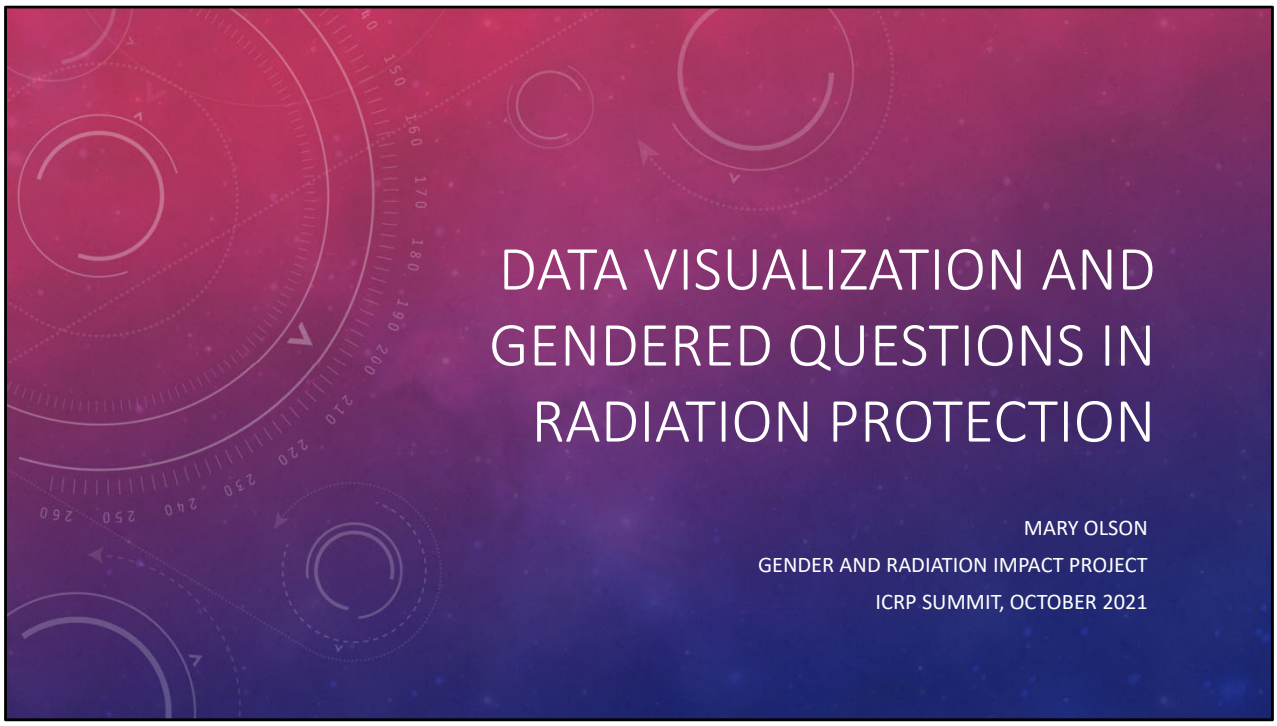


Mary Olson

Gender and Radiation Impact Project
www.genderandradiation.org
Asheville, North Carolina USA

Olson.mary@gmail.com

ABSTRACT

Data visualization and Gendered Questions in Radiation Protection

Mary Olson (gender.radiation@gmail.com)

Gender and Radiation Impact Project (NGO)

Recognition that age and biological sex are key factors in outcome of radiation exposure is reflected in the Discussion Paper on The Future of Radiological Protection. Use of a hypothetical "fixed" or universal exposure level in visualization of exposure outcomes in a large population such as the A bomb survivors, and application of a lifecycle model as compared to the population model are explored. The author is an evolutionary biologist with decades of national and global policy engagement, and she examines the efficacy of the idea of multiple standards from the perspective of the need for reparation.

Keywords: Gender; radiation; girl; protection; lifecycle

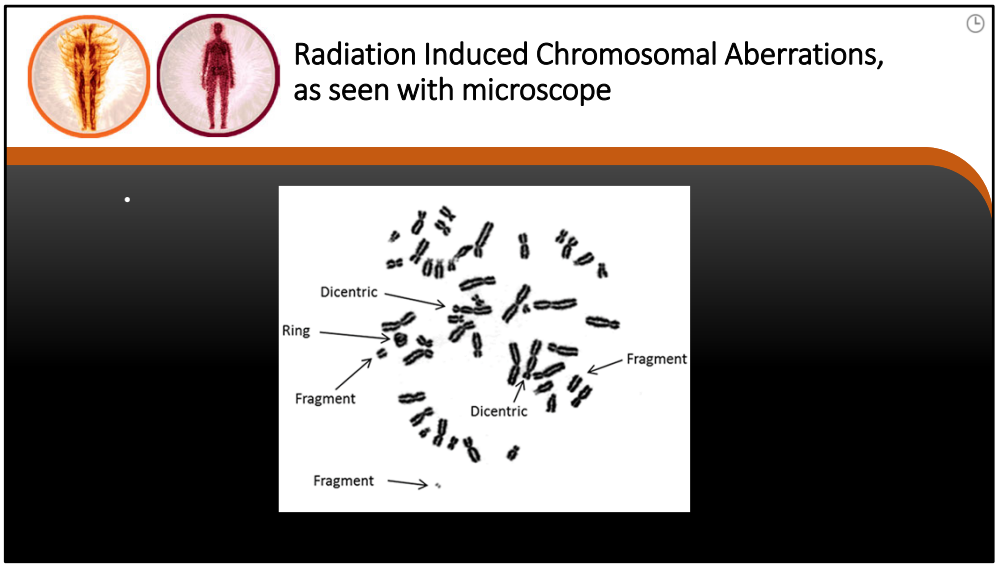
This paper is based on findings published by this author in 2019:

Disproportionate impact of radiation and radiation regulation

Interdisciplinary Science Reviews, May 2019

doi.org/10.1080/03080188.2019.1603864

The website for Gender and Radiation Impact Project is www.genderandradiation.org The RESOURCES tab has a link to the text of this paper in author manuscript form.



