

## **Male to Female Ratio at Birth: the Role of Background Radiation vs. Other Factors**

### **Appendix**

The author is sincerely grateful to the colleagues for their responses to the articles [37-41]. The following citations from the responses should be further commented. The author feels that these quotes are essential to the argument.

**Hagen Scherb:** A social factor that may skew the birth sex ratio is gender selective abortion, a practice reported from parts of Asia and parts of North Africa [42]. However, this method requires advanced techniques for prenatal gender ascertainment that were not available at the time of the Windscale fire in 1957 and during the era of the major atmospheric nuclear weapons testing prior to 1963 [38].

**Author:** Apart from sex-selective abortions, requiring prenatal gender testing, there has always been some percentage of female neonaticide and neglect of newborn girls, the ancient tools of the demographic regulation in certain cultures [31-33]. Moreover, since olden times, there have been methods of attempted prenatal gender prediction and selection, possibly successful in some percentage of cases [43]. Finally, a reduced M/F ratio has been linked to older age at childbearing [44]. The age of mothers at childbirth tends to be higher in more developed countries, generally tending to increase [45]. The higher M/F ratios at birth and their dynamics in Europe compared to the USA, illustrated by graphs in the Reply by Hagen Scherb [38], have an explanation unrelated to radiation: the ongoing immigration to Europe from Asia and Africa including the regions with the son preference. The immigration to the USA occurs largely from Latin America, that is, countries where prenatal sex-selection seems to be not part of the culture, the son preference considered to be “fairly mild” [46]. Immigrants bring their reproductive stereotypes with them; the dynamics of the sex ratio at birth is probably influenced by the immigration.

**Hagen Scherb:** We found a significant dose-response association of Chernobyl fallout with subsequent sex ratio increases at the district level in Germany [38].

**Author:** The increase in the male proportion at birth with an odds ratio of 1.0090 in 1987 in the data subset from Bavaria, former GDR and West Berlin [47] was deemed “extremely small” [29]. The first year dose from Chernobyl accident in the former GDR was around 0.21, in the Western part of the country (former FRG)-0.16 mSv [5], which is a small addition to national averages from NRB (around 3.6 mSv/a in Germany; 3-7 mSv/a in the majority of European countries) [5,48]. The slight increase in the perinatal mortality in the Eastern part of Germany after 1986 was discussed in support of the role of radiation after the Chernobyl accident [49-51]. The ratio perinatal deaths/total births in GDR and West Berlin: 1986-2,183/242,068=9.02 per 1,000 total births; 1987-2,281/246,704=9.24 per 1,000 [49]. This increase might have been caused by social factors (decline of the communist regime) and emigration of some medical personnel from the former GDR to the West. In general, oscillations of the perinatal mortality in Central and Eastern Europe after the Chernobyl accident [49,52] could have been caused by sociopolitical transformations of the late 1980s.

**Hagen Scherb et al.:** Without specific empirical evidence and reference, Sergei V. Jargin insinuates a possible cause of the observed long-term increases in perinatal mortality in contaminated prefectures after

Fukushima: “It is not surprising that cataclysms with evacuation of people, associated with stress, temporary derangements of perinatal care services, of diets, etc., are accompanied by an increase in the perinatal mortality”. Our data clearly show that in highly tsunami-impacted regions there is indeed a more than 50% increase in perinatal mortality, but this is confined to March and April 2011 only. From May through December 2011, nowhere in Japan perinatal mortality remained elevated. Moreover, the perinatal mortality increase in Chiba, Saitama, and Tokyo 10 months after the natural and technical catastrophes cannot be explained by “derangements of perinatal care” as the general infrastructure had not been compromised at all in these 3 prefectures [39].

**Author:** It is known by the example of Chernobyl accident that evacuations of people, psychological stress and anxiety favored by exaggerated risks ascribed to the low-dose radiation are noxious factors. In particular, exposures to stress after a nuclear accident may have detrimental effects on pregnant women [53,54]. Expectant mothers with anxiety and post-traumatic stress were reported to be at a higher risk of preterm birth [55]. There was an increase in the induced abortion rate after the Chernobyl accident [56-59]. Certain publications in professional journals may prevent physicians from giving adequate advice to pregnant women inquiring about a possible abortion. Radiation phobia with psychosomatic manifestations [60] is probably more prevalent in more contaminated areas thus contributing to dose-effect correlations. Reiterations of the perinatal mortality “jump” [61,62] after the Fukushima Daiichi accident can contribute to anxiety in pregnant women and elevate the abortion rate. Moreover, it cannot be excluded that radiophobia contributed to illegal abortions during the last trimester of pregnancy possibly influencing perinatal mortality figures. Considering that certain percentage of abortions after a prenatal ultrasonic gender testing must have been sex-selective, the enhanced abortion rate might contribute to an increased M/F ratio at birth.

