National Cancer Institute

Thyroid Cancer Risk from *In Utero* Exposure to Chernobyl Fallout

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Chernobyl Nuclear Reactor Accident

- **April 26, 1986 accident at ChNPP**
- **Principal radionuclide: Iodine-131 (I-131)**
- **I-131 concentrates in the thyroid gland**

Exposure to the Embryo/Fetus

- **I-131 readily crosses the placenta**

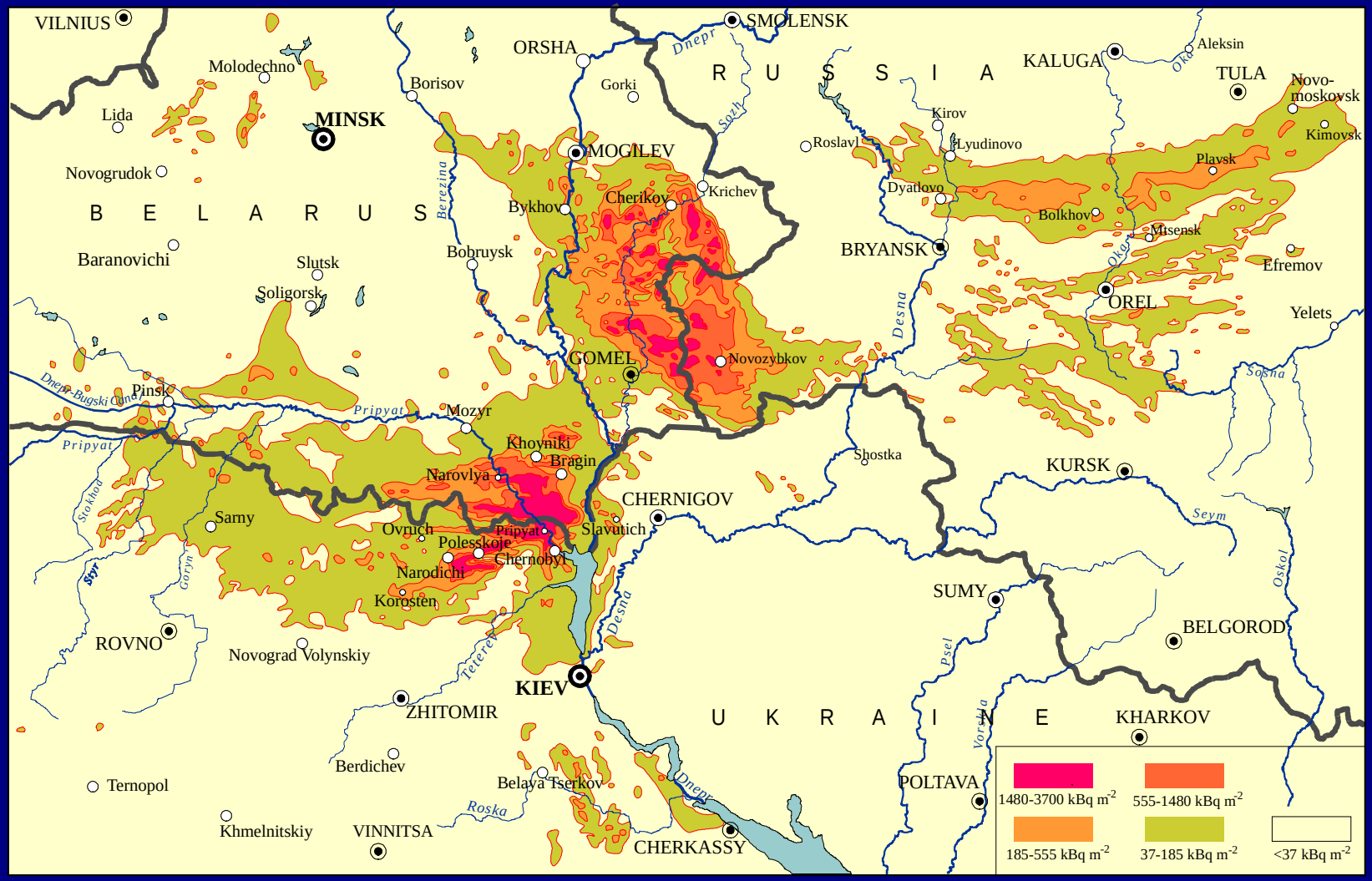
- **I-131 uptake begins ~10-12 weeks gestation**
- **Uptake increases faster than thyroid mass**

- **In late gestation, fetal I-131 levels many-fold higher than maternal levels**