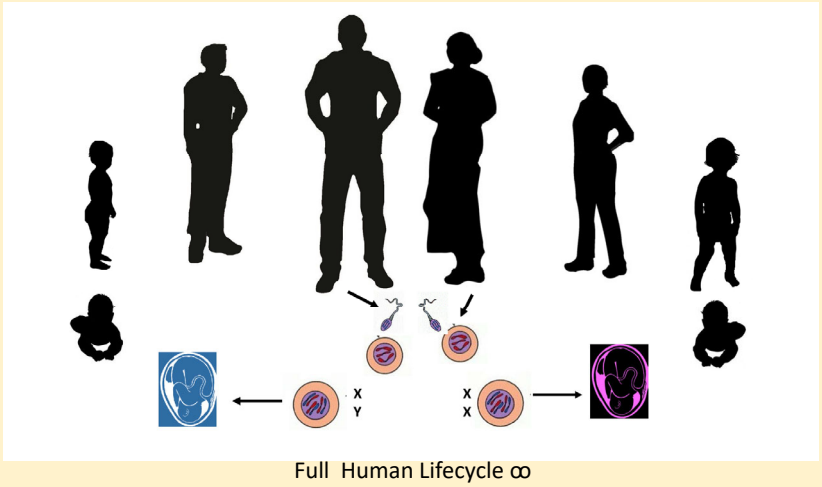
Radiation is invisible but we can see the damage it has done to these chromosomes.

***

Resources:

Dicentric and other chromosomal aberrations are common in people who have suffered acute radiation exposure. The damaged chromosomes are found in white blood cells and can be assessed as a biological dosimeter. More information here:

http://www.rerf.jp/radefx/late_e/chromoab.html



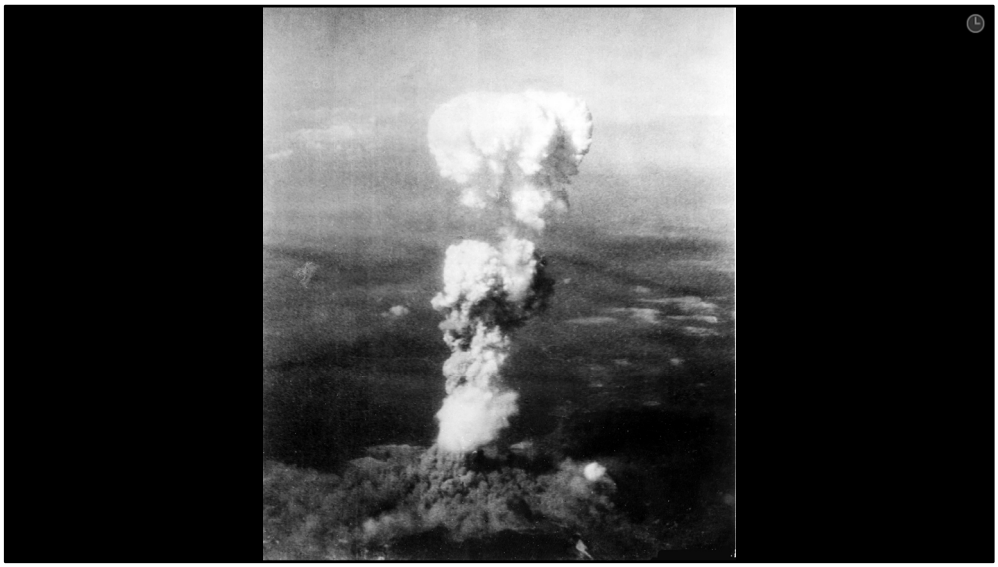
Full Human Lifecycle ∞

This author explores questions about biological impact of ionizing radiation in the context of a lifecycle.

Radiation impacts are most often projected in terms of a reference individual or a population distribution. In a population, age groups are treated as subpopulations– which does not reflect that every adult was also a child, and impacts during childhood may dominate outcomes that appear in adulthood.

This paper discusses gendered findings and so, instead of showing our life-cycle as a single lobe—which is not adequate—simple expansion to a figure-8 shows the somatic post-conception phases separately. Nonetheless, the data-set used does not include reproductive phase data. This author acknowledges that gap in this discussion.

The recommendations in this paper are made in the spirit of a good "First step." Factoring the consequences of radiation exposure during the reproductive phases is vital to our survival as a species over the long haul.



The Japanese survivors of the atomic destruction of Hiroshima and Nagasaki by the United States in 1945 are the one large data-set that has tracked people exposed to radiation for decades. Tragically they are a group who were of all ages when exposed, and the data collected is disaggregated by biological sex.

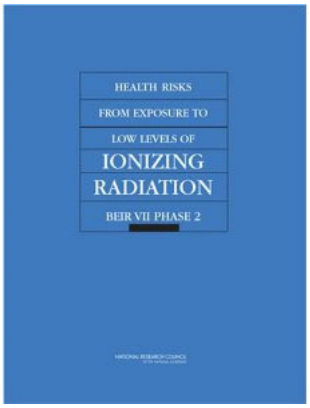
The horrific origin of this data set must not be overlooked, and I personally wish this history had never happened--the atomic bombs had never been dropped on cities full of people. Using the data ties us directly to those acts—and I am called to join the survivors in saying “Never again.”

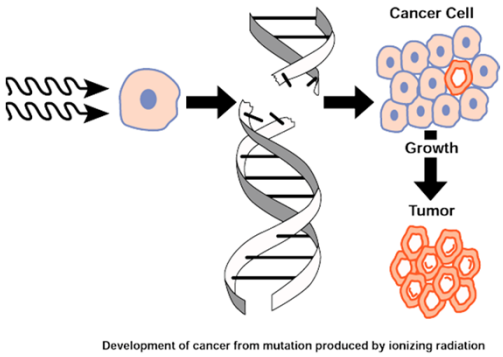
This photo was taken moments after the destruction of Hiroshima. The cloud we see is what was, moments before, a city with trees, homes, boys, girls, women and men.

The immediate and indiscriminate destruction resulted in loss of more than 150,000 people.

