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Is the human sex odds at birth distorted in the vicinity of nuclear facilities (NF)? A preliminary geo-spatial-temporal approach

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Abstract

The trend in the human sex odds at birth in Europe was significantly distorted after the Chernobyl Nuclear Power Plant accident (ChNPP), and childhood cancers are significantly increased in the vicinity of German nuclear power plants (NPP). Therefore, the question arises whether the human sex odds at birth is also distorted in the vicinity of nuclear reactors and nuclear storage or processing facilities (NF). In this paper we investigate the feasibility of an ecological study based on official gender specific annual birth data of all municipalities of Belgium, Switzerland, and the following parts of Germany: Baden-Württemberg, Bavaria, Lower Saxony, North Rhine-Westphalia, and Rhineland-Palatinate. The analyses involve 316 360 municipality- or district-years, with 22 643 476 live births and an overall sex odds (SO = male live births/female live births) of 1.0546. During the operation time periods of the ascertained 28 NF in Germany and Switzerland, lagging for gestation period, and within 5 km distance from these sites, there is a non-significantly increased sex odds with a sex odds ratio (SOR) vs. the remainder of the study region and non-operational time periods of $SOR_{5km} = 1.0056$, $p = 0.3615$. However, within the distances of 15 km, 30 km, and 50 km, we may observe more precisely estimated elevated sex odds ratios: $SOR_{15km} = 1.0040$, $p = 0.0463$, $SOR_{30km} = 1.0035$, $p = 0.0026$, and $SOR_{50km} = 1.0017$, $p = 0.0567$. A significant Rayleigh function ($p=0.0023$) with mode at 14.4 km, 95%-CI = [10.9 km, 29.3 km], yields a $SOR_{peak} = 1.0051$. Moreover, there is a reciprocal distance association ($1/r$) of the sex odds beyond 10 km distance from NF, $p = 0.0016$. Therefore, evidence of a far-reaching genetic effect in the vicinity of 28 NF in Germany and in Switzerland is achieved. Further studies in this important area of environmental health research are recommended.

1. Introduction

Over the past decades, many animal experiments and epidemiological studies have revealed the vulnerability of living beings exposed to adverse chemical or physical environmental conditions. Environmental ionizing radiation is of interest as it can induce germ cell mutations and somatic cell mutations alike. Ever since the discovery of the mutagenic properties of ionizing radiation, the possibility of sex odds shifts in exposed human populations was considered. Children's development from conception through the embryonic and fetal periods to infancy is known to be especially radiosensitive. Recently, it has been shown that childhood cancers are significantly increased in the vicinity of German nuclear reactors (Spix et al. 2008; Nussbaum 2009). In this context, the Chernobyl accident is of interest and importance. Thyroid cancer in

children occurred very early and in far too great a number of cases relative to previous (pretended) experience (Balter 1996). In fact, the World Health Organization and the International Atomic Energy Agency have failed to investigate and communicate the many easily accessible detrimental health effects attributable to the Chernobyl catastrophe (Tickell 2009; Scherb 2010; Scherb and Voigt 2010; Yablokov et al. 2010). A possible genetic effect of ionizing radiation — an impact on the human sex odds at birth (Schull and Neel 1958) — has not been investigated at all by national or international institutions nor by the scientific community despite the simplicity and exactness of this measure, not to speak of the important implications if this trait was significantly distorted after Chernobyl. Note, we prefer the term “sex odds” instead of “sex ratio” because odds is the appropriate notation of a probability divided by one minus this probability. Importantly, there will be no confusion when it comes to consider the “odds ratio”, which then is the “sex odds ratio” and not the inconvenient “sex ratio ratio”. We investigated trends in the sex odds before and after the Chernobyl accident (1982–1992) in several European countries and found a significant jump and a broken stick effect in the sex odds trends in 1987 immediately in the year following the Chernobyl accident (Figure 1) (Scherb and Voigt 2007; Scherb 2010).

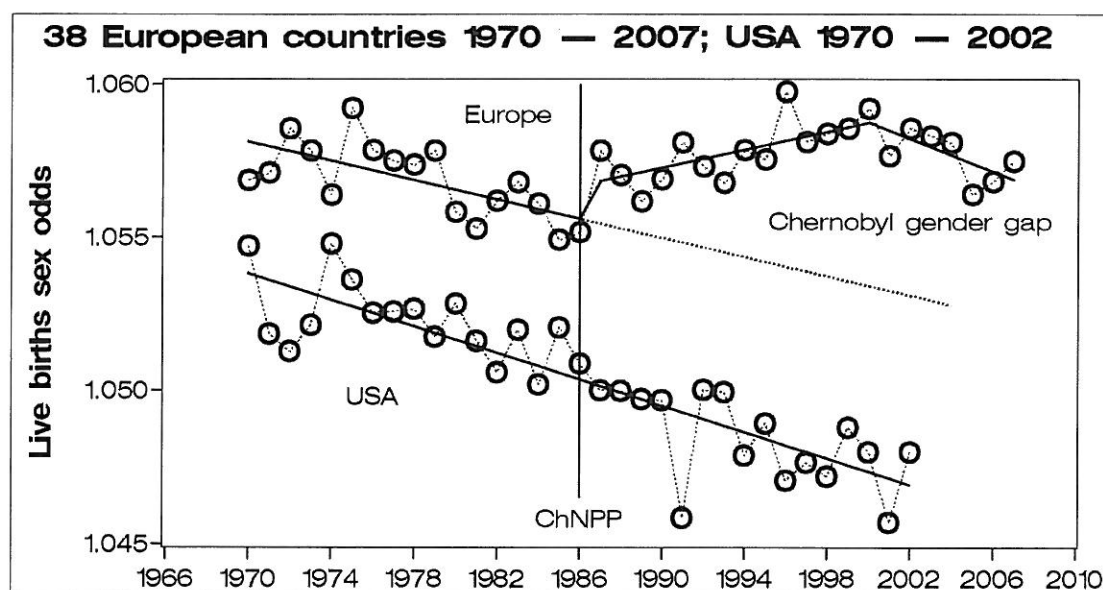


Figure 1: Trends of the annual live births sex odds (male/female) in the USA 1970 to 2002, and in Europe 1970 to 2007

In this paper, as an introductory and preliminary work, we will address the question whether the human sex odds at birth (secondary sex odds) is distorted in some way around NF, possibly similar to the increased childhood cancers near NPP (KiKK study). We are well aware of our municipality-based study’s larger geographical non-differential misclassification error compared to the KiKK study where cases and controls were located up to approximately ± 25 meters. However, in the case of a far-reaching effect this may be of less concern. In an outlook, we conjecture possible associations of the sex odds with other sources of radiation as for example cosmic rays.