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http://www.ox.ac.uk/media/news_releases_for_journalists/120611.html

# Natural exposure to gamma rays in background radiation linked to childhood leukaemia

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Findings demonstrate that there are small effects of radiation at very low doses

A small but statistically significant link between risk of childhood leukaemia and the gamma rays we are all exposed to from our natural environment has been detected in an Oxford University-led study.

Exposure to gamma rays from natural sources in the environment isn't something that can readily be altered, but the study adds to our understanding of the small cancer risks associated with other low doses of radiation, such as from medical X-rays and CT scans.

Guidelines on exposure to low doses of radiation have largely been based on estimated risks from models using data from Japanese survivors of the atomic bombs, where radiation exposures were brief and very much higher. As a result, there have been some long-standing uncertainties about the extrapolation of these risks to low radiation doses.

The researchers conclude that the size of the increased risk of childhood leukaemia with natural gamma-ray exposure is consistent with these models and supports their continued use in radiation protection.

The results of the study contradict the idea that there are no adverse radiation effects, or might even be beneficial effects, at these very low doses and dose rates.

The Oxford University researchers, along with colleagues from the US National Cancer Institute, The University of Manchester and the Health Protection Agency, have published their findings in the journal Leukemia.

The case-control study, based on tens of thousands of records from a UK national cancer registry, is the largest such study ever conducted on links between childhood cancers and natural background radiation levels.

It has needed a study of this very large size to be able to reliably identify the small effect of background radiation on childhood leukaemia. Previous studies have lacked the size and statistical power to be able to detect any link.

'We found a statistically significant correlation between natural gamma-rays and childhood leukaemia,' says lead researcher Dr Gerald Kendall of the Childhood Cancer Research Group at Oxford University. 'What is new in our findings is the direct demonstration that there are radiation effects at these very low doses and dose-rates.'

The researchers believe that the association between natural gamma-rays and childhood leukaemia is likely to be causal.

Gamma rays in background radiation come largely from naturally occurring radioactive isotopes of uranium, thorium and potassium in the environment. In the UK, children have an annual radiation dose of roughly 0.7 mSv (millisievert) to bone marrow from natural gamma-rays.

Background radiation accounts for only a minority of childhood leukaemias. The cause of most cases is unknown.

While there is some variation in natural gamma-ray exposure around the UK, the radiation doses are small and there is very little that can be done to mediate or prevent any cancer risk. In this respect it is different from naturally occurring radon gas: radon exposure can be controlled but gamma exposure where you live is inevitable.

'In terms of preventing childhood cancers caused by natural gamma-rays, there's not a lot you can do,' explains Dr Kendall.

'We have estimated that about 15% of the 500 or so cases of childhood leukaemia which occur annually in the UK are due to natural background radiation.

'Natural gamma-rays account for about half the dose reaching children's bone marrow from all sources. So they account for approaching 40 childhood leukaemias a year.

'That means even if the entire UK population were to move to mid-Wales, fewer than 15 childhood leukaemias per year would be prevented.'

The three counties with the lowest mean gamma-ray dose rates are Powys in mid-Wales, Dorset and Wiltshire at 70 nGy/hr (nanograys per hour).

The three counties with the highest are South Yorkshire, Cornwall and the Isles of Scilly, and the Scottish Borders at 120 nGy/hr.

The researchers used records from the National Registry of Childhood Tumours to investigate associations with natural background radiation.

The National Registry of Childhood Tumours has an essentially complete record of UK cases of childhood cancers, allowing the researchers to compare the radiation exposures for almost 27,500 cases diagnosed between 1980 and 2006 (including over 9,000 childhood leukaemias) with a set of almost 37,000 matched control children without cancer.

Cumulative radiation exposures from birth to cancer diagnosis were estimated for where the mother was living at the time of the child's birth.

The team found that there was a 12% increase in the risk of childhood leukaemia for every millisievert of natural gamma-ray dose to the bone marrow. While this finding was statistically significant, even with a study of this size there is still some uncertainty around the size of the effect. The relative risk increase is likely to lie within a range from 3% to 22% per millisievert.

There were no statistically significant associations between other childhood cancers and natural gamma-rays, or between any cancers and levels of radon in the natural background radiation.

Dr Kendall adds: 'The findings are relevant to understanding the risks from low radiation exposures such as medical X-rays and CT scans; planning for the disposal of nuclear waste; and the risks from the exposures received by people living near Chernobyl or Fukushima.

'The risk estimates used by those involved in radiation protection for such situations have tended to rely on models that extrapolate risk from data on Japanese survivors of the atomic bombs where radiation exposures were very high. Our findings are consistent with these models.'

Professor Richard Wakeford of The University of Manchester, a co-author of the study, said: 'Radiation protection measures assume that even low doses of radiation pose some, albeit small, risk of cancer. Naturally occurring gamma-rays provide an ever-present, very low-level source of exposure to radiation, but this very large epidemiological study suggests that even at these very low levels there is a very small risk to health. However, the results are what would be expected from previous scientific evidence, and indicate that the current assumptions underlying radiation

protection are about right.'