This painting was made from memory by a Hibakusha (survivor) from Nagasaki.

Art Credit:
Painting by a Hibakusha from Nagasaki, recording events witnessed. Made available by Hibakusha Stories Project; http://www.hibakushastories.org/





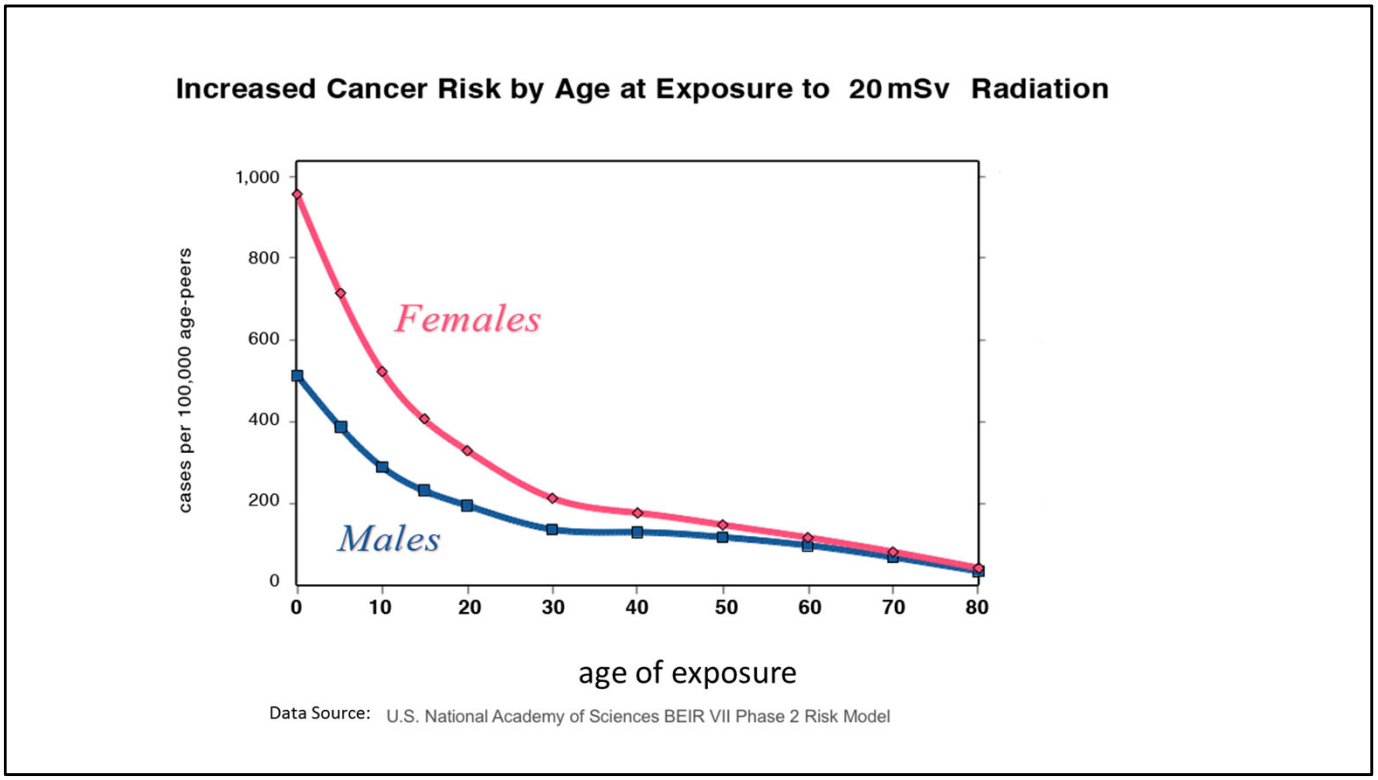
Development of cancer from mutation produced by ionizing radiation

U.S. National Academy of Science:
Biological Effects of Ionizing Radiation (BEIR VII Phase 2)
published 2006. Sixty years of Life Span Study (LSS)

60 years of A-bomb survivor data published by The US National Academy of Science in 2006. The Biological Effects of Ionizing Radiation, VII, phase 2.

My findings come from an independent analysis of the NAS report: I did not collect any data myself.

There are many different studies of the A-bomb survivors. It is important to note that all of the visualizations following are rooted in the fact that the only outcome studied was cancer, and only external radiation exposure was factored.



This graph based on A-bomb survivor data shows a scenario, a "what if" everyone in the data-set had the same (or fixed) ONE-TIME radiation exposure of 20 mSv (similar to a medical CT-scan).

Across the bottom of the plot is the age of exposure. The vertical axis is incidence of cancer in each age-cohort, across 60 years.

A further hypothetical feature is the amplification of the age-cohorts to 100,000 individuals in each.

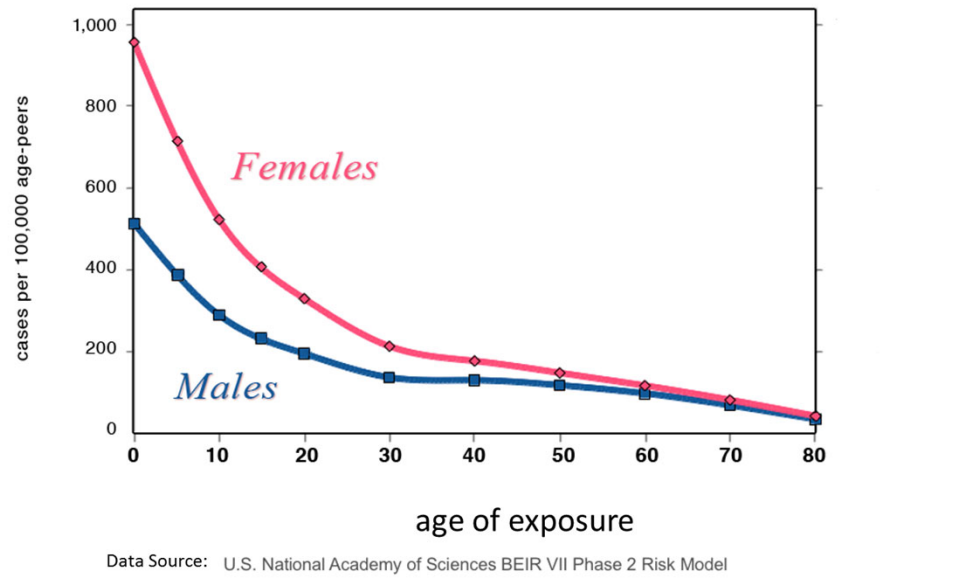
Examination of the axes, we see the age span is birth to 80 years old at the time exposed…

…and we see that the top of the left axis corresponds to 1000 cancers or an overall 1 percent increase in excess cancer—since each cohort is 100,000.

