

PERSISTENCE OF ELEVATED INCORPORATED CESIUM-137 IN THE POLISSIA REGION OF UKRAINE

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Abstract

Since the 1986 Chernobyl disaster, international and official governmental agencies assert, on theoretical basis, that exposures to chronic low dose ionizing radiation (IR) cannot be teratogenic to the exposed populations in Ukraine. On the other hand, our population-based monitoring of congenital anomalies in the Polissia region (P) of the Rivne province of Ukraine cast doubts on such official hypotheses, mainly because of persistent elevation of population-based rates of Neural Tube Defects [1]. P is a zone of wetlands considered among the most polluted regions in Ukraine by Chernobyl IR. An initial 2001-2010 survey of whole body counts (WBC) of incorporated levels of Cs-137 concerned 6228-2964 males and 18250-7344 females from P-notP respectively. The average WBC of males and females was 2640-2223 Bq and 507-435 from P-notP respectively. The modest male-female contrasts presumably reflect differences in body weight. A second survey (2011-2013) concerned 2073 and 1419 pregnant women from P-notP. The mean WBC Bq were 2767 and 738 respectively. The present survey (2014-2016) concerns 3990-2474 pregnant women from P-notP respectively. The mean WBC Bq were 2095 and 678 respectively. The P-notP contrasts are statistically significant. The results demonstrate persistence of higher levels of Cs-137 incorporation by pregnant women in P and lack of temporal decrement. The Cs-137 is unlikely to be the sole source of exposure to IR. A previous survey of dried potato stems plants from P, demonstrated incorporated levels of Sr-90 and Cs-137 in nearly equal Bq proportions. Other investigators documented that both rivers that transverse P are polluted by tritium discharges by two nuclear power plant complexes, one of which is the largest in Europe. Regarding the persistent levels of incorporated Cs-137, we speculate that it reflects a slow transit of this nuclide across the biota toward nutrients reaching pregnant women and their embryos. The established infrastructure and available population-based data from a variety of cohorts represent an available resource for further research. However, complex genetic, teratogenic, and in particular epigenetic alterations concerning congenital anomalies and oncogenesis are largely beyond the scope of our team and calls for participation by international partners.

