HelmholtzZentrum münchen
German Research Center for Environmental Health

EpiRadBio

Ultrasonography survey
and thyroid cancer in the Fukushima Prefecture

Peter Jacob, Alexander Ulanovsky, Christian Kaiser
Department of Radiation Sciences
Institute of Radiation Protection

IAEA International Experts Meeting Fukushima, Vienna, February 2014

SEVENTH FRAMEWORK PROGRAMME

HELMHOLTZ | ASSOCIATION

1. Ultrasonography survey

1.1 Three groups of municipalities in the Fukushima Prefecture

13 municipalities (2011/2012)

12municipalities (2012/2013)

34municipalities(2013/2014)

Fukushima Medical University (2013)
http://www.fmu.ac.jp/radiationhealth/results/20130605.html

0-18 years
at time of accident.
First screening
from October 2011
to March 2014

1. Ultrasonography survey

1.2 Observations as of 30 September 2013

Targeted period of primary examination	Apr 2011 – Mar 2012	Apr 2012 – Mar 2013
Municipalities	13	12
Participants in primary examination	41 493	138 865
Requiring secondary examination	216	971
Second examination completed	176 (81%)	698 (72%)
Suspected malignancies in FNA biopsies	14	44
Surgeries: Pathologies	11: 10 PTC, 1 benign	16: 16 PTC
Prevalence[a]	13/41493 = 0.03%	44/138865 = 0.03%

[a]: prevalence is expected to increase by completing secondary examination for more persons

Fukushima Medical University (2013)
http://www.fmu.ac.jp/radiationhealth/results/media/13-2_ThyroidUE.pdf

2. Questions addressed

What are the expectations concerning thyroid cancer in the screened population?

1. Prevalence[a] during first screening
2. Subsequent incidence[b] independent of exposure from accident
3. Incidence due to exposure from accident

[a] Number of cases per number of individuals screened

[b] Number of new cases per number of individuals during a certain time period

3. Prevalence

3.1 Basic assumption

Ratio of
prevalences in population screened in Fukushima Prefecture and in UkrAm cohort
equals to ratio of
incidence rates according to country specific data,
modified by factor according to study protocol, f_{sp}

$$P_{Fp} / P_{UA} = f_{sp} \lambda_{Japan,Fp} / \lambda_{Ukraine,U1}$$

3. Prevalence

3.2 Data on prevalence

UkrAm cohort, first screening: 13 127 participants, average age: 22 years

11.2 (95%CI: 3.2; 22.5) cases not associated with radiation

P_{UA} =0.09% (95%CI: 0.02%; 0.17%)

Tronko et al. J Natl Cancer Inst 2006

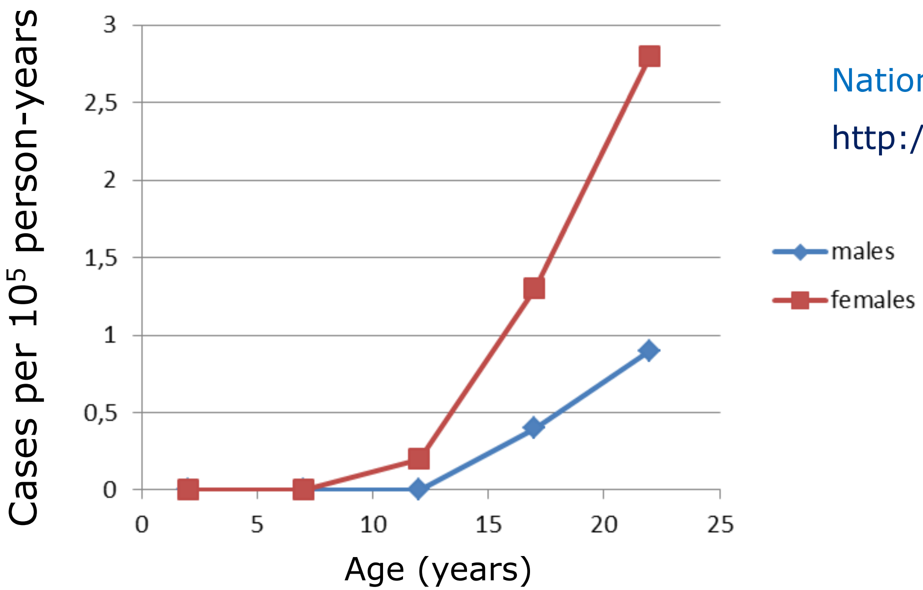
f_{sp} = triangular distribution [1; 3.2][a]

