Avens Publishing Group
J Environ Stud
May 2018 Vol.:4, Issue:1

Open Access Review Article

Journal of Environmental Studies

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

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Submission: 13 April, 2018
Accepted: 09 May, 2018
Published: 18 May, 2018

Keywords: Ionizing radiation; Demography; Gender imbalance

Introduction

An increase in the male to female (M/F) ratio at birth supposedly under the impact of radiation exposures from nuclear testing (worldwide) and Chernobyl fallout (in Europe) has been investigated by Victor Grech, professor at the Department of Pediatrics, Mater Dei Hospital, Malta [1,2]. The conclusions were that "elevated levels of man-made ambient radiation may have reduced total births, affecting pregnancies carrying female pregnancies more than those carrying male pregnancies, thereby skewing M/T (male live births divided by total live births) toward a higher male proportion" and "birth rates are greatly reduced and the M/T ratio is skewed upward significantly with population exposure to ionizing radiation, even at great distances from major nuclear events" [1,2]. However, social factors that could have influenced M/F ratios at birth were not analyzed. The natural radiation background (NRB) was not mentioned, although additional doses due to contamination were often negligible compared the NRB. Worldwide annual doses from NRB are generally expected to be in the range of 1-10 mSv, with 2.4 mSv being the estimated global average [3]. Some national averages are ≥10 mSv [4]. In Europe, mean annual doses from NRB are ≥5-7 mSv in several countries [5]. There are many places in the world where the dose rate from NRB is 10-100 times higher than the average e.g. 260 mGy/a in Ramsar, Iran [6], or 70 mGy/a at certain locations in Kerala, India [7]; yet there are no reliable data on shifts of sex ratios at birth in such areas. For example, a study based on ≥150,000 consecutive live singleton newborns in Kerala did not indicate any impact of elevated NRB on the sex ratio [8]. The maximum annual dose from the global fallout due to nuclear tests was estimated to be 0.14 mSv in 1963, having decreased by almost an order of magnitude by 1979 [3]. According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), "as far as whole body doses are concerned, the six million residents of the areas of the former Soviet Union (SU) deemed contaminated received average effective doses for the period 1986-2005 of about 9 mSv, whereas for the 98 million people considered in the three republics, the average effective dose was 1.3 mSv, a third of which was received in 1986. This represents an insignificant increase over the dose due to background radiation over the same period (~50 mSv)" [9]. In other countries, individual doses from the Chernobyl fallout were lower: the first year doses after the accident reached 1 mSv only at singular locations in Central Europe; all country overages are ≤1 mSv/a [5,10]. For comparison, a single computed tomographic (CT) examination produces a dose within the range 2-20 mSv, while doses from interventional diagnostic procedures usually range from 5 to 70 mSv [11]. Health risks have never been proven for the above-mentioned doses [12]. Annual individual doses in the vicinity of reactors have been in the range 0.001-0.5 mSv [3], so that the above dose comparisons pertain also to the reported shift of sex ratios at birth in people residing near nuclear facilities [13].

Experimental and other relevant research has not been discussed in [1,2]. The following studies should be cited in this connection. Experiments using 18 generations of exposed mice with the daily dose ~0.29 mGy suggested that low-dose low-rate exposures do not affect the sex ratio in mouse litters [14]. No radiation-induced sex ratio changes in the offspring of mice were found by other researchers [15-19]. On the contrary, a study and review from the year 1968 concluded that there is a sex ratio shift following spermatogonial exposure in rats [20]. It should be commented that doses used in animal experiments are much higher than average doses to the residents of contaminated territories after the Chernobyl accident. These latter doses are generally within "the window for maximum adaptive response protection" [21]. According to experimental data, this window occurs at doses between 0 and 100 mGy (or higher) from a low dose rate, low LET (linear energy transfer) radiation exposure, where the risk is expected to be reduced below the spontaneous level of cancer risk [21]. In a study from 1958, radiation was found to influence the sex ratio of infants born to survivors of the atomic bombing [22]; but the association was not seen in later studies, while the data on the total number of births in Hiroshima and Nagasaki in the period 1956-1962 indicated no significant difference in the sex ratio of infants [23]. Male radiologists tended to father even a lower proportion of boys compared to the control group [24]. Significance of supposedly radiation-related shifts of sex ratios calculated by Grech and co-workers has been questioned [25-28]. A comprehensive review concluded that "there is little consistent evidence that ionizing radiation affects the sex ratio" [29].

