59, 62.80)	117	37.06	183.52	(74.98, 449.16)
1996–2001	38	13.00	144.80	(243.03, 86.28)	55	19.63	97.21	(59.75, 158.15)

Ref.: Mahoney, M. C et al. Int. J. Epidemiol. 2004, 33, Thyroid Cancer incidence trends in Belarus: examining the impact of Chernobyl , 1031 pp.

Atomunglücke

Durch Tschernobyl:

→ 16.000 (3.400-72.000) Schilddrüsenkrebsfälle

.

→ 25.000 (11.000-59.000) Andere Krebsfälle

→ 15.000 zusätzliche Krebstodesfälle

IJC International Journal of Cancer

Estimates of the cancer burden in Europe from radioactive fallout from the Chernobyl accident

Elisabeth Cardis[1*], Daniel Krewski[2], Mathieu Boniol[1], Vladimir Drozdovitch[1], Sarah C. Darby[3], Ethel S. Gilbert[4], Suminori Akiba[5], Jacques Benichou[6], Jacques Ferlay[1], Sara Gandini[7], Catherine Hill[8], Geoffrey Howe[9], Ausrele Kesminiene[1], Mirjana Moser[10], Marie Sanchez[1], Hans Storm[11], Laurent Voisin[1] and Peter Boyle[1]

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[2]*McLaughlin Centre for Population Health Risk Assessment, Institute of Population Health, University of Ottawa, Ottawa, Ontario, Canada*
[3]*Clinical Trial Service Unit, University of Oxford, United Kingdom*
[4]*Radiation Epidemiology Branch, Division of Epidemiology and Genetics, National Cancer Institute, Bethesda, MD, USA*
[5]*Kagoshima University, Graduate School of Medical and Dental Sciences, Kagoshima, Japan*
[6]*Biostatistics Unit, University of Rouen Medical School and Rouen University Hospital, Rouen, France*
[7]*European Institute of Oncology, Milano, Italy*
[8]*Institut Gustave-Roussy, Villejuif, France*
[9]*Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA*
[10]*Federal Office of Public Health, Bern, Switzerland*
[11]*Danish Cancer Society, Copenhagen, Denmark*

The Chernobyl accident, which occurred April 26, 1986, resulted in a large release of radionuclides, which were deposited over a very wide area, particularly in Europe. Although an increased risk of thyroid cancer in exposed children has been clearly demonstrated in the most contaminated regions, the impact of the accident on the risk of other cancers as well as elsewhere in Europe is less clear. The objective of the present study was to evaluate the human cancer burden in Europe as a whole from radioactive fallout from the accident. Average country- and region-specific whole-body and thyroid doses from Chernobyl were estimated using new dosimetric models and radiological data. Numbers of cancer cases and deaths possibly attributable to radiation from Chernobyl were estimated, applying state-of-the-art risk models derived from studies of other irradiated populations. Simultaneously, trends in cancer incidence and mortality were examined over time and by dose level. The risk projections suggest that by now Chernobyl may have caused about 1,000 cases of thyroid cancer and 4,000 cases of other cancers in Europe, representing about 0.01% of all incident cancers since the accident. Models predict that by 2065 about 16,000 (95% UI 3,400–72,000) cases of thyroid cancer and 25,000 (95% UI 11,000–59,000) cases of other cancers may be expected due to radiation from the accident, whereas

Epidemiological studies focusing on the most contaminated regions of the 3 most affected countries have confirmed a causal relationship between the observed increased risk of thyroid cancer and exposure to radioactive iodines from the Chernobyl fallout among those who were children or adolescents when the accident happened.[3–5] Other types of cancer, including leukemia, have also been investigated,[1,6–17] but as yet no association with radiation exposure has been clearly demonstrated. Recent studies suggest a possible doubling of the risk of leukemia among Chernobyl cleanup workers[18] and a small increase in the incidence of premenopausal breast cancer[19] in the most contaminated districts (with average whole-body doses above 40 mSv), both of which appear to be related to radiation dose. These findings need confirmation in further epidemiological studies with careful individual dose reconstruction.

The full extent of the health impact of Chernobyl on the population is difficult to gauge. Ten years ago, Cardis and collaborators[20] estimated that about 9,000 deaths from cancers and leukemia might be expected over the course of a lifetime in the most exposed populations in Belarus, the Russian Federation and

Fukushima, Japan, 3/2011

Quelle: ippnw forum , März 2016, Titelblatt.


5/11 10:07:48
2912
現場名 2-E-29汚泥仮置場
作業工種 除染前モニタリング
測定点 玄関前
測定日 H25・5・11
立会者 菊池(興)・赤井・遠部
浦水地区1
コリメーター有
シンチレーション
1cm 0.31 μSv/h
50cm 0.46 μSv/h
100cm 0.48 μSv/h
1cm 731 cpm
(GM管)


0.386 μSv/h
2012.11.24


2011.11.12


2013.02.23

ÜBERBLEIBSEL DER DEKONTAMINIERUNG: SÄCKE MIT VERSTRAHLTEM ERDREICH FÜLLEN GANZE LANDSCHAFTEN.

Quelle: ippnw forum , März 2016, S.23.