Upper bound: # nodules > 5 mm / # nodules > 10 mm = 1568 / 475 = 3.3

[a] based on data as of 31 July 2013

Jacob et al. Radiat Environ Biophys 2014

3.3 Data on incidence rates



National Cancer Center

http://ganjoko.jp/pro/statistics/en/ table download.html

$\lambda_{Japan,Fp}$ = 0.3 cases per 10^5 person-years (0.0003 %/year)

$\lambda_{Ukraine,U1}$ = 1.8 cases per 10^5 person-years (0.0018%/year)

3. Prevalence

3.3 Prediction for three population groups

Municipalities/Prefectures	Targeted period of screening	Prevalence (%) [a]
13 in Fukushima Prefecture	Apr 2011–Mar 2012	0.027 (0.007, 0.069)
12 in Fukushima Prefecture	Apr 2012–Mar 2013	0.034 (0.009, 0.088)
Aomori, Yamanashi and Nagasaki	Nov 2012–Jan 2013	0.032 (0.008, 0.084)

[a] arithmetic mean and 95% confidence interval

Jacob et al. Radiat Environ Biophys 2014

4. Incidence not related to radiation from accident

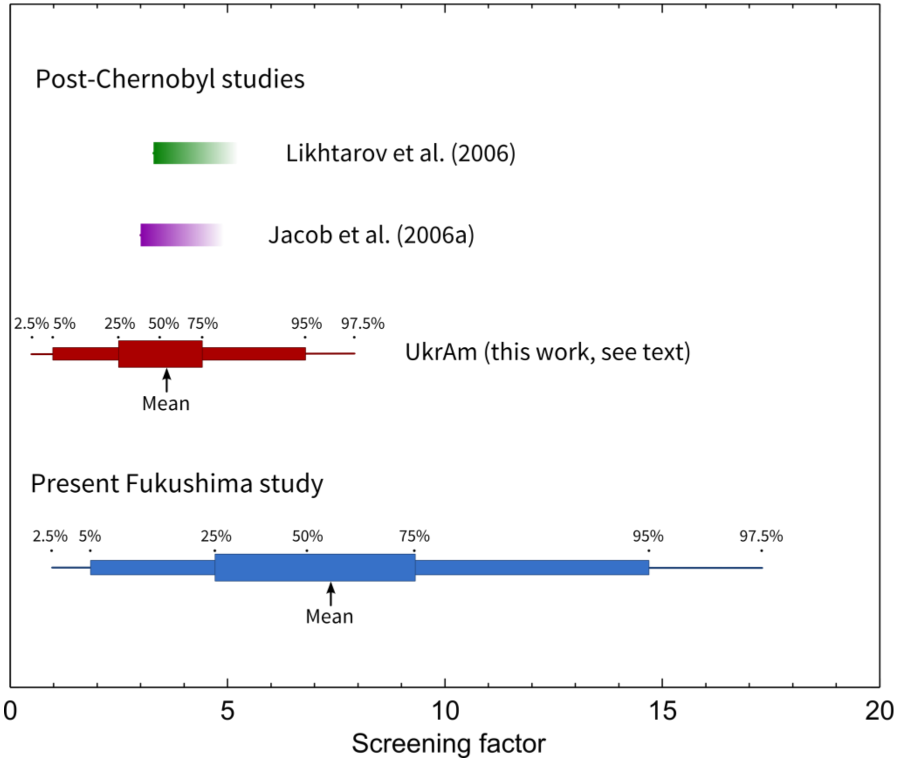
4.1 Screening factor

Screening factor in UkrAm cohort * f_{sp}

$= (EAR_{UA}/ERR_{UA})/\lambda_{Ukraine,U2\text{-}4} * f_{sp}$

= 7.4 (95% CI: 0.95; 17.3)

Brenner et al. Environ Health Persp 2011
Jacob et al. Radiat Environ Biophys 2014



4. Incidence not related to radiation from accident

4.2 Results