data by Victor Grech and co-workers should be viewed taking into account possible mechanisms unrelated to radiation. So, except for Baltic States, all regions of the former SU showed a significant increase in M/T ratio from 1986 on [2]. The highest M/F ratios at birth were reported from the South Caucasus (Azerbaijan, Armenia and Georgia) [2,30], being explained by the son preference and sex-

ISSN: 2471-4879

selective abortions [30]. The same is probably true for the North Caucasus, where the birth rate has been the highest in Russian Federation. Masculinity has traditionally high value in the Caucasus. The elevation of the M/T and M/F ratios at birth in the former SU coincided with the increasing availability of the prenatal ultrasonic gender testing in the late 1980s [2,30]. A relatively high M/T ratio at the time of generally unavailable prenatal gender testing (1981-1985) in Caucasus [2] might be seen as indication to female neonaticide, which is the ancient family planning tool [31-33]. Gender imbalance due to the son preference and sex-selective abortions occurs in China, India and some neighboring countries [31] as well as among Asian immigrants to Europe and the USA [34,35]. On one hand, there are many immigrants from the Caucasus in the former SU (except for the Baltic States mentioned above); on the other hand, similar tendencies of son preference might exist also in other groups of the ex-Soviet population favored by manliness propaganda remarkable since the early 2000s [36]. Insufficient security coupled with the tolerant attitude towards violations of the law might have motivated some families to have sons - for protection and more success. All these social phenomena in the former SU coincided with the elevation of M/F or M/T ratios. Analogously, dynamics of M/T ratio in Central Europe [2] could have been influenced by the ongoing immigration from countries with son preference and gender imbalance [34].

Conclusion

The conclusions by Victor Grech that "elevated levels of man-made ambient radiation may have reduced total births, affecting pregnancies carrying female pregnancies more than those carrying male pregnancies, thereby skewing M/T toward a higher male proportion" [1] and that "the M/T ratio is skewed upward significantly with population exposure to ionizing radiation, even at great distances from major nuclear events" [2] have not been sufficiently corroborated. A significant role of radiation from nuclear testing and Chernobyl fallout as a factor modifying the sex ratio at birth is improbable. Dose-response relationships at low radiation doses should be studied in large-scale animal experiments involving different mammal species, comparable doses and dose rates, reliably shielded from biases and conflicts of interest.