Thyroid Cancer Detection by Ultrasound Among Residents Ages 18 Years and Younger in Fukushima, Japan: 2011 to 2014

Toshihide Tsuda,[a] *Akiko Tokinobu,*[b] *Eiji Yamamoto,*[c] *and Etsuji Suzuki*[b]

Methods: After the release, Fukushima Prefecture performed ultrasound thyroid screening on all residents ages ≤18 years. The first round of screening included 298,577 examinees, and a second round began in April 2014. We analyzed the prefecture results from the first and second round up to December 31, 2014, in comparison with the Japanese annual incidence and the incidence within a reference area in Fukushima Prefecture.

(*Epidemiology* 2016;27: 316–322)

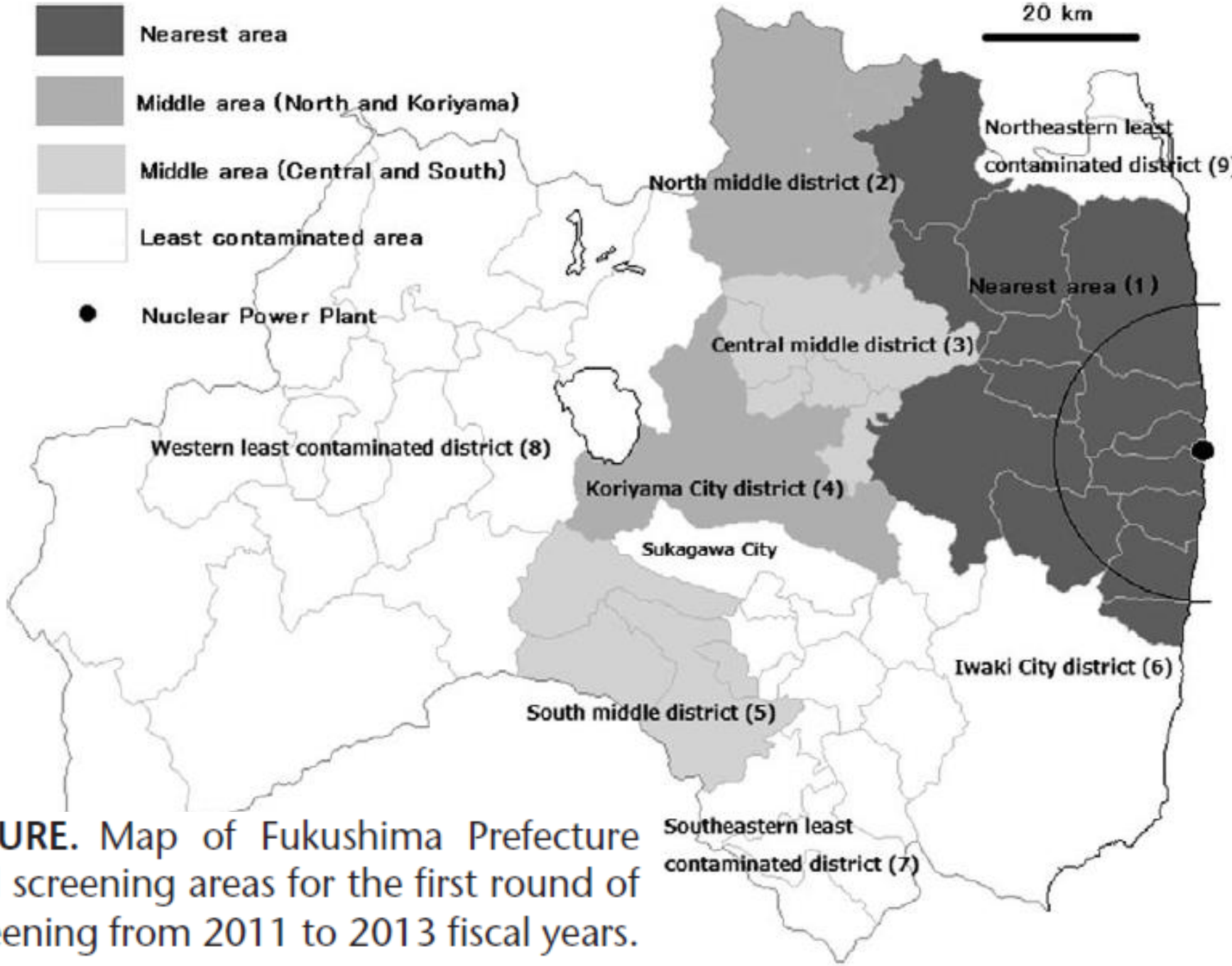

FIGURE. Map of Fukushima Prefecture and screening areas for the first round of screening from 2011 to 2013 fiscal years.

(*Epidemiology* 2016;27: 316–322)

Thyroid Cancer Detection by Ultrasound Among Residents Ages 18 Years and Younger in Fukushima, Japan: 2011 to 2014

Toshihide Tsuda,[a] *Akiko Tokinobu,*[b] *Eiji Yamamoto,*[c] *and Etsuji Suzuki*[b]

Conclusions: An excess of thyroid cancer has been detected by ultrasound among children and adolescents in Fukushima Prefecture within 4 years of the release, and is unlikely to be explained by a screening surge.