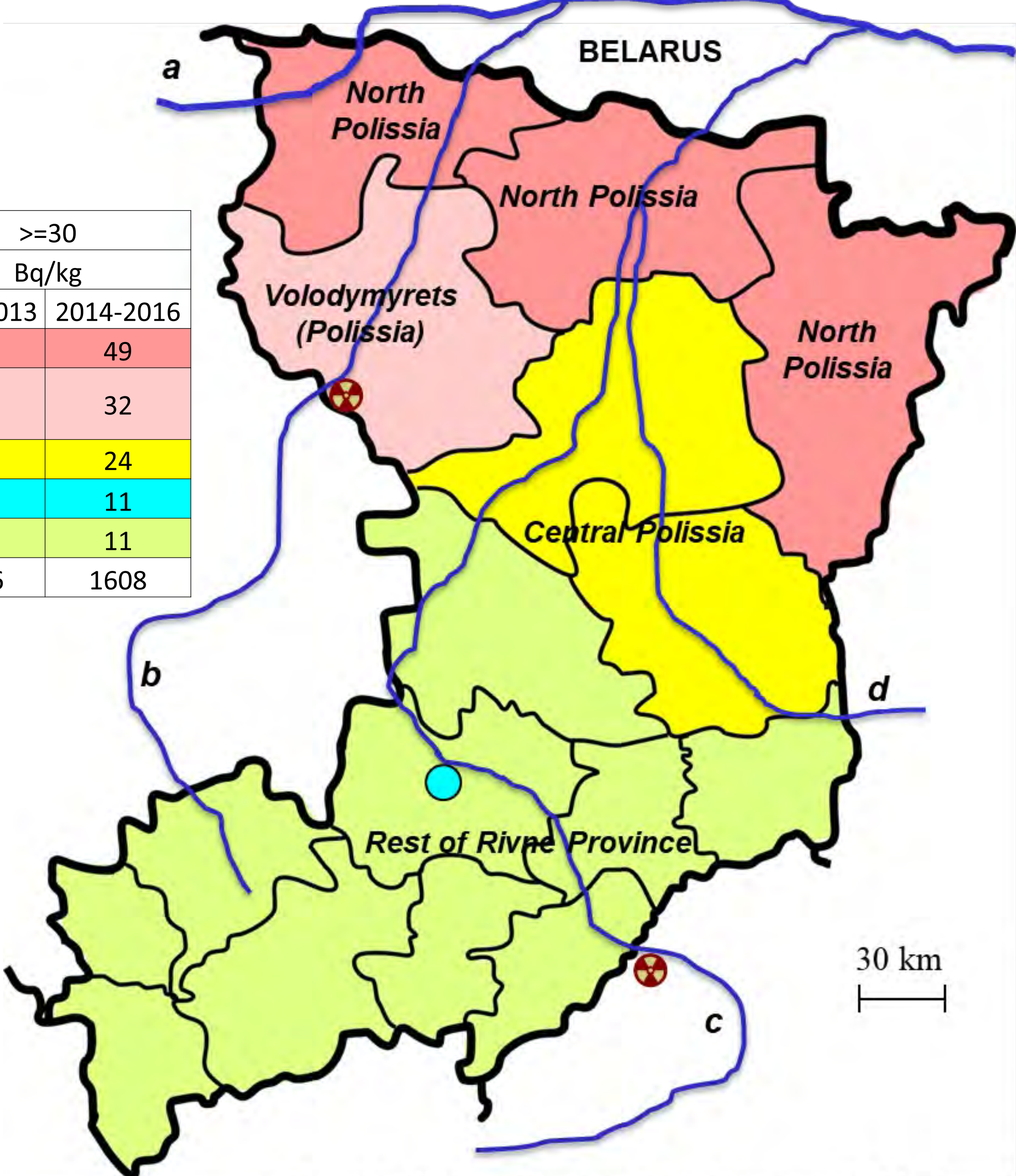
[1] Wertelecki W, Chambers CD, Yevtushok L, et al. Chernobyl 30 years later: Radiation, pregnancies, and developmental anomalies in Rivne, Ukraine. Eur J Med Genet. 2017 Jan;60(1):2-11. doi: 10.1016/j.ejmg.2016.09.019. Epub 2016 Sep 30. PubMed PMID: 27697599.

[2] Wertelecki W, Koerblein A, levtushok B, et al. Elevated congenital anomaly rates and incorporated cesium-137 in the Polissia region of Ukraine. Birth Defects Res A Clin Mol Teratol. 2016 Mar;106(3):194-200. doi: 10.1002/bdra.23476. Epub 2016 Feb 12. PubMed PMID: 26871487.

Whole Body Counts (WBC) Cs-137 2011-2016: Rivne Province: Pregnant Women by Age

Region	20-29		>=30	
	Bq/kg		Bq/kg	
	2011-2013	2014-2016	2011-2013	2014-2016
North Polissia	61	43	65	49
Volodymyrets County excluding NPP City	40	33	34	32
Central Polissia	28	24	30	24
Rivne City	11	12	11	11
Rest of Province	11	10	11	11
All WBC (N)	3855	3517	1646	1608

⚡ Nuclear Power Plant (NPP)