Fixing a variable

- Fixing DOSE or EXPOSURE allows us to look at cancer as a function of age-at-exposure and time…
- And to do so for each sex

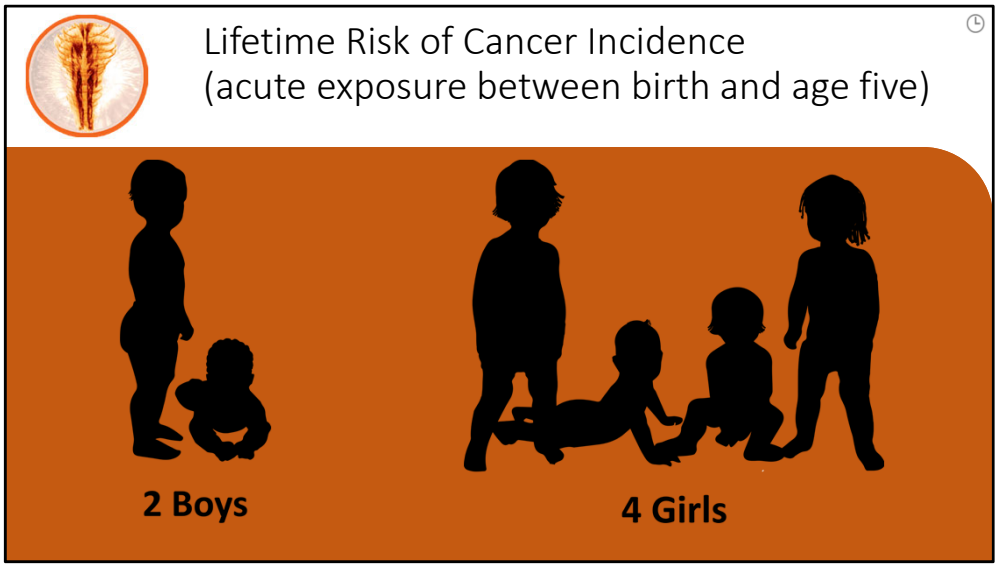
- Fixing AGE and SEX, typically by use of a “reference individual” allows us to look at cancer as a function of dose,
- …which historically has dropped out the time factor in data visualization, or assumed that TIME is also fixed.



Returning to the same projection of excess cancer as a function of age-of-exposure, it is easy to see, children had more cancer outcomes from the exposure--and, important to note, the cancers were not necessarily in childhood.

Thanks to data disaggregation it is possible to draw a pink line (female) and a blue line (male). You can see the pink line--females—is very different than the blue line.

The two lines never cross—in every age-cohort, females suffered more cancer than did males. However, the degree difference based on sex is far from constant.



In fact, among the youngest aged cohort, girls were twice as likely to get cancer at some point than were boys in that group.

For every male in the 0-5 cohort that suffered cancer at some point in their lives, TWO females got cancer at some point in their lives.

The BEIR VII report is where these numbers are found; the report itself does not offer extensive discussion of biological sex as a risk factor. I published my initial findings in 2011.

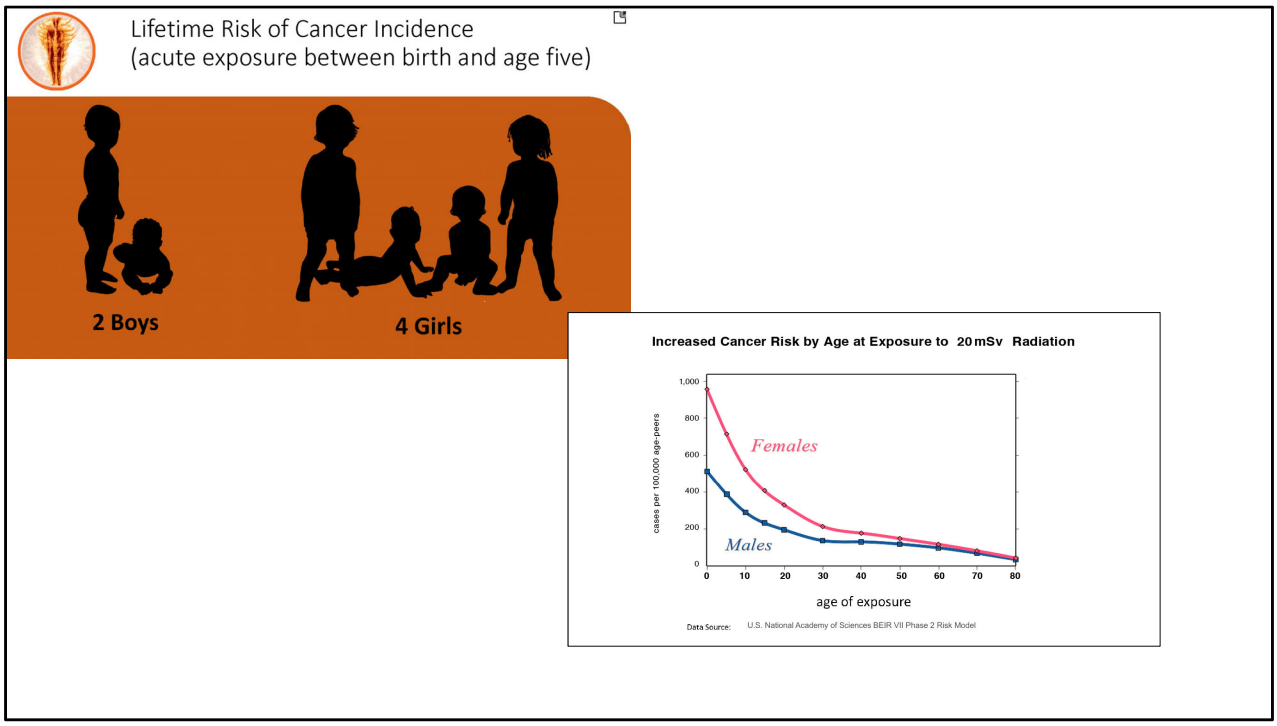
Independent from my work, Dr. Arjun Makhijani , et al, published the similar findings in 2005.

