Fact Sheet: The KiKK Study Explained

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Background

In 2003, the German Federal Office for Radiation Protection (BfS), in response to concerns resulting from previous German Childhood Cancer Registry (GCCR) studies (1, 2, 3), initiated a case-control study of children less than 5 years of age living within 5 km of a nuclear power plant (NPP). This study, named the *Kinderkrebs in der umgebung von Kernkraftwerken* (KiKK) study, looked at all childhood cancer cases diagnosed between 1980 and 2003 compared to control children without cancer. The KiKK study (4) used distance from a NPP as a substitute for radiation exposure to evaluate the risk of childhood cancer and focused on cases within the 5 km zone of the 16 NPPs in Germany.

The main finding was an increased risk of leukemia in children less than five years of age with decreasing distance from a NPP. The authors of this paper caution the readers that their findings are unexpected given the very low observed levels of radiation and they state that the cause of childhood leukemia remains unexplained and may be due to uncontrolled confounding or pure chance (4).

CNSC Perspective

CNSC staff have analyzed the KiKK and other recent scientific literature regarding the sources and health effects of radiation exposure. The reason for the increased childhood leukemia rate around German NPPs is unclear. However, the increased rates could not be explained by the actual radiation emissions from the German NPPs.

Since childhood leukemia is thought to be caused by several factors, other factors may have been responsible for the observed results. Therefore, other factors in the environment need to be considered. More extensive, interdisciplinary research on the causes and mechanisms of the development of childhood leukemia is required to fully understand the disease.

What follows are the details of recent key international studies that have examined the relationship of distance from nuclear power plants and leukemia in children.

KiKK Study Follow-Up

Kaatsch *et al* (2008) (6)

Kaatsch *et al* (6) conducted a follow-up to the initial KiKK study. The study focused on the 593 childhood leukemia cases (rather than all malignancies) registered between 1980 and 2003 at the GCCR in children who were under 5 years of age

and living near one of the 16 nuclear power sites when diagnosed. Distance from a NPP served as a proxy for the radiation exposure caused by the facilities.

Kaatsch *et al* (6) indicate that "When leaving each nuclear power plant out of the calculations one by one, the results change only marginally: the regression coefficients vary between 1.39 and 2.09, all results remain statistically significant." Thus, results could not be attributed to a single reactor site, but were consistent for all 16 nuclear power sites in total.

However, the authors then state: “The maximum deviation from the overall coefficient of 1.75 is seen when analyzing the data excluding the nuclear power plant Krümmel (regression coefficient: 1.39 with lower 95% CL of 0.14) (6)." A well-known childhood leukemia cluster started in 1990 and continued to at least 2005 in the surrounding area of Krümmel. Thus, the estimated risk in the 5 km ring was highly sensitive to whether or not the Krümmel NPP was included in the KiKK study (7, 8).

The authors noted that an increasing trend with the inverse distance from the sites, considered as a continuous variable, was not detected when the distance was categorical (6). Likewise, the risk estimates obtained in the incidence analysis (9) also appeared to be lower than those obtained with the case-control approach (6). The authors also indicate that the results were largely attributed to cases in previous studies of the GCCR from 1980 to 1990 (1) and 1991 to 1995 (2), especially in the 5 km zone as there was overlap between these studies and the more recent one (1980-2003). In fact, the risk estimate of 1.78 (lower 95% CL: 0.99) determined that the most recent time period (1996-2003) was lower than in the previous time periods, and only a tendency towards an increase in risk with closer residential proximity was seen (6).

The strength of this study was the availability of individual measurements of residential proximity to the nearest NPP for each subject based on the residence at time of diagnosis. However, individual radiation exposures from the NPP emissions, other sources of radiation exposure (i.e., medical exposures), time spent at places other than their home address, and residential history of the study subjects was not available.

The authors noted the association may be influenced by other factors related to childhood leukemia (i.e., social class, pesticides, factors influencing immunological factors, exposure to other ionizing radiation). Unfortunately, the response rates to the study interview were very poor, especially in the 5 km zone, so no conclusions on the relationship between potential cofounding risk factors and the reported finding could be drawn. Without information on any of the possible causes of childhood leukemia, it is not possible to make any inference on risks.