References

1. Grech V (2015) Atomic bomb testing and its effects on global male to female ratios at birth. Int J Risk Saf Med 27: 35-44.
2. Grech V (2014) The Chernobyl accident, the male to female ratio at birth and birth rates. Acta Medica (Hradec Kralove) 57: 62-67.
3. UNSCEAR (2000) Sources and effects of ionizing radiation. Annex B: Exposures from natural radiation sources. Annex C: Exposures from man-made sources of radiation. Annex J: Exposures and effects of the Chernobyl accident. United Nations Scientific Committee on the Effects of Atomic Radiation, New York, USA.
4. IAEA (2004) Radiation, people and the environment. International Atomic Energy Agency, Vienna, Europe, pp, 1-84.
5. Mould RF (2000) Chernobyl Record. The Definitive history of Chernobyl catastrophe. Institute of Physics, CRC Publishers, Boca Raton, USA, pp. 1-320.
6. Sacks B, Meyerson G, Siegel JA (2016) Epidemiology without biology: false paradigms, unfounded assumptions, and specious statistics in radiation science (with commentaries by Inge Schmitz-Feuerhake and Christopher Busby and a reply by the authors). Biol Theory 11: 69-101.
7. Nair RR, Rajan B, Akiba S, Jayalekshmi P, Nair MK, et al. (2009) Background radiation and cancer incidence in Kerala, India-Karanagappally cohort study. Health Phys 96: 55-66.
8. Koya PK, Jaikrishan G, Sudheer KR, Andrews VJ, Madhusoodhanan M, et al. (2015) Sex ratio at birth: scenario from normal- and high-level natural radiation areas of Kerala coast in south-west India. Radiat Environ Biophys 54: 453-463.
9. UNSCEAR (2008) Report to the General Assembly. Sources and Effects of Ionizing Radiation. Annex D: Health effects due to radiation from the Chernobyl Accident. United Nations Scientific Committee on the Effects of Atomic Radiation, New York, USA, pp. 1-683.
10. UNSCEAR (1988) Sources, effects and risks of ionizing radiation. Annex D: Exposures from the Chernobyl accident. United Nations Scientific Committee on the Effects of Atomic Radiation, New York, USA, pp. 309-374.
11. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M (2008) Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology 248: 254-263.
12. Jargin SV (2018) Hormesis and radiation safety norms: comments for an update. Hum Exp Toxicol: 960327118765332.
13. Scherb H, Kusmierz R, Voigt K (2016) Human sex ratio at birth and residential proximity to nuclear facilities in France. Reprod Toxicol 60: 104-111.
14. Nakajima H, Yamaguchi Y, Yoshimura T, Fukumoto M, Todo T (2015) Fukushima simulation experiment: assessing the effects of chronic low-dose-rate internal 137Cs radiation exposure on litter size, sex ratio, and biokinetics in mice. J Radiat Res 56 Suppl 1: i29-i35.
15. Walsh S, Satkunam M, Su B, Festarini A, Bugden M, et al. (2015) Health, growth and reproductive success of mice exposed to environmentally relevant levels of Ra-226 via drinking water over multiple generations. Int J Radiat Biol 91: 576-584.
16. Iwasaki T, Hashimoto N, Endoh D, Imanisi T, Itakura C, Sato F (1996) Life span and tumours in the first-generation offspring of the gamma-irradiated male mouse. Int J Radiat Biol 69: 487-492.
17. Domingo JL, Paternain JL, Llobet JM, Corbella J (1989) The developmental toxicity of uranium in mice. Toxicology 55: 143-152.
18. Delcour-Firquet MP (1983) Effects of irradiated wheat flour in the AKR mouse. IV. Effects on reproduction. Toxicol Eur Res 5: 27-30.
19. Dev PK, Pareek BP, Goyal PK, Mehta G, Gupta SM (1983) Effects of prenatal gamma-radiation on the development of mice and its modification by 2-mercaptopropionylglycine. Acta Anat (Basel) 116: 339-345.
20. Havenstein GB, Taylor BA, Hansen JC, Morton NE, Chapman AB (1968) Genetic effects of cumulative x irradiation on the secondary sex ratio of the laboratory rat. Genetics 59: 255-274.
21. Mitchel RE (2009) The dose window for radiation-induced protective adaptive responses. Dose Response 8: 192-208.
22. Schull WJ, Neel JV (1958) Radiation and the sex ratio in man. Science 128: 343-348.
23. Schull WJ, Neel JV, Hashizume A (1966) Some further observations on the sex ratio among infants born to survivors of the atomic bombings of Hiroshima and Nagasaki. Am J Hum Genet 18: 328-338.
24. Hama Y, Uematsu M, Sakurai Y, Kusano S (2001) Sex ratio in the offspring of male radiologists. Acad Radiol 8: 421-424.
25. Scherb H, Grech V, Kusmierz R, Voigt K (2016) Letter to the Editor "Radiation and environmental biophysics" : comment on "Sex ratio at birth: scenario from normal- and high-level natural radiation areas of Kerala coast in south-west India" by Koya PK, Jaikrishan G, Sudheer KR, Andrews VJ, Madhusoodhanan M, et al. (2015) Radiat Environ Biophys 55: 3-4.
26. Grech V (2014) Births and male: female birth ratio in Scandinavia and the United Kingdom after the Windscale fire of October 1957. Int J Risk Saf Med 26: 45-53.
27. Koya PK, Jaikrishan G, Sudheer KR, Andrews VJ, Madhusoodhanan M, et al.

ISSN: 2471-4879

(2016) Letter to the Editor "Radiation and environmental biophysics" Authors' response to comments by Scherb et al. (REBS-D-15-00121) on "Sex ratio at birth: scenario from normal- and high-level natural radiation areas of Kerala coast in Southwest India" REBS 54:453-463 (2015). Radiat Environ Biophys 55: 5-7.