*** **Art Credit:** Saro Lynch-Thomason, Fullsteam Labs

Source:

Olson, 2011. NIRS Briefing Paper: "Atomic Radiation is more harmful to women." posted: http://www.nirs.org/radiation/radhealth/radhealthhome.htm

Makhijani, 2005 started the Healthy from the Start Campaign to address disproportionate impact of ionizing radiation on young females.
http://ieer.org/projects/healthy-from-the-start/
And http://ieer.org/resource/health-and-safety/open-letter-to-president-bush-on-protecting-the-most-vulnerable/



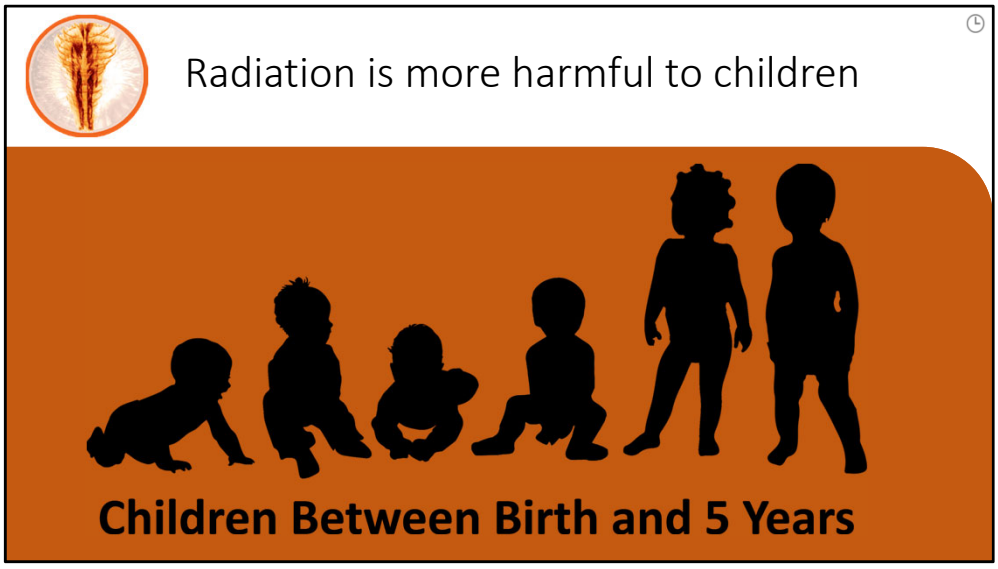
As a data visualization, the silhouette figures illustrate the two data points at the far left edge of the graphic image.

This is where gendered findings diverge the most—and in the view of this author, these data points should instruct both radiation regulation and nuclear policy engagement.

Fundable research questions

- In biological research, a doubling of outcome between any two study groups is a MAJOR finding of a biological signal. Women, exposed as girls suffering twice the cancer as men exposed as boys is a huge SIGNAL.
- The question of WHY the bodies (soma) of boys are more resistant to cancer from exposure to ionizing radiation compared to the soma of girls is a very good research question…and to date, this author has not seen answered.
- More literature is needed, on this, and many other associated questions.

Additional research questions are offered in Olson, 2019.



Children's bodies are small; so the same amount of radiation delivers a larger dose. The US Environmental Protection Agency (EPA) assesses children at a lower risk of exposure for the same reason.—being small. The EPA approach is not supported by the fixed dose exposure projection.

Since children are growing, the cells in their bodies are dividing more rapidly. DNA is more likely to be damaged when in cell division. Is there a difference between males and females in growth rate? Maturation?

***

Resources on Disproportionate Impact of Radiation on Children / In Utero:
Dr Alice Stewart; broad description of her work:
http://www.nytimes.com/2002/07/04/world/alice-stewart-95-linked-x-rays-to-diseases.html and Gayle Green, 2001. "Alice Stewart, the Woman Who Knew Too Much."

Orignial Study: Stewart, et al, 1958. "Survey of Childhood Malignancies" British Medical Journal, June 28, pages 5086 – 1508.

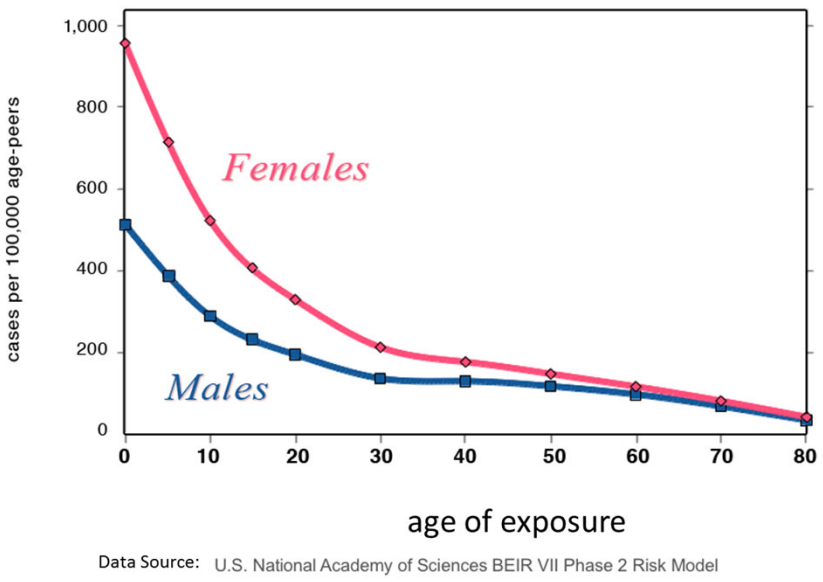
Dr Rosalie Bertell; "No Immediate Danger?" 1985. Women's Press Toronto, Canada and also Summertown Books, USA.