(*Epidemiology* 2016;27: 316–322)

28/2008

11/2011

EDITOR'S CHOICE

Is cancer risk of radiation workers larger than expected?

P Jacob,[1] W Rühm,[1] L Walsh,[2] M Blettner,[3] G Hammer,[3] H Zeeb[3]

See Editorial, p 785

[1] Hemholtz Zentrum München, Institute of Radiation Protection, Neuherberg, Germany; [2] Federal Office for Radiation Protection, Department of Radiation Protection and Health, Oberschleißheim, Germany; [3] Johannes Gutenberg – University Mainz, Institute of Medical Biostatistics, Epidemiology and Informatics, Mainz, Germany

Correspondence to: P Jacob, Hemholtz Zentrum München, Institute of Radiation Protection, D-85764 Neuherberg, Germany; Jacob@helmholtz-muenchen.de

Accepted 13 May 2009
Published Online First 30 June 2009

ABSTRACT

Occupational exposures to ionising radiation mainly occur at low-dose rates and may accumulate effective doses of up to several hundred milligray.

The objective of the present study is to evaluate the evidence of cancer risks from such low-dose-rate, moderate-dose (LDRMD) exposures.

Our literature search for primary epidemiological studies on cancer incidence and mortality risks from LDRMD exposures included publications from 2002 to 2007, and an update of the UK National Registry for Radiation Workers study. For each (LDRMD) study we calculated the risk for the same types of cancer among the atomic bomb survivors with the same gender proportion and matched quantities for dose, mean age attained and mean age at exposure. A combined estimator of the ratio of the excess relative risk per dose from the LDRMD study to the corresponding value for the atomic bomb survivors was 1.21 (90% CI 0.51 to 1.90).

The present analysis does not confirm that the cancer risk per dose for LDRMD exposures is lower than for the atomic bomb survivors. This result challenges the cancer risk values currently assumed for occupational exposures.

Occup Environ Med 2009;**66**:789–796. doi:10.1136/oem.2008.043265

EDITOR'S CHOICE

Is cancer risk
expected?

P Jacob,[1] W Rühm,[1] L V

See Editorial, p 785

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Accepted 13 May 2009
Published Online First 30 June 2009

ABSTRACT

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up to several hundred milligray.
The objective of the present stu
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Our literature search for primary
on cancer incidence and mortalit
exposures included publications
an update of the UK National Re
Workers study. For each (LDRMI
the risk for the same types of c
bomb survivors with the same g
matched quantities for dose, me
mean age at exposure. A combir
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to the corresponding value for th
was 1.21 (90% CI 0.51 to 1.90)
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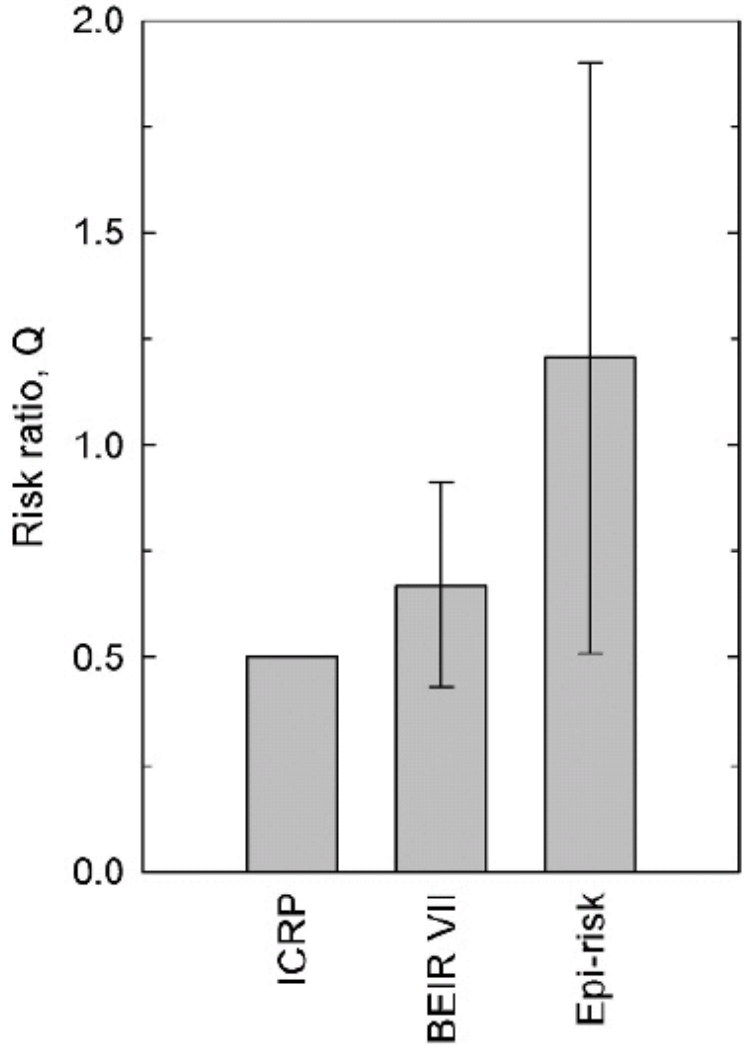


Figure 3 Ratio *Q* of excess relative risk-per-dose values for cancer after low-dose-rate, moderate-dose exposures and after acute, high-dose exposures as recommended by the International Commission on Radiological Protection (ICRP),[2] used by BEIR VII (95% CI),[3] and derived in the present analysis from epidemiological studies (epi-risk, 90% CI).