28. Körblein A (2014) Letter to the Editor. Int J Risk Saf Med 26: 171.
29. Terrell ML, Hartnett KP, Marcus M (2011) Can environmental or occupational hazards alter the sex ratio at birth? A systematic review. Emerg Health Threats J 4: 7109.
30. Michael M, King L, Guo L, McKee M, Richardson E, Stuckler D (2013) The mystery of missing female children in the Caucasus: an analysis of sex ratios by birth order. Int Perspect Sex Reprod Health 39: 97-102.
31. Hesketh T, Lu L, Xing ZW (2011) The consequences of son preference and sex-selective abortion in China and other Asian countries. CMAJ 183: 1374-1377.
32. Drixler F (2013) Mabiki: infanticide and population growth in Eastern Japan, 1660-1950. University of California Press, Berkeley, USA, pp. 1-388.
33. Li D (1997) Preference for sons: past and present. China Popul Today 14: 15-16.
34. Singh N, Pripp AH, Brekke T, Stray-Pedersen B (2010) Different sex ratios of children born to Indian and Pakistani immigrants in Norway. BMC Pregnancy Childbirth 10: 40.
35. Egan JF, Campbell WA, Chapman A, Shamshirsaz AA, Gurram P, et al. (2011) Distortions of sex ratios at birth in the United States: evidence for prenatal gender selection. Prenat Diagn 31: 560-565.
36. Jargin SV (2013) Some aspects of medical education in Russia. Am J Med Stud 1.2: 4-7.
37. Grech V (2016) Letter to the Editor. Int J Risk Saf Med 28: 175-176.
38. Scherb H (2016) Letter to the Editor. Int J Risk Saf Med 28: 177-180.
39. Scherb H, Mori K, Hayashi K (2016) Authors' reply: Letter to the Editor by Sergei V. Jargin: Increases in perinatal mortality in prefectures contaminated by the Fukushima nuclear power plant accident. Medicine Correspondence Blog.
40. Jargin SV (2016) Letter to the Editor. Int J Risk Saf Med 28: 171-174.
41. Jargin SV (2016) Letter to the Editor: Increases in perinatal mortality in prefectures contaminated by the Fukushima nuclear power plant accident. Medicine Correspondence Blog.
42. Hesketh T, Xing ZW (2006) Abnormal sex ratios in human populations: causes and consequences. Proc Natl Acad Sci USA 103: 13271-13275.
43. Allahbadia GN (2002) The 50 million missing women. J Assist Reprod Genet 19: 411-416.
44. Mathews TJ, Hamilton BE (2005) Trend analysis of the sex ratio at birth in the United States. Natl Vital Stat Rep 53: 1-17.
45. OECD Family Database (2017) Age of mothers at childbirth and age-specific fertility. Directorate of Employment, Labour and Social Affairs, pp. 1-8.
46. Williamson NE (1982) Sex preference and its effect on family size and child welfare. Draper Fund Rep: 22-25.
47. Scherb H, Voigt K (2007) Trends in the human sex odds at birth in Europe and the Chernobyl Nuclear Power Plant accident. Reprod Toxicol 23: 593-599.
48. World Nuclear Association (2016) Nuclear radiation and health effects.
49. Scherb H, Weigelt E, Brüske-Hohlfeld I (1999) European stillbirth proportions before and after the Chernobyl accident. Int J Epidemiol 28: 932-940.
50. Scherb H, Weigelt E, Brüske-Hohlfeld I (2000) Regression analysis of time trends in perinatal mortality in Germany 1980-1993. Environ Health Perspect 108: 159-165.
51. Körblein A, Küchenhoff H (1997) Perinatal mortality in Germany following the Chernobyl accident. Radiat Environ Biophys 36: 3-7.
52. Körblein A (2003) Strontium fallout from Chernobyl and perinatal mortality in Ukraine and Belarus. Radiats Biol Radioecol 43: 197-202.
53. Brunton PJ (2013) Effects of maternal exposure to social stress during pregnancy: consequences for mother and offspring. Reproduction 146: R175-R189.
54. Mulder EJ, Robles de Medina PG, Huizink AC, Van den Bergh BR, Buitelaar JK, et al. (2002) Prenatal maternal stress: effects on pregnancy and the (unborn) child. Early Hum Dev 70: 3-14.