See also www.ieer.org – "Healthy from the Start."

Along with discounting impact of ionizing radiation on children, the US EPA also considers young girls and boys to be “sub populations” – which discounts the findings presented here—and over simplifies since every adult was, at one time a child.

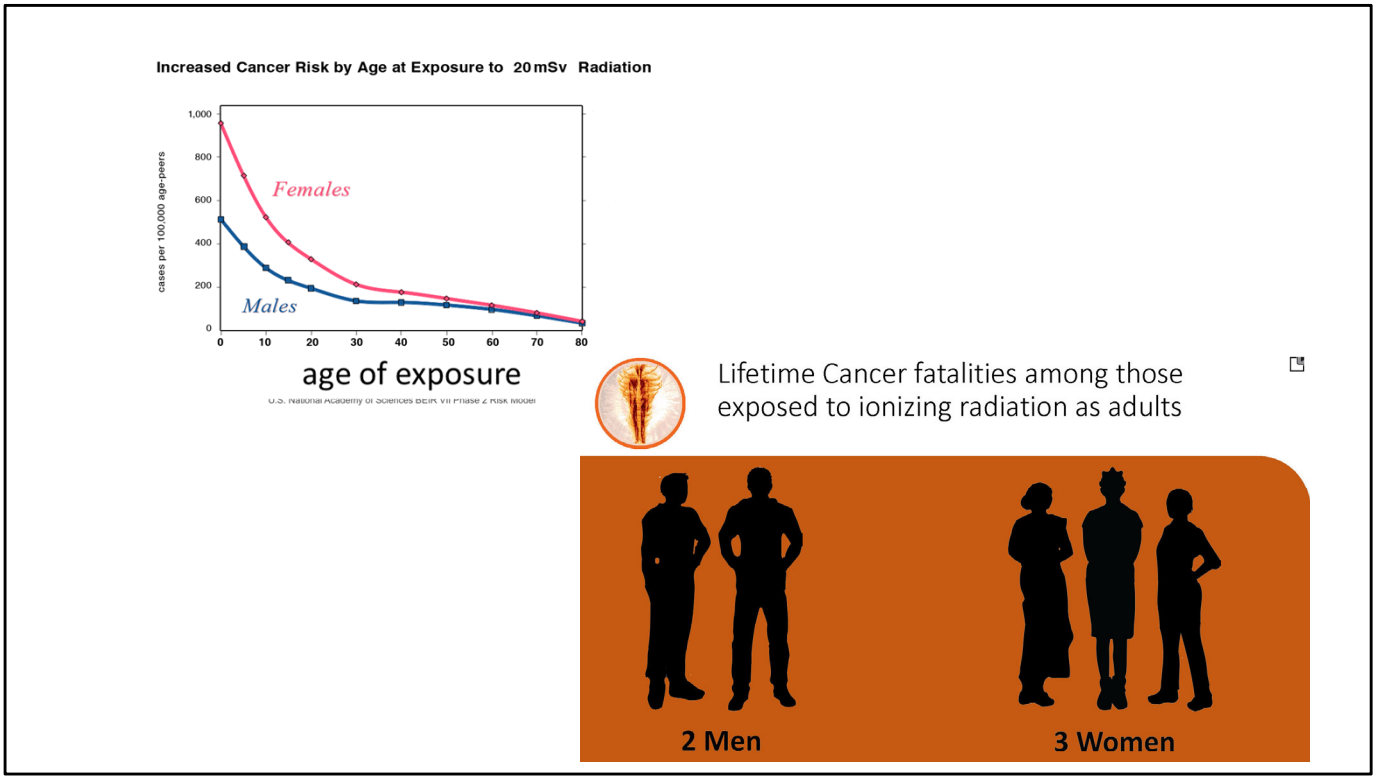
Girls in Los Angeles or Beijing are subpopulations. Girls are inextricable links—without whom no other phase of the lifecycle can exist.

If girls are exposed, as many children are today, and survive to womanhood, their risk of cancer is many times higher than is predicted by current regulatory models—even if a hybrid hermaphrodite is employed.



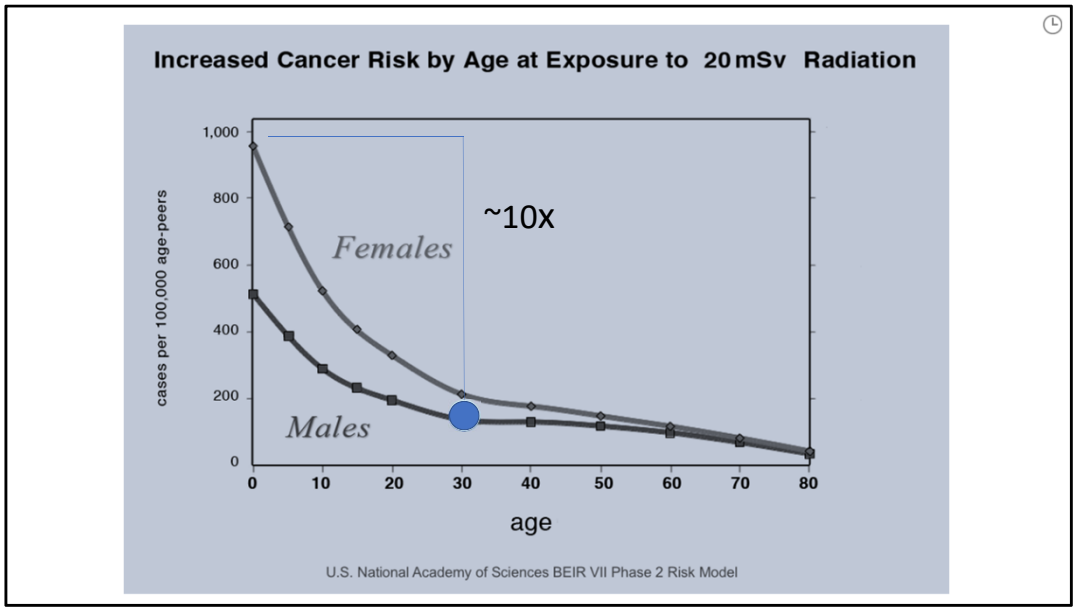
Back to the same projection—to now look at the middle of the plot—the young adult male data helped to inform the Reference Man, still in use by the primary federal regulator in the USA, the US Nuclear Regulatory Commission..