A separate paper finding an increase in risk of leukaemia linked to radiation exposure from CT scans in childhood was published in The Lancet on 7 June.

Dr Kendall of Oxford University believes the increase in risk that the authors found to be associated with the radiation dose received from a CT scan is 'certainly compatible' with the findings of this study.

Dr Mark Little of the Radiation Epidemiology Branch at the National Cancer Institute in the USA was a co-author on both studies. Dr Little says: 'CT scans will remain very valuable for medical imaging and diagnosis, especially when serious health conditions are suspected. There should be no need to change current practice in the UK: CT scans should continue to be used when medically justified, although radiation doses should be kept as low as possible, and alternative procedures which not involve radiation exposure should be considered if appropriate.'

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# Notes for Editors:

- A pre-publication version of the paper has been made public this week on the website of the journal Leukemia at http://www.nature.com/leu/journal/vaop/naam/abs/leu2012151a.html. The full, corrected and typeset version will be published in the coming weeks.
- The study was funded by the Department of Health for England and Wales, the Scottish government, and the charity CHILDREN with CANCER. These organisations had no role in the study design, analysis, reporting or interpretation of the data.
- The Lancet paper on medical CT scans and childhood leukaemia and brain tumours is available at: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(12)60815-0/abstract

  The Lancet held a press briefing on the paper in London and issued a press release.
- The Health Protection Agency (HPA) explains that:

  Every day all over the world people are exposed to ionising radiation, almost all from natural sources in the environment or for medical reasons. Ionising radiation has enough energy to cause damage to cells which can increase the risk of cancer later in life. However these risks to health are actually low and ionising radiation is widely used in cancer therapy. In general the health effects of ionising radiation are dependent on the dose received. While low doses increase the risk of cancer later in life, very high doses act like a poison and can be fatal.

  http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/DoseComparisonsForIonisingRadiation/
- In the UK, the HPA has calculated that on average people are exposed to about 2.7 millisieverts (mSv) of radiation a year.The 2.7 mSv dose that people in the UK are exposed to comes from a number of sources. Many building materials contain low degrees of natural radioactivity and radon gas seeps from the ground into all buildings, so the largest exposure

is to naturally occurring radiation in homes and workplaces. There are also significant contributions from naturally occurring radioactivity in food and from medical exposures.

http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/DoseComparisonsForIonisingRadiation/)

- A millisievert is a measure of radiation dose which accounts for the fact that ionising radiation can affect different parts of the body to differing degrees. The millisievert dose also allows for the different effects of different types of radiation: X rays, gamma rays, neutrons, alpha particles and beta particles.

  NB: The gray (Gy) is another unit for radiation dose, but it does not take into account the differing biological effect in different parts of the body. This is ripe for confusion, but in the specific case of gamma rays, sieverts and grays are equivalent.
- Comparison of radiation doses from different sources of exposure:

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| Chest X-ray | 0.02mSv |
| Transatlantic flight | 0.07mSv |
| Nuclear power station worker average annual occupational exposure | 0.18mSv |
| UK annual average radon dose | 1.3mSv |
| UK average annual radiation dose | 2.7mSv |
| USA average annual radiation dose | 6.2mSv |
| CT scan of the chest | 6.6mSv |
| Average annual radon dose to people in Cornwall | 7.8mSv |
| Annual exposure limit for nuclear industry employees | 20mSv |
| Level at which changes in blood cells can be readily observed | 100mSv |
| Acute radiation effects including nausea and a reduction in white blood cell count | 1000mSv |
| Dose of radiation which would kill about half of those receiving it in a month | 5000mSv |

- http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/DoseComparisonsForIonisingRadiation/
- The World Health Organisation estimates that following the Fukushima Dai-ichi nuclear power station accident, most residents of Fukushima Prefecture and neighbouring Japanese prefectures received a dose below 10 mSv. Residents of Namie town and Iitate village, the two most affected areas, received estimated doses of 10–50 mSv. http://www.who.int/ionizing_radiation/pub_meet/faqs_dose_estimation/en/index.html
- **Oxford University's Medical Sciences Division** is one of the largest biomedical research centres in Europe, with over 2,500 people involved in research and more than 2,800 students. The University is rated the best in the world for medicine, and it is home to the UK's top-ranked medical school.

  From the genetic and molecular basis of disease to the latest advances in neuroscience, Oxford is at the forefront of medical research. It has one of the largest clinical trial portfolios

in the UK and great expertise in taking discoveries from the lab into the clinic. Partnerships with the local NHS Trusts enable patients to benefit from close links between medical research and healthcare delivery.

A great strength of Oxford medicine is its long-standing network of clinical research units in Asia and Africa, enabling world-leading research on the most pressing global health challenges such as malaria, TB, HIV/AIDS and flu. Oxford is also renowned for its large-scale studies which examine the role of factors such as smoking, alcohol and diet on cancer, heart disease and other conditions.