**Hagen Scherb:** The doubling of the background radiation level, say, from 1 mSv/a to 2 mSv/a, represents a doubling of an important physical environmental parameter relevant for the development of life on the earth, and cannot as such be considered a ‘low dose’ and of no effect [38].

**Author:** A local increase from 1 to 2 mSv/a is of minor significance as the doses would remain under the global average from NRB equal to 2.4 mSv/a. Considering the possibility of radiation hormesis [12], the doubling of “background radiation level... from 1 mSv/a to 2 mSv/a” [38] can be even beneficial. An increase of the mean value from 2.4 to 4.8 mSv/a can be regarded as a real doubling. An increase of comparable scale (excluding thyroid doses) occurred only in the vicinity of the Chernobyl reactor approximately for one year after the accident [5].

**Hagen Scherb:** Furthermore, the letter to the editor [40] implies that low doses of radiation are innocuous. This flies in the face of the linear no-threshold (LNT) hypothesis that states that at even at low doses, there is a linear relationship between dose and risk, particularly vis-a-vis the probability of cancer induction, all the way down to zero exposure [38].

**Author:** The literature on the LNT was overviewed previously [63]. In brief, the LNT postulates that linear dose-effect correlations, proven to some extent for higher doses, can be extrapolated down to minimal doses. The DNA damage and repair are permanent processes in dynamic equilibrium. Living organisms have probably been adapted to NRB in a similar way as to other environmental factors: various chemical substances, products of radiolysis of water, ultraviolet light, and various stressors. Natural selection is slow; adaptation to a changing

environmental factor would probably correspond to some average from the past. The NRB has been decreasing during the time of life existence on the Earth [64]. The conservative nature of mutation repair mechanisms in contemporary living organisms suggests that these mechanisms evolved in the distant past and that organisms may have retained some capability of efficient reparation of damage from higher NRB than that existing today [64]. With the dose rates tending to a wide range NRB level, radiation-related risks would probably tend to zero, and can even fall below zero within some dose range in accordance with hormesis confirmed by many experiments [65-70]. Admittedly, experiments do not always agree with epidemiological research. Epidemiological studies of low-dose radiation effects may be prone to bias, for example, surveillance bias, dose-dependent selection and self-selection, higher participation of cases (cancer patients) compared to controls etc. [71-74]. Better recollection by cases of the facts related to radiation (recall bias) [75] may contribute to overestimation of doses in the cases. It can be reasonably assumed that people informed on their higher doses would visit medical institutions more frequently being given averagely more attention. In the author's opinion, the reported relationships of low-dose exposures with the sex ratio at birth and with other non-cancer endpoints, being devoid of physiological plausibility, witness against cause-effect relationships of the same doses with cancer, reported on the basis of epidemiological research.

In this connection, ideological bias aimed at the strangulation of nuclear energy should be pointed out, well in agreement with the interests of fossil fuel producers. Nuclear power has returned to the agenda because of the concerns over increasing global energy demand, declining fossil fuel reserves and climate changes. Health burdens were reported to be greatest for power stations based on lignite, coal, and oil. The health burdens are smaller for natural gas and still lower for nuclear power. This ranking also applies for greenhouse gas emissions [76]. The global development of nuclear energy must be managed by a powerful international executive based in the most developed parts of the world. It would prevent dissemination of nuclear technologies to unstable regions, where wars and terrorism are not excluded. It would enable construction of nuclear power plants (NPP) in optimally suitable places, disregarding national borders, considering all socio-political, geological and other preconditions, quality of working by local professionals, etc. [77]. In this way, nuclear accidents like in Fukushima (2011), caused by the earthquake and tsunami, or in Chernobyl (1986), favored by disregard for written instructions [5,78,79], would be prevented.