Occup Environ Med 2009;**66**:789–796. doi:10.1136/oem.2008.043265

Is cancer risk of radiation workers larger than expected?

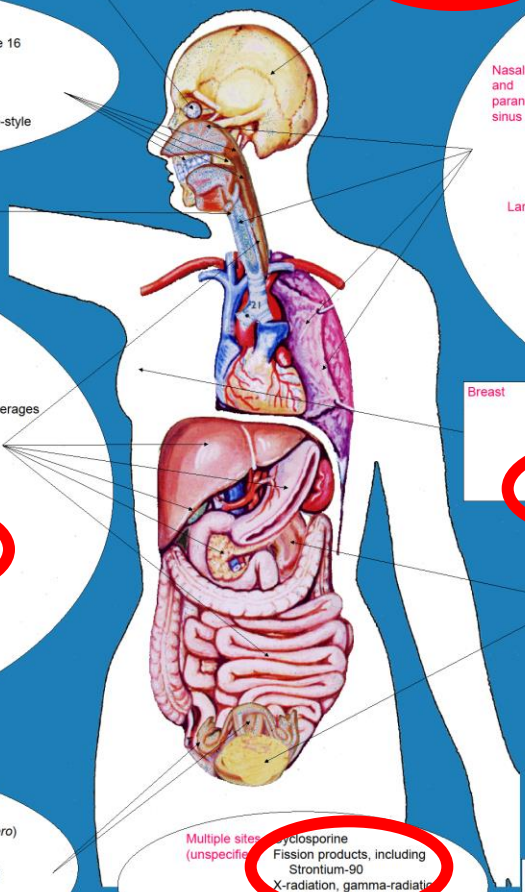
P Jacob,[1] W Rühm,[1] L Walsh,[2] M Blettner,[3] G Hammer,[3] H Zeeb[3]

Occup Environ Med 2009;**66**:789–796. doi:10.1136/oem.2008.043265

What this paper adds

- Occupational exposures to ionising radiation occur normally at low-dose rate and may sum up to moderate doses in the order of 100 mGy.
- Limits of occupational exposures are based on the assumption that cancer risk factors are lower than for the atomic bomb survivors by a factor of two.
- Twelve recent epidemiological studies on cancer after low-dose-rate, moderate-dose exposures were included in this analysis of cancer risks related to such exposures.
- The studies provide evidence that cancer risk factors for occupational exposures are not lower than for atomic bomb survivors.
- The new evidence for cancer risks should be taken into account in optimisation procedures for the use of radionuclides and ionising radiation at the work place and in medicine.

IARC Monographs : The known causes of human cancer by organ site (updated 12.2014)



Eye
Human immunodeficiency virus type 1
Ultraviolet-emitting tanning devices
Welding

Brain and central nervous system
X-radiation, gamma-radiation

Oral cavity
Alcoholic beverages
Betel quid with tobacco
Betel quid without tobacco
Human papillomavirus type 16
Smokeless tobacco
Tobacco smoking

Pharynx (oro-, hypo- and/or NOS)
Alcoholic beverages
Betel quid with tobacco
Human papillomavirus type 16
Tobacco smoking

Nasopharynx
Epstein-Barr virus
Formaldehyde
Salted fish, Chinese-style
Wood dust

Tonsil
Human papillomavirus type

Salivary gland
X-radiation, gamma-radiation

Thyroid
Radioiodines, including iodine-131 (exposure during childhood and adolescence)
X-radiation, gamma-radiation

Lung
Aluminium production
Arsenic and inorganic arsenic compounds
Asbestos (all forms)
Beryllium and beryllium compounds
Bis(chloromethyl)ether; chloromethyl methyl ether (technical grade)
Cadmium and cadmium compounds
Chromium (VI) compounds
Coal, indoor emissions from household combustion
Coal gasification
Coal-tar pitch
Coke production
Diesel engine exhausts
Gamma-radiation
Haematite mining (underground)
Iron and steel founding
MOPP (vincristine-prednisone-nitrogen mustard-procarbazine mixture)
Nickel compounds
Outdoor air pollution
Outdoor air pollution, particulate matter in
Painter (occupational exposure as)
Plutonium
Radon-222 and its decay products
Rubber production industry
Silica dust, crystalline
Soot
Tobacco smoke, secondhand
Tobacco smoking
X-radiation

Nasal cavity and paranasal sinus
Isopropyl alcohol manufacture using strong acids
Nickel compounds
Radium-226 and its decay products
Radium-228 and its decay products
Tobacco smoking

Larynx
Acid mists, strong inorganic
Alcoholic beverages
Asbestos (all forms)
Tobacco smoking

Pleura or peritoneum (mesothelioma)
Asbestos (all forms)
Erionite
Painter (occupational exposure as)

