

## **The Gender Problem in Radiation Protection**

Gender is a range of characteristics used to distinguish between males and females, particularly in the cases of men and women and the masculine and feminine attributes assigned to them. While the social sciences sometimes approach gender as a social construct, and some gender studies particularly do, research in the natural and medical sciences investigates whether biological differences in males and females influence the development of gender in humans.

### **Biological sex differences**

Differences between the sexes are part of the human condition. We all have a mother and a father. Most of us are attracted to members of the opposite sex, and the rest of us notice the difference from those who do. And we can't help but notice the sex of our children, friends, and our colleagues, in every aspect of life.

The most obvious differences between males and females include all the features related to reproductive role, notably the endocrine (hormonal) systems and their physiological and behavioral effects, including gonadal differentiation, internal and external genital and breast differentiation, and differentiation of muscle mass, height, and hair distribution.

Also, the topic of possible sex differences is of great scientific interest. Sex is a fundamental problem in biology, and sexual reproduction and sex differences go back a billion years. There's an interesting theory, which predicts that there should be an overall equal investment of organisms in their sons and daughters; neither sex is predicted to be superior or inferior across the board.

The nature and source of sex differences are also of practical importance. Most of us agree that there are aspects of the world, including gender disparities, that we want to change. But if we want to change the world we must first understand it, and that includes understanding the sources of sex differences.

First, there are many biological mechanisms by which a sex difference could occur. There are large differences between males and females in levels of sex hormones, especially prenatally, in the first six months of life, and in adolescence. There are receptors for hormones all over the brain, including the cerebral cortex. There are many small differences in men's and women's brains,

including the overall size of the brain (even correcting for body size), the density of cortical neurons, the degree of cortical asymmetry, the size of hypothalamic nuclei, and several others.

Second, many of the major sex differences — certainly some of them, maybe all of them, are universal.

Third, stability over time. Surveys of life interests and personality have shown little or no change in the two generations that have come of age since the second wave of feminism. There is also, famously, resistance to change in communities that, for various ideological reasons, were dedicated to stamping out sex differences, and found they were unable to do so.

Fourth, many sex differences can be seen in other mammals. It would be an amazing coincidence if these differences just happened to be replicated in the arbitrary choices made by human cultures at the dawn of time. There are large differences between males and females in many mammals in aggression, in investment in offspring, in play aggression play versus play parenting, and in the range size, which predicts a species' sex differences in spatial ability.

Fifth, many of these differences emerge in early childhood. A bit later in development there are vast and robust differences between boys and girls, seen all over the world. Boys far more often than girls engage in rough-and-tumble play, which involves aggression, physical activity, and competition. Girls spend a lot more often in cooperative play. Girls engage much more often in play parenting. There are sex differences in intuitive psychology, that is, how well children can read one another's minds. For instance, several large studies show that girls are better than boys in solving the "false belief task," and in interpreting the mental states of characters in stories.

Sixth, genetic boys brought up as girls. In a famous 1970s incident called the John/Joan case, one member of a pair of identical twin boys lost his penis in a botched circumcision. Following advice from the leading gender expert of the time, the parents agreed to have the boy castrated, given female-specific hormones, and brought up as a girl. All this was hidden from him throughout his childhood. At age 14, suffering from depression, his father finally told him the truth. He underwent further surgery, married a woman, adopted two children, and got a job in a slaughterhouse.

Seventh, a lack of differential treatment by parents and teachers. There is a widespread myth that teachers (who of course are disproportionately female) are dupes who perpetuate gender inequities by failing to call on girls in class, and who otherwise having low expectations of girls' performance.

Eighth, studies of prenatal sex hormones: the mechanism that makes boys boys and girls girls in the first place. There is evidence that differences in prenatal hormones make a difference in later thought and behavior even within a given sex. In the condition called congenital adrenal hyperplasia, girls in utero are subjected to an increased dose of androgens, which is neutralized postnatally. But when they grow up they have male-typical toy preferences — trucks and guns — compared to other girls, male-typical play patterns, more competitiveness, less cooperativeness, and male-typical occupational preferences.

Ninth, circulating sex hormones. Though it's possible that all claims of the effects of hormones on cognition will turn out to be bogus, something will be salvaged from this somewhat contradictory literature. There are, in any case, many studies showing that testosterone levels in the low-normal male range are associated with better abilities in spatial manipulation. And in a variety of studies in which estrogens are compared or manipulated, there is evidence, admittedly disputed, for statistical changes in the strengths and weaknesses in women's cognition during the menstrual cycle, possibly a counterpart to the changes in men's abilities during their daily and seasonal cycles of testosterone.

Tenth, imprinted X chromosomes. In the past fifteen years an entirely separate genetic system capable of implementing sex differences has been discovered. In the phenomenon called genetic imprinting, a chromosome such as the X chromosome can be altered depending on whether it was passed on from one's mother or from one's father. This makes a difference in the condition called Turner syndrome, in which a child has just one X chromosome, but can get it either from her mother or her father. When she inherits an X that is specific to girls, on average she has a better vocabulary and better social skills, and is better at reading emotions, at reading body language, and at reading faces.