a, b, c, d – Rivers Prypiat, Styr, Horyn, and Sluch

Mean WBCs (Bq) of Cs-137 in women, Rivne province

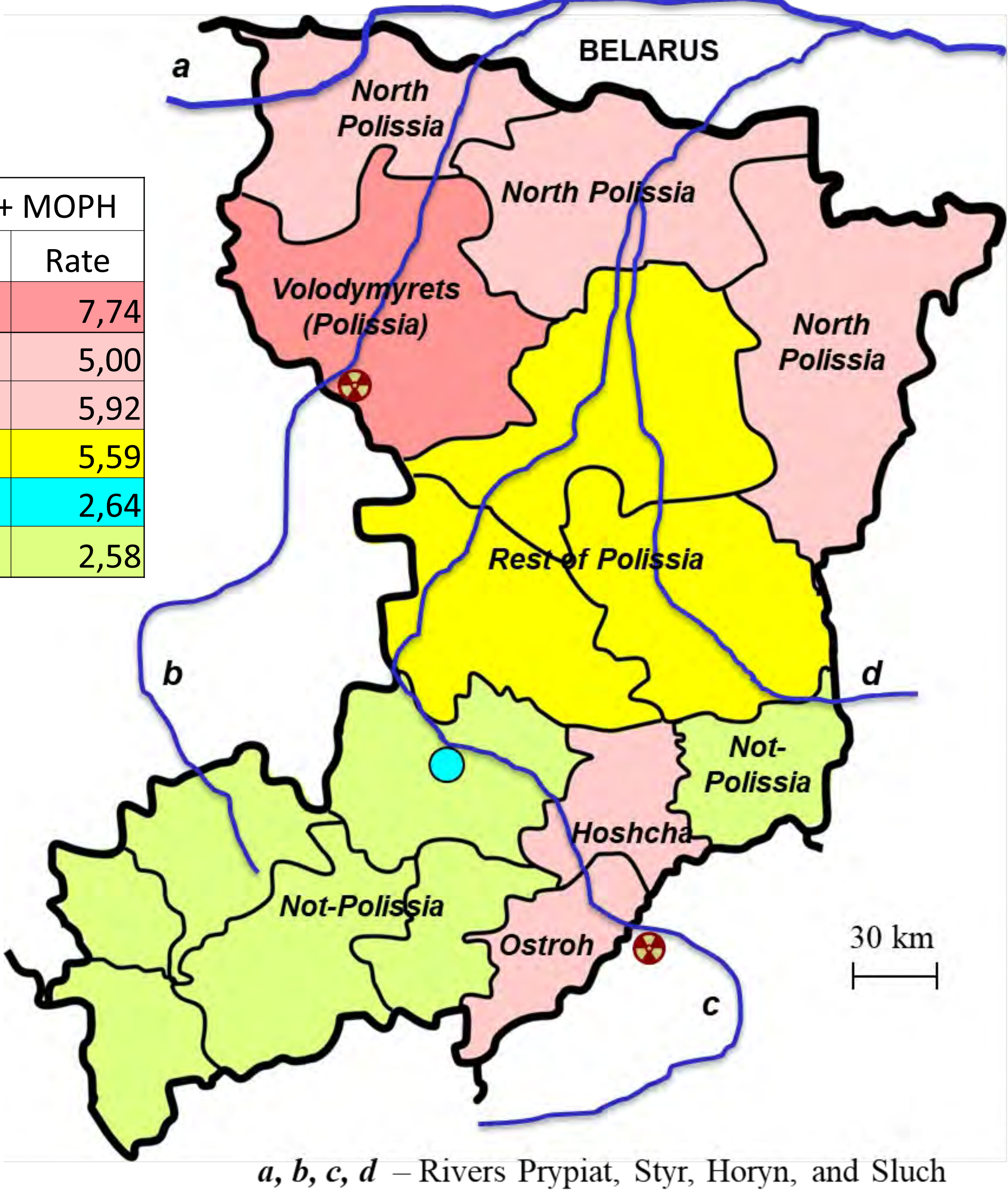
Area	WBC, Bq ⁽¹⁾			
	Women (2001-2010) ⁽²⁾		Pregnant (2011-2014) ⁽³⁾	
	N	Mean	N	Mean
North Polissia	5054	4365	1036	3808
Central Polissia	13196	1403	1882	1856
not-Polissia	7344	435	1877	713

(1) Excludes individuals with <100 Bq WBC.
(2) Excludes individuals under 20 years of age.
(3) Includes only individuals of 20-34 years of age and of 45-85 kg body weight.