55. Hoirisch-Clapauch S, Brenner B, Nardi AE (2015) Adverse obstetric and neonatal outcomes in women with mental disorders. Thromb Res 135 Suppl 1: S60-S63.
56. Ericson A, Källén B (1994) Pregnancy outcome in Sweden after the Chernobyl accident. Environ Res 67: 149-159.
57. Little J (1993) The Chernobyl accident, congenital anomalies and other reproductive outcomes. Paediatr Perinat Epidemiol 7: 121-151.
58. Spinelli A, Osborn JF (1991) The effects of the Chernobyl explosion on induced abortion in Italy. Biomed Pharmacother 45: 243-247.
59. Trichopoulos D, Zavitsanos X, Koutis C, Drogari P, Proukakis C, et al. (1987) The victims of Chernobyl in Greece: induced abortions after the accident. Br Med J (Clin Res Ed) 295: 1100.
60. Hubert D (1990) 4 years after Chernobyl: medical repercussions. Bull Cancer 77: 419-428.
61. Scherb HH, Mori K, Hayashi K (2016) Increases in perinatal mortality in prefectures contaminated by the Fukushima nuclear power plant accident in Japan: a spatially stratified longitudinal study. Medicine (Baltimore) 95: e4958.
62. Scherb H, Mori K, Hayashi K (2016) Authors' reply: Letter to the Editor by Körblein A: Questionable choice of regression model. Medicine Correspondence Blog.
63. Jargin SV (2016) Biological effectiveness of ionizing radiation: acute *vs.* protracted exposures. J Environ Stud 2: 1-5.
64. Karam PA, Leslie SA (1999) Calculations of background beta-gamma radiation dose through geologic time. Health Phys 77: 662-667.
65. Baldwin J, Grantham V (2015) Radiation hormesis: historical and current perspectives. J Nucl Med Technol 43: 242-246.
66. Calabrese EJ (2015) Model uncertainty via the integration of hormesis and LNT as the default in cancer risk assessment. Dose Response 13: 1559325815621764.
67. Doss M (2013) Linear no-threshold model *vs.* radiation hormesis. Dose Response 11: 480-497.
68. Scott BR (2014) Radiation-hormesis phenotypes, the related mechanisms and implications for disease prevention and therapy. J Cell Commun Signal 8: 341-352.
69. Caratero A, Courtade M, Bonnet L, Planel H, Caratero C (1998) Effect of a continuous gamma irradiation at a very low dose on the life span of mice. Gerontology 44: 272-276.
70. Socol Y, Dobrzyński L, Doss M, Feinendegen LE, Janiak MK, et al. (2013) Commentary: ethical issues of current health-protection policies on low-dose ionizing radiation. Dose Response 12: 342-348.
71. McGeoghegan D, Binks K, Gillies M, Jones S, Whaley S (2008) The non-cancer mortality experience of male workers at British Nuclear Fuels plc, 1946-2005. Int J Epidemiol 37: 506-518.
72. Zablotska LB, Bazyka D, Lubin JH, Gudzenko N, Little MP, et al. (2013) Radiation and the risk of chronic lymphocytic and other leukemias among chornobyl cleanup workers. Environ Health Perspect 121: 59-65.
73. Watanabe T, Miyao M, Honda R, Yamada Y (2008) Hiroshima survivors exposed to very low doses of A-bomb primary radiation showed a high risk for cancers. Environ Health Prev Med 13: 264-270.

ISSN: 2471-4879

74. Jargin SV (2015) Solid cancer increase among Chernobyl liquidators: alternative explanation. Radiat Environ Biophys 54: 373-375.
75. Kesminiene A, Evrard AS, Ivanov VK, Malakhova IV, Kurtinaitis J, et al. (2008) Risk of hematological malignancies among Chernobyl liquidators. Radiat Res 170: 721-735.
76. Markandya A, Wilkinson P (2007) Electricity generation and health. Lancet 370: 979-990.
77. Jargin SV, Kaloshin AK (2015) Back to the mechanisms of cancer incidence increase after Chernobyl. Int J Cancer Res Mol Mech 1: 1-5.
78. Beliaev IA (2006) Chernobyl. Death shift. Moscow, Russia.
79. Semenov AN (1995) Chernobyl. Ten years later. Moscow, Russia.