Inspection of the pink line in relation to the blue line in the midsection shows that risk is down for both groups—but remains elevated among females compared to males.



Over their lifetime women exposed as adults suffered 50% more cancer death than did men in the same age group.

For every 2 men in these cohorts who died of cancer, three women died of cancer



Decision makers in the USA only see information in the blue circle because the primary federal regulator uses Reference Man.

The rest of the information is effectively invisible. Females, and children are invisible.

The differential of a factor of ten between the somatic outcomes for females exposed gin childhood compared to the outcomes for the more cancer-resistant young adult male is also not presented to decision-makers.

***

Reference Man, a convention in radiation regulation, is routinely used in USA

Exposure calculations are based on these parameters:

- 25—30 years old
- 170 cm / 5’ 7” tall
- 70 kg / 154 pounds
- Average temperature 10-20 C
- Western European / North American industrialized lifestyle
- White (Caucasian)

In the United States, Refence Man is used to calculate exposure, evaluate compliance with regulations, and assess risk.

Reference Man is defined by seven parameters of

- Sex
- Age
- Height
- Weight
- Climate
- Culture / socio-economics
- Race

Radiation regulation based on Reference Man results in systematic under-reporting of radiation harm for the global population.

Read slide

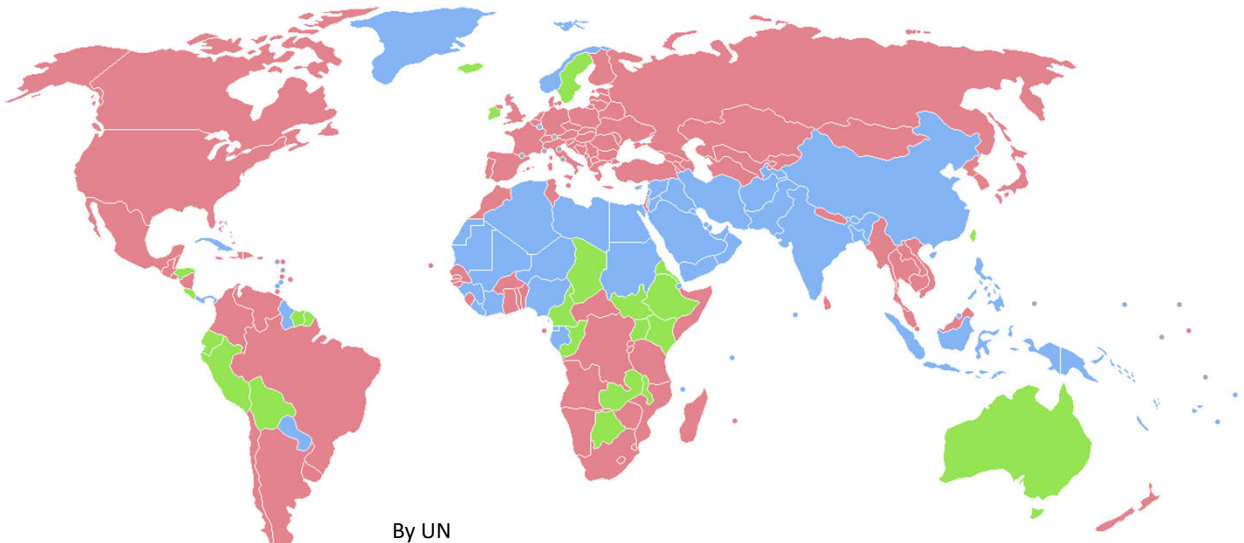
This discussion unequivocally shows that when nuclear impacts are on Native Lands, women and children in these communities are at higher risk of cancer as an outcome.

This data-set cannot address the fact that environmental exposure is most typically radioactive contamination of air, water and food-chains., resulting in internal radiation exposures.

Another fundable research question:

Is biological sex a factor in the outcomes from exposure due to internalized radioactivity?

***



By UN http://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf, via commons.wikimedia.org

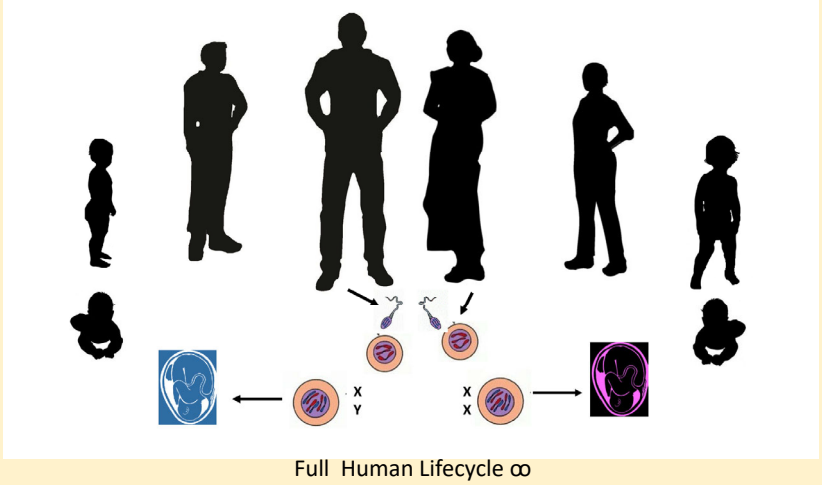
Justice is an important consideration in public policy. Reparations for Permanent Peoples must rise to the top of any civilized body.