Stomach
Helicobacter pylori
Tobacco smoking
X-radiation, gamma-radiation

Upper aerodigestive tract
Acetaldehyde associated with consumption of alcoholic beverages

Liver (hepatocellular carcinoma)
Aflatoxins
Alcoholic beverages
Estrogen-progestogen contraceptives
Hepatitis B virus
Plutonium
Thorium-232 and its decay products
Tobacco smoking (in smokers and

Liver (angiosarcoma)
Vinyl chloride

Biliary tract
1,2-Dichloropropane
Chlonorchis sinensis
Opisthorchis viverrini

Oesophagus
Acetaldehyde associated with consumption of alcoholic beverages
Alcoholic beverages
Betel quid with tobacco
Betel quid without tobacco
Smokeless tobacco
Tobacco smoking
X-radiation

Gall bladder
Thorium-232 and its decay products

Pancreas
Smokeless tobacco
Tobacco smoking

Colon and rectum
Alcoholic beverages
Tobacco smoking
X-radiation, gamma-radiation

Anus
Human immunodeficiency virus type 1
Human papillomavirus type 16

Breast
Alcoholic beverages
Diethylstilbestrol
Estrogen-progestogen contraceptives
Estrogen-progestogen menopausal therapy
X-radiation, gamma-radiation

Urinary bladder
Aluminium production
4-Aminobiphenyl
Arsenic and inorganic arsenic compounds
Auramine production
Benzidine
Chlornaphazine
Cyclophosphamide
Magenta production
2-Naphthylamine
Painter (occupational exposure as)
Rubber production industry
Schistosoma haematobium
Tobacco smoking
ortho-Toluidine
X-radiation, gamma-radiation

Kidney
Tobacco smoking
Trichloroethylene
X-radiation, gamma-radiation

Renal pelvis and ureter
Aristolochic acid,
Phenacetin
Phenacetin, analgesic mixtures containing
Tobacco smoking

Endometrium
Estrogen menopausal therapy
Estrogen-progestogen menopausal therapy
Tamoxifen

Vagina
Diethylstilbestrol (exposure *in utero*)
Human papillomavirus type 16

Uterine cervix
Diethylstilbestrol (exposure *in utero*)
Estrogen-progestogen contraceptives
Human immunodeficiency virus type 1
Human papillomavirus types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59
Tobacco smoking

Vulva
Human papillomavirus type 16

Ovary
Asbestos (all forms)
Estrogen menopausal therapy
Tobacco smoking

Penis
Human papillomavirus type 16

Bone
Plutonium
Radium-224 and its decay products
Radium-226 and its decay products
Radium-228 and its decay products
X-radiation, gamma-radiation

Endothelium (Kaposi sarcoma)
Human immunodeficiency virus type 1
Kaposi sarcoma herpes virus

Multiple sites (unspecified)
Cyclosporine
Fission products, including Strontium-90
X-radiation, gamma-radiation
Exposure *in utero*

All cancers combined
2,3,7,8-Tetrachlorodibenzo-*para*-dioxin

Leukaemia/lymphoma
Azathioprine
Benzene
Busulfan
1,3-Butadiene
Chlorambucil
Cyclophosphamide
Cyclosporine
Epstein-Barr virus
Etoposide with cisplatin and bleomycin
Fission products, including Strontium-90
Formaldehyde
Helicobacter Pylori
Hepatitis C virus
Human immunodeficiency virus type 1
Human T-cell lymphotropic virus type 1
Kaposi sarcoma herpes virus
Melphalan
MOPP (vincristine-prednisone-nitrogen mustard-procarbazine mixture)
Phosphorus-32, as phosphate
Rubber production industry
Semustine [1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea, or methyl-CCNU]
Thiotepa
Thorium-232 and its decay products
Tobacco smoking
Treosulfan
X-radiation, gamma-radiation

Skin (melanoma)
Solar radiation
Polychlorinated biphenyls
Ultraviolet-emitting tanning devices

Skin (other malignant neoplasms)
Arsenic and inorganic arsenic compounds
Azathioprine
Coal-tar distillation
Coal-tar pitch
Cyclosporine
Methoxsalen plus ultraviolet A
Mineral oils, untreated or mildly treated
Shale oils
Solar radiation
Soot
X-radiation, gamma-radiation

Group 1 agents with less than *sufficient* evidence in humans
2,3,4,7,8-Pentachlorodibenzofuran
Polychlorinated biphenyls with a WHO TEF ("dioxin-like")
4,4'-Methylenebis(2-chloroaniline) (MOCA)
Alpha- and beta-particle emitters
Areca nut
Aristolochic acid
Benzidine, dyes metabolised to
Benzo[*a*]pyrene
Ethanol in alcoholic beverages
Ethylene oxide
Etoposide
Ionizing radiation (all types)
Neutron radiation
N'-Nitrosonornicotine (NNN) and 4-(*N*-nitroso-methylamino)-1-(3-pyridyl)-1-butanone (NNK)
Ultraviolet radiation

International Agency for Research on Cancer

World Health Organization

Occupational Exposure to Ionizing Radiation Is Associated with Autoimmune Thyroid Disease

Henry Völzke, André Werner, Henri Wallaschofski, Nele Friedrich, Daniel M. Robinson, Stefan Kindler, Matthias Kraft, Ulrich John, and Wolfgang Hoffmann

Institute of Epidemiology and Social Medicine (H.V., A.W., N.F., S.K., U.J.), Medical Department (H.W., D.M.R., M.K.), and Institute for Community Medicine (W.H.), Ernst Moritz Arndt University, D-17487 Greifswald, Germany

The Journal of Clinical Endocrinology & Metabolism 90(8):4587–4592

doi: 10.1210/jc.2005-0286

Context: The thyroid gland is a potential target organ for radiation-related damage.