The authors noted that the radiation exposure near a NPP in routine operation is extremely small compared to exposure to ionizing radiation of the general public from other sources (1,000-100,000 less than the annual average natural radiation (1.4 mSv) or medical (1.8 mSv) exposures in Germany). The authors did not attribute the increased childhood leukemia to the NPP emissions and noted the findings were not consistent with current radiation biological and epidemiological evidence (10). The authors concluded the observed positive distance trend remains unexplained and no statements on the cause of the increase cancer rates can be made (6).

Further Analyses

Grosche (2008) (11)

Grosche (11) conducted a further analysis of the data used in the KiKK case-control study and concluded that the observed trend in risk decreased over time, indicative of some agent being involved for which the prevalence is reduced over time. However, currently, there is no clear explanation for a causal relationship between any chemical or physical risk factor and the observed risk.

COMARE (2011) (7)

The 14th Committee on Medical Aspects of Radiation in the Environment (7) also observed that for 1991-1995 and 1996-2003, the evidence for an increased risk of leukemia in young children living within the 5 km zone of German NPPs, excluding Krümmel, is only weak. Nonetheless, the Krümmel cluster could not be explained by the routine radioactive

discharges.

German Radiological Protection Commission (SSK, 2008) (12)

The German Radiological Protection Commission (SSK) appointed an interdisciplinary international working group of experts to review the current knowledge on radiation and leukaemia, to summarize an independent reanalysis of the KiKK data, and to make a final evaluation of the study's overall design, conduct, results and interpretation.

The experts noted several limitations of the KiKK study, such as the lack of information on exposure and other risk factors known to be related to childhood leukaemia. The evidence for increased childhood cancer risk was only limited to the 5 km zone and the risk decreased with time. They stated that distance from a NPP is not suitable for establishing a correlation with radiation exposure from NPPs; and the actual exposures from the German NPPs are lower by a factor of 1,000 than those that could cause the risks reported by the KiKK study. Likewise, the natural radiation exposure within the study area, medical radiation exposure, and any fluctuations in these exposures are both greater by several orders of magnitude than the additional radiation exposures caused by the relevant NPPs.

A reassessment of the KiKK results also showed that the marked impact of the urban/rural status of the residence area on the estimated risk (12). Thus, the international expert working group concluded that the reasons for the increased childhood leukemia rate that the KiKK study observed remain unclear. Since leukemia is caused by multiple factors, numerous influencing factors could have been responsible for the observed result (12, 13).

Little *et al* (2008) (14) and Laurier *et al* (2008) (15)

Little *et al* (14) and Laurier *et al* (15) reviewed the KiKK study and came to similar conclusions that the excess leukemia in children aged 0-4 years around the 5 km zone of the German NPPs was not supported by studies from other countries and to date, nothing can explain the observed excess. The most likely explanation is the hypothesis of an infectious agent associated with population mixing around nuclear sites (16); however, the infectious agent has yet to be found. The 14th Committee on Medical Aspects of Radiation in the Environment (7) came to similar conclusions.

Other Studies

Since the KiKK study was published, several other studies in the United Kingdom (17), France (18), Switzerland (19) and Finland (20) have come to the conclusion that there is no relationship between childhood leukemia and distance from a NPP. While the French Geocap study (8) did find a relationship between distance and childhood leukemia using a case-control methodology, the use of a dose-based geographic zoning (DBGZ) methodology yielded very different results for the same data. Using DBGZ, the odds ratio and standardized incidence ratio was close to one in all of the dose categories indicating that the association cannot be explained by the NPP gaseous discharges (8, 21).

Conclusion

When drawing conclusions about the health effects of radiation, it is important to consider all the evidence. Thus any claims of a link between childhood leukemia and radiation from nuclear power plants are unfounded and not supported by a wealth of evidence resulting from multiple epidemiology studies.

The CNSC keeps up-to-date on emerging research to ensure the most recent information, based on sound science, is considered in protecting the health and safety of the public, workers and the environment. CNSC staff contributes to the scientific radiation knowledge through their roles on international scientific committees, and through the conduct of Canadian studies of the relationship between ionizing radiation, workers and members of the public.

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