AND omission of half the world's population as a function of biological sex by radiation regulators is another justice issue, particularly since there is disproportionate radiation harm to the half that has been excluded from adequate protection.

The map here shows 2015 data mapping the sex ratio of the global population. Pink shows areas where females exceed males, blue the opposite. Green shows where males and females were equal in numbers.

Dual, or Multi Regulatory Limits are Unjust

- The ICRP discussion paper, Fit for Purpose, rehearses the possibility of multiple radiological protection standards
- This plan must be rejected in protection of the general public
- Environmental Exposures do not modulate according to the age or sex of the individual exposed—so modulation of protection would effectively be a fiction



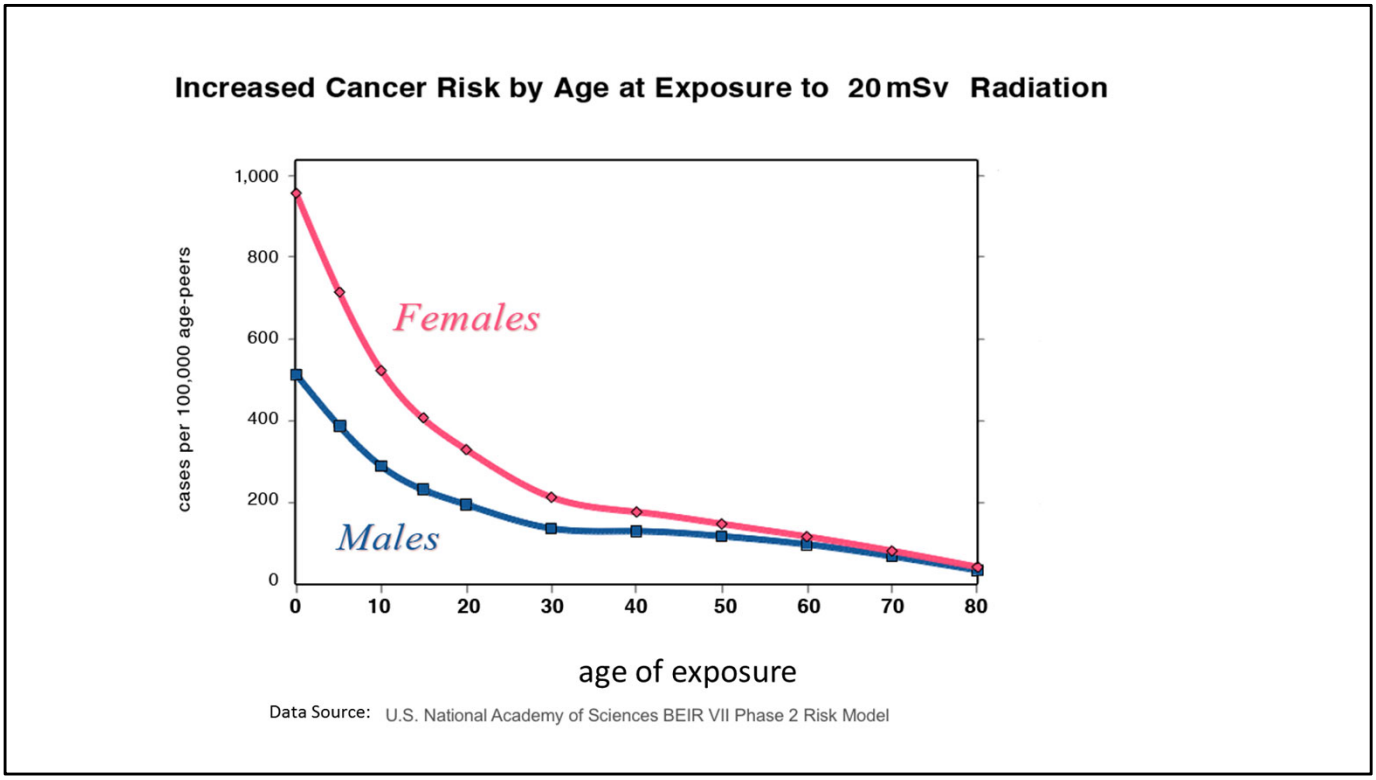
Full Human Lifecycle ∞

A life-cycle view reminds us that every life-phase is an inextricable link in the total cycle.

A Life-cycle-informed universal Reference Individual

- These findings show cancer is a function of biological sex and age-of-exposure. YOUNG GIRLS are the life-phase at greatest risk of harm from radiation.

- A reference individual centered on a female under the age of six and **applied universally**, would better protect the entire human life-cycle while providing the first meaningful protection to those most-harmed.

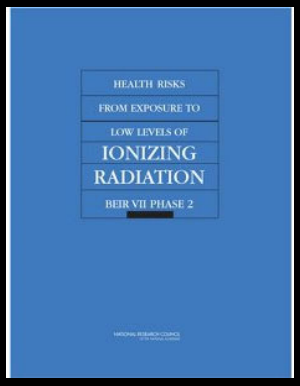


Finally, this picture is possible to see as an age-and-sex cancer-response to exposure to ionizing radiation that can be applied to individuals across their lifespan, and read much like an actuarial table:

- Find your age
- Find your sex
- Read off the relative (60-year) risk of cancer as the outcome from a 20 mSv exposure to an external source of ionizing radiation, such as you might get in diagnostic imaging
- ….might be you, or someone you love.

This author suggests that a double risk for girls compared to boys is important information for a parent to have…and 50% greater risk compared to same-aged male colleagues has changed her fieldwork.

Public protectors have an obligation to center protection on those most-at-risk—given 100 years of exclusion, it is a needed reparation.



U.S. National Academy of Science:
Biological Effects of Ionizing Radiation (BEIR VII Phase 2)
published 2006.

The Biological Effects of Ionizing Radiation, VII; Phase 2 is in print from the National Academy of Science Press and also available at no charge for a PDF file download here: http://www.nap.edu/openbook.php?isbn=030909156X

GENDER + RADIATION IMPACT PROJECT

www.genderandradition.org

See: https://www.genderandradiation.org/blog/2020/12/31/my-six-mentors