Potential Radiosensitivity of the Fetus

- **Small thyroid mass**
- **Rapid cell division**

Chernobyl Accident Fallout: Ukraine



Ukraine-American *In Utero* Study: Objectives

- **Estimate risk of thyroid cancer**
- **Explore incidence of non-thyroid cancer**

Ukraine-American *In Utero* Study: Methods

- **For thyroid cancer:**

  -in-depth screening examinations, 2003-2006

  -in-person mother-child interviews

- **For non-thyroid cancer:**

  -record linkage, National Cancer Registry, 1997-2009

Ukraine-American *In Utero* Study: Design

- Study area: **most affected northern oblasts,**
- 2,582 mother-child pairs: **Women pregnant on April 26,1986 or the two months following**

  -1,494 from contaminated areas

  -1, 088 from no/low-contaminated areas

(Hatch et al., JCEM, 2009; Likhtarov et al., Health Phys, 2011)

Distribution of I-131 Thyroid Dose Estimates

Trimester ATA	N	Mean, mGy
‘Contaminated’ group		
1	400	3.7
2	575	104.2
3	469	206.5
‘Comparison’ group		
1	321	0.3
2	276	7.0
3	419	13.1

Statistical Methods

- **Estimated EOR/Gy for thyroid cancer (linear logistic regression models)**

  sensitivity analyses

  comparison of radiosensitivity

- **Estimated SIRs for non-thyroid cancers (indirect standardization)**

Screening Cases with Thyroid Neoplasia

#	Dx	Source of dx	Trimester ATA	Sex	Age, yr	I-131 dose, mGy	
						Total	Postnatal
1	PTC[1]	PMC[4]	3	F	19.9	18.6	4.2
2	PTC	PMC	3	F	19.8	421.2	395.2
3	PTC	PMC	3	F	19.8	453.6	3.6
4	PTC	PMC	3	F	17.7	16.2	0
5	PTC	FNA[5]	2	F	16.5	139.3	0
6	PTC	FNA	2	F	20.9	86.4	0
7	FTC[2]	PMC	1	F	19.4	3.1	0
8	HCN[3]	FNA	2	M	20.8	33.0	0

[1]PTC, papillary thyroid cancer. [2]FTC, follicular thyroid cancer. [3]HCN, Hurthle cell neoplasm. [4]PMC, pathomorpology. [5]FNA, fine needle aspiration biopsy.

Results: Thyroid Cancer

Outcome	EOR[1]/Gy	95% CI	P
In utero			
Thyroid cancer or neoplasia[3] (n=8)	5.35	NE[2]-77.29	0.24
Thyroid cancer[4] (n=7)	11.66	NE-1,982	0.12
1-5 year old			
Thyroid cancer (n=13)	3.24	NE-539	0.01

[1]Adjusted for sex and age. [2]NE, not estimable.
[3]Exclusion of one case with postnatal I-131 dose > 30 mGy or one case exposed during 1st trimester had little influence on EOR/Gy.
[4]Hurthle cell neoplasm excluded.

Registry-linked Non-thyroid Cancers: 1997-2009

#	Diagnosis	Trimester ATA	Sex	Age, yr	I-131 dose, mGy
1	Hodgkin's disease	3	M	18.3	309.7
2	Hodgkin's disease	2	F	20.4	18.4
3	Hodgkin's disease	1	M	15.7	0
4	Brain cancer, NOS[1]	3	F	12.3	3.8
5	Diffuse astrocytoma	1	F	14.2	0
6	Choriocarcinoma	2	F	22.1	66.9