Primary Microcephaly (MIC) and/or Microphthalmia (MOPH) in Rivne Province: 2000-2015

Region	Livebirths	MIC + MOPH	
		N	Rate
Volodymyrets incl. NPP	27137	21	7,74
North Polissia	36005	18	5,00
Ostroh + Hoshcha	13504	8	5,92
Rest of Polissia	59046	33	5,59
Rivne City	45535	12	2,64
Rest of not-Polissia	65934	17	2,58

⚡ Nuclear Power Plant (NPP)



a, b, c, d – Rivers Prypiat, Styr, Horyn, and Sluch

Mean Cesium-137 Whole Body Counts and Specific Activity (Bq/kg) for Pregnant Women⁽¹⁾ by Body Weight and Region, Rivne Province, 2011-2013

Weight ⁽²⁾ (kg)	Region	N	Bq/kg		
			Mean	SD	SE ⁽³⁾
< 50	Polissia	56	54.9	56.0	7.5
	not-Polissia	58	14.4	7.9	1.0
50-54	Polissia	249	52.8	45.9	2.9
	not-Polissia	182	13.9	11.1	0.8
55-59	Polissia	370	44.6	43.2	2.2
	not-Polissia	218	13.0	9.9	0.7
60-64	Polissia	409	42.8	37.5	1.9
	not-Polissia	288	10.9	7.5	0.4
65-69	Polissia	364	39.3	30.7	1.6
	not-Polissia	236	11.2	10.8	0.7
70-74	Polissia	308	42.6	42.4	2.4
	not-Polissia	194	11.5	16.9	1.2
75-79	Polissia	164	42.1	56.9	4.4
	not-Polissia	125	9.8	7.6	0.7
> 79	Polissia	153	37.3	31.6	2.6
	not-Polissia	118	9.5	7.7	0.7
All	Polissia	2073	43.5	41.6	0.9
	not-Polissia	1419	11.7	10.7	0.3

(1) Pregnant women of at least 20 years of age weighing 45-85 kg who are gestating a single fetus. Subsequent examinations and pregnancies are excluded. (2) The average body weight in Polissia and not-Polissia are 64.4 and 64.5 kg, respectively. The corresponding SD and SE are 9.1 and 0.2 in Polissia and 9.6 and 0.3 in not-Polissia, respectively. (3) SE = SD/sqrt(N).

Highest Population Rates⁽¹⁾ in Europe (2005-2009) of Four Congenital Malformations compared to rates in Polissia and non-Polissia Regions of Rivne Province, Ukraine (2000-2009)

Neural Tube Defects	Microcephaly	Microphthalmia	Conjoined Twins
25.96 Polissia	6.35 Polissia	3.57 Polissia	0.55 Rivne
16.33 non-Polissia	5.35 Wales	1.63 Wales	0.49 N. England
14.47 N. England	5.03 So.-West England	1.51 Dublin	0.35 Wales and Wessex
13.60 Wales	4.52 Valencia	1.22 N Netherlands;	0.31 E. Midlands & So.
		non-Polissia	Yorkshire
12.77 Paris	3.88 Basque C. (Spain)	1.21 So.-West England	0.26 Wielkopolska

(1) Rate per 10 000 births of congenital malformations (not individuals) inclusive of live births, fetal deaths of 20 or more weeks of gestation (extract from Wertelecki et. al., 2014).

COMMENTS

- Whole body counts (WBC) of Cs-137 incorporated by pregnant women are persistently elevated in regions impacted by Chernobyl radiation.
- Highest elevated WBC are recorded in North Polissia regions of Rivne and in areas proximal to two nuclear power plants (NPP).
- Primary microcephaly and/or microphthalmia rates are lowest in areas not polluted by Chernobyl radiation and distal from NPPs.
- The above patterns suggest but do not prove a causal relationship of radiation and rates of primary microcephaly and/or microphthalmia.
- The above observations suffice to justify a call for in-depth international collaborative investigations regarding low dose radiation impacts on fetal brain development.