Objective: The aim of the analysis was to investigate the association between occupational exposure to ionizing radiation and autoimmune thyroid disease (AITD).

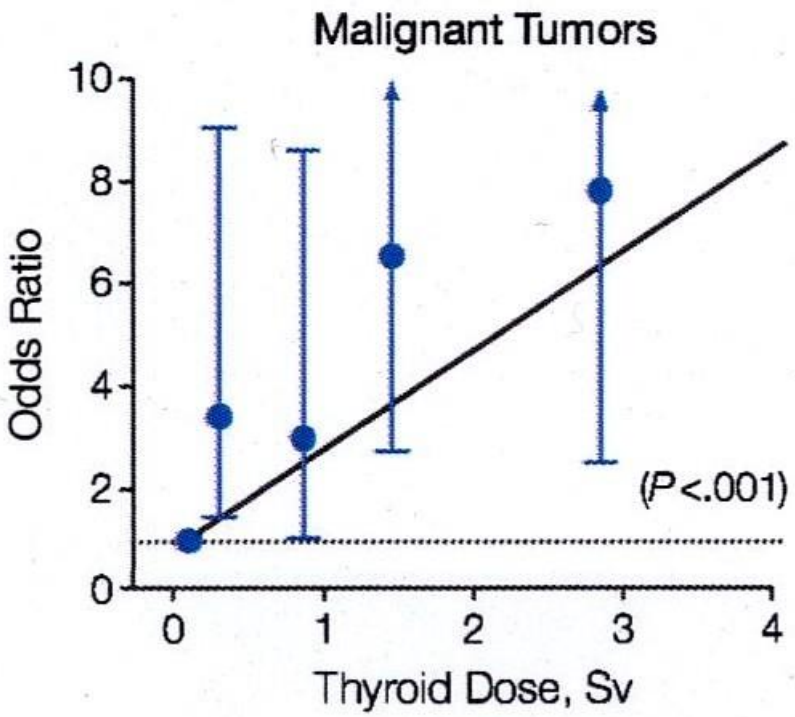
Design: Our design was the cross-sectional Study of Health in Pomerania.

Setting: The setting was the general community.

Subjects: Analyses were performed in a population-based sample of 4299 subjects. Among them, 160 persons reported a history of occupational exposure to ionizing radiation.

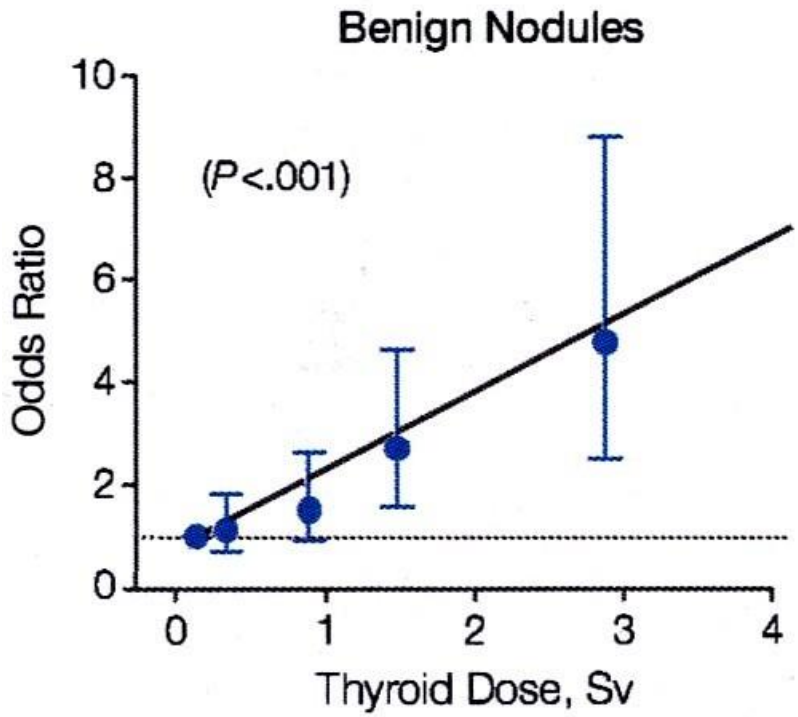
Main Outcome Measure: AITD was defined as the combined presence of hypoechogenicity in thyroid ultrasound and antithyroxiperoxidase antibodies greater than 200 IU/ml.