There is thus evidence for sex differences that are relevant to statistical gender disparities. There are reliable average differences in life priorities, in an interest in people versus things, in risk-seeking, in spatial transformations, in

mathematical reasoning, and in variability in these traits. And there are ten kinds of evidence that these differences are not completely explained by socialization and bias, although they surely are in part. A person's sex as male or female has also legal significance — sex is indicated on government documents, and laws provide differently for men and women.

### **Does radiation risk depend on gender?**

The health status of men versus women and boys versus girls can be significantly different by virtue of the differences in their gender (sex). This is true regardless of any exposure to ionizing radiation.

Many studies have found that a number of major illnesses are influenced by gender. The same holds true for the potential risks associated with exposure to x-rays or ionizing radiation from radioactive materials or accelerators.

For example, female breasts are more sensitive to ionizing radiation than male breasts. While men can develop breast cancer, it is extremely rare.

### **ICRP Publication 103 – 2007 Recommendations**

In the 1990 Recommendation, the Commission concluded that, for the purpose of controlling occupational exposure, there was no reason to distinguish between the two sexes. The Commission maintains this policy with the 2007 Recommendations. Some radiation-related cancers are as mentioned sex-specific, and for many others gender is a major modifier of radiation-related risk. In accord with current ICRP procedures, intermediate and final numerical risk estimates are gender-averaged. Radiation risks were also calculated by retaining gender specificity of intermediate results and gender-averaging only at the final stage. The final results were similar, within acceptable limits, for the two methods of calculation. According to ICRP gender specific data are thus not recommended for the general purposes of radiological protection.

In the ICRP 2007 Recommendation tables are given (A.4.10 – 19) of sex-specific population detriments. These sex-specific values for detriment do not have specific functions in the Commission's system of radiological protection.

However, if a female worker has declared that she is pregnant, additional controls have to be considered to protect the fetus. It is the Commission's view

that the methods of protection at work for women who are pregnant should provide a level of protection for the fetus broadly similar to that provided for members of the public. The Commission considers that this policy will be adequately applied if the mother is exposed, prior to her declaration of pregnancy, under the system of protection recommended by the Commission. Once an employer has been notified of a pregnancy, additional protection of the fetus should be considered. The working conditions of a pregnant worker, after declaration of pregnancy, should be such as to ensure that the additional dose to the fetus would not exceed about 1 mSv during the remainder of the pregnancy.

The Commission strongly recommends that in order to protect the fetus or infant, females who have declared that they are pregnant should not be involved in emergency actions involving high radiation doses.

The Commission states it is essential to ascertain whether a female patient is pregnant prior to radiation therapy and some abdominal interventional procedures. Cancer in the pelvis can rarely be adequately treated with radiation therapy during pregnancy without severe or lethal consequences for the fetus. Absorbed doses below 100 mGy to the fetus should not be considered a reason for terminating a pregnancy.

In many countries, radiation exposure of pregnant females as subjects in biomedical research is not specifically prohibited. However, their involvement in such research is very rare and should be discouraged unless pregnancy is an integral part of the research.

**European Commission Proposal for a COUNCIL DIRECTIVE  
Brussels, 29.9.2011 COM(2011) 593 final laying down basic safety  
standards for protection against the dangers arising from exposure to  
ionising radiation**

**Protection of pregnant women**

1. As soon as a pregnant woman informs the undertaking of her condition, in accordance with national legislation or national practice, the protection of the unborn child shall be comparable with that provided for members of the public. The employment conditions for the pregnant woman shall therefore be such that

the equivalent dose to the unborn child is as low as reasonably achievable and unlikely to exceed 1 mSv during at least the remainder of the pregnancy.

2. As soon as a breastfeeding woman informs the undertaking of her condition, she shall not be employed in work involving a significant risk of intake of radio nuclides.

## **PROTECTION OF PATIENTS AND OTHER INDIVIDUALS SUBJECTED TO MEDICAL EXPOSURE**

### Special protection during pregnancy and breastfeeding

1. In the case of a woman of childbearing age, the referrer and the practitioner shall inquire as specified by Member States whether she is pregnant or breastfeeding, if relevant.

If pregnancy cannot be excluded, depending on the type of medical exposure, in particular if abdominal and pelvic regions are involved, special attention shall be given to the justification, particularly the urgency, and to the optimization of the medical exposure, taking into account the exposure both of the expectant mother and the unborn child.

2. In the case of breastfeeding women, in nuclear medicine, depending on the type of medical examination or treatment, special attention shall be given to the justification, particularly the urgency, and to the optimization of the medical exposure, taking into account the exposure both of the mother and the child.

3. Without prejudice to paragraphs 1 and 2, Member States shall take measures to increase the awareness of women to whom this Article applies, such as public notices in appropriate places.

### **Conclusions by the author**

The radiation protection policy as outlined by ICRP in its Recommendation 103 takes does not take care of the gender problem. The radiation legislation in the European Union follows the ICRP policy. The fetus will be well protected according to the ICRP policy. When more radiation risk data will be collected in the future for male and female, the present ICRP conclusion may eventually change.

**Reference**

ICRP Publication 103: The 2007 Recommendations of the International Commission on Radiological Protection. *Annals of the ICRP*; Volume 37; Nos. 2-4 2007.