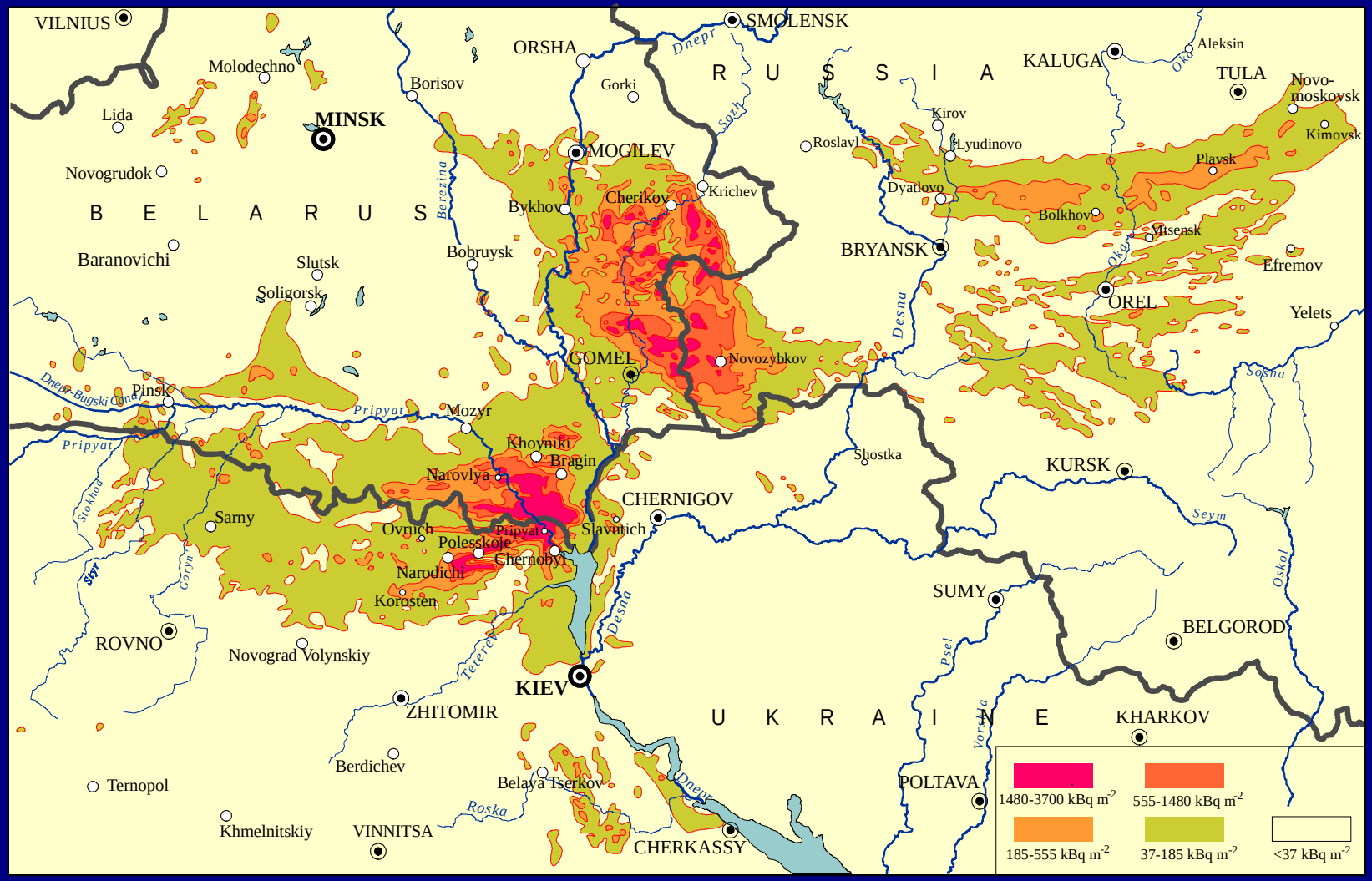
[1]NOS, not specified.

Results: Non-thyroid Cancers

Categories	O	E[1]	SIR (O/E)	95% CI
All	6	5.0	1.20	0.47-2.42
Lymphoma	3	1.3	2.28	0.57-5.90
Leukemia	0	0.8	0.00	0.00-2.52

[1]Estimated by applying sex- and age-specific cancer rates to person-years at risk (assuming different scenarios for losses to follow-up).

Chernobyl Accident Fallout: Belarus



Belarus-Japanese *In Utero* Study

- **Ultrasound thyroid screening study in 2000**
- **School children living 150 km from ChNPP**
- **Thyroid cancer pre/post-accident**

- Shibata et al., Lancet 2001

Belarus-Japanese *In Utero* Study

- **Group I: born before the accident**
- **Group II: exposed *in utero* (N=2,409)**
- **Group III: exposed post-natally**

OR (II v I) = 11 (3-176)

OR (III v I) = 121 (9-31,000)

Belarus-American *In Utero* Study

- **Cohort of 3000**
- **Exposed *In Utero***
- **Gomel, Mogilev oblasts**
- **Dose reconstruction for I-131 and Cs-137**
- **Linkage with Belarusian Cancer Registry, Chernobyl State Registry**

- **Currently in progress**

Summary of Findings to Date:
Thyroid Cancer Risk from *In Utero* Exposure to Chernobyl Fallout

Elevated risks have been observed:

- **Belarus: OR = 11**
- **Ukraine: EOR/Gy = 11 (ns)**

Ongoing work will tell us more

Collaborators

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Thank you for your attention