Dose Response for Thyroid Diseases



JAMA. 2006;295:1011-1022

Dose Response for Thyroid Diseases



JAMA. 2006;295:1011-1022

Effect of low doses of ionising radiation in infancy on cognitive function in adulthood: Swedish population based cohort study

Per Hall, Hans-Olov Adami, Dimitrios Trichopoulos, Nancy L Pedersen, Pagona Lagiou, Anders Ekbom, Martin Ingvar, Marie Lundell, Fredrik Granath

BMJ 328(2004), 19-24, bmj.com

Abstract

Objective To determine whether exposure to low doses of ionising radiation in infancy affects cognitive function in adulthood.
Design Population based cohort study.
Setting Sweden.
Participants 3094 men who had received radiation for cutaneous haemangioma before age 18 months during 1930-59.
Main outcome measures Radiation dose to frontal and posterior parts of the brain, and association between dose and intellectual capacity at age 18 or 19 years based on cognitive tests (learning ability, logical reasoning, spatial recognition) and high school attendance.
Results The proportion of boys who attended high school decreased with increasing doses of radiation to both the frontal and the posterior parts of the brain from about 32% among those not exposed to around 17% in those who received >250 mGy. For the frontal dose, the multivariate odds ratio was 0.47 (95% confidence interval 0.26 to 0.85, P for trend 0.0003) and for the posterior dose it was 0.59 (0.23 to 1.47, 0.0005). A negative dose-response relation was also evident for the three cognitive tests for learning ability and logical reasoning but not for the test of spatial recognition.
Conclusions Low doses of ionising radiation to the brain in infancy influence cognitive abilities in adulthood.

3094 Männer nach Strahlentherapie wg. Hämangiom vor dem 18. LM

Umfangreiche Dosisermittlung (mittl. Organdosis Gehirn < 100, Max.>250 mGy)

High school attendance, military cognitive tests (learning ability, logical reasoning)

Risiken konsistent erhöht (vergl. Tinea capitis)

kein wesentlicher Einfluss von Confoundern

Stat. sign. Trends

Höhere Risiken bei Dosismaximum im Frontalhirn

Mittl. Organdosis kann für Kleinkinder im diagnostischen CT erreicht werden

What is already known on this topic

High doses of ionising radiation to the developing human brain cause mental retardation

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It is unknown whether low level exposure in infancy has more subtle effects on cognitive function

What this study adds

Intellectual development is adversely affected when the infant brain is exposed to ionising radiation at doses equivalent to those from computed tomography of the skull

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Diagnostic evaluation of children with minor head injures needs to be re-evaluated

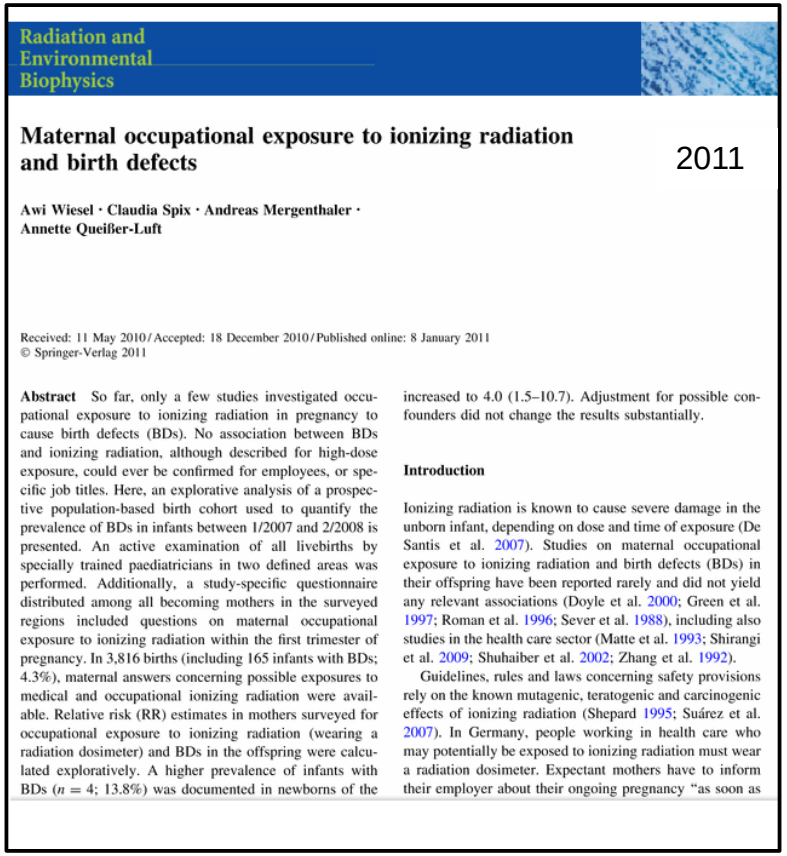
BMJ 328(2004), 19-24, bmj.com

Radiat Environ Biophys (2011) 50:325–328
DOI 10.1007/s00411-010-0350-9

SHORT COMMUNICATION

Maternal occupational exposure to ionizing radiation and birth defects

Awi Wiesel · Claudia Spix · Andreas Mergenthaler · Annette Queißer-Luft



Radiation and Environmental Biophysics

Maternal occupational exposure to ionizing radiation and birth defects

2011

Awi Wiesel · Claudia Spix · Andreas Mergenthaler · Annette Queißer-Luft

Received: 11 May 2010 / Accepted: 18 December 2010 / Published online: 8 January 2011

Abstract So far, only a few studies investigated occupational exposure to ionizing radiation in pregnancy to cause birth defects (BDs). No association between BDs and ionizing radiation, although described for high-dose exposure, could ever be confirmed for employees, or specific job titles. Here, an explorative analysis of a prospective population-based birth cohort used to quantify the prevalence of BDs in infants between 1/2007 and 2/2008 is presented. An active examination of all livebirths by specially trained paediatricians in two defined areas was performed. Additionally, a study-specific questionnaire distributed among all becoming mothers in the surveyed regions included questions on maternal occupational exposure to ionizing radiation within the first trimester of pregnancy. In 3,816 births (including 165 infants with BDs; 4.3%), maternal answers concerning possible exposures to medical and occupational ionizing radiation were available. Relative risk (RR) estimates in mothers surveyed for occupational exposure to ionizing radiation (wearing a radiation dosimeter) and BDs in the offspring were calculated exploratively. A higher prevalence of infants with BDs ($n = 4$; 13.8%) was documented in newborns of the 29 surveyed mothers compared to that in 3,787 births from unexposed mothers ($n = 161$; 4.3%), corresponding to a RR of 3.2 (1.2–8.7). Excluding deformations, the RR increased to 4.0 (1.5–10.7). Adjustment for possible confounders did not change the results substantially.

Introduction

Ionizing radiation is known to cause severe damage in the unborn infant, depending on dose and time of exposure (De Santis et al. 2007). Studies on maternal occupational exposure to ionizing radiation and birth defects (BDs) in their offspring have been reported rarely and did not yield any relevant associations (Doyle et al. 2000; Green et al. 1997; Roman et al. 1996; Sever et al. 1988), including also studies in the health care sector (Matte et al. 1993; Shirangi et al. 2009; Shuhaiber et al. 2002; Zhang et al. 1992).

Guidelines, rules and laws concerning safety provisions rely on the known mutagenic, teratogenic and carcinogenic effects of ionizing radiation (Shepard 1995; Suárez et al. 2007). In Germany, people working in health care who may potentially be exposed to ionizing radiation must wear a radiation dosimeter. Expectant mothers have to inform their employer about their ongoing pregnancy "as soon as

ly a few studies investigated occu-
ionizing radiation in pregnancy to
3Ds). No association between BDs
ı, although described for high-dose
be confirmed for employees, or spe-
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Nicht-Krebserkrankungen durch ionisierende Strahlung

Herz-/Kreislauferkrankungen:
1 – 13% / Sv

Ähnlich hohe Mortalität wie durch Krebserkrankungen (5% / Sv)

ehp ENVIRONMENTAL HEALTH PERSPECTIVES

2012

Systematic Review and Meta-analysis of Circulatory Disease from Exposure to Low-Level Ionizing Radiation and Estimates of Potential Population Mortality Risks

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Background: Although high doses of ionizing radiation have long been linked to circulatory disease, evidence for an association at lower exposures remains controversial. However, recent analyses suggest excess relative risks at occupational exposure levels.

Objectives: We performed a systematic review and meta-analysis to summarize information on circulatory disease risks associated with moderate- and low-level whole-body ionizing radiation exposures.

Methods: We conducted PubMed/ISI Thomson searches of peer-reviewed papers published since 1990 using the terms "radiation" AND "heart" AND "disease," OR "radiation" AND "stroke," OR "radiation" AND "circulatory" AND "disease." Radiation exposures had to be whole-body, with a cumulative mean dose of < 0.5 Sv, or at a low dose rate (< 10 mSv/day). We estimated population risks of circulatory disease from low-level radiation exposure using excess relative risk estimates from this meta-analysis and current mortality rates for nine major developed countries.

Results: Estimated excess population risks for all circulatory diseases combined ranged from 2.5%/Sv [95% confidence interval (CI): 0.8, 4.2] for France to 8.5%/Sv (95% CI: 4.0, 13.0) for Russia.

Conclusions: Our review supports an association between circulatory disease mortality and low and moderate doses of ionizing radiation. Our analysis was limited by heterogeneity among studies (particularly for noncardiac end points), the possibility of uncontrolled confounding in some occupational groups by lifestyle factors, and higher dose groups (> 0.5 Sv) generally driving the observed trends. If confirmed, our findings suggest that overall radiation-related mortality is about twice that currently estimated based on estimates for cancer end points alone (which range from 4.2% to 5.6%/Sv for these populations).

Key words: cancer, circulatory disease, heart disease, radiation, stroke. *Environ Health Perspect* 120:1503–1511 (2012). http://dx.doi.org/10.1289/ehp.1204982 [Online 22 June 2012]

a review by the Health Protection Agency's AGIR in the United Kingdom estimated substantial excess risks for ischemic heart disease (IHD) and stroke, but concluded that a significantly elevated risk was detectable only for exposures above about 0.5 Gy (AGIR 2010).

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Das Gütesiegel „Der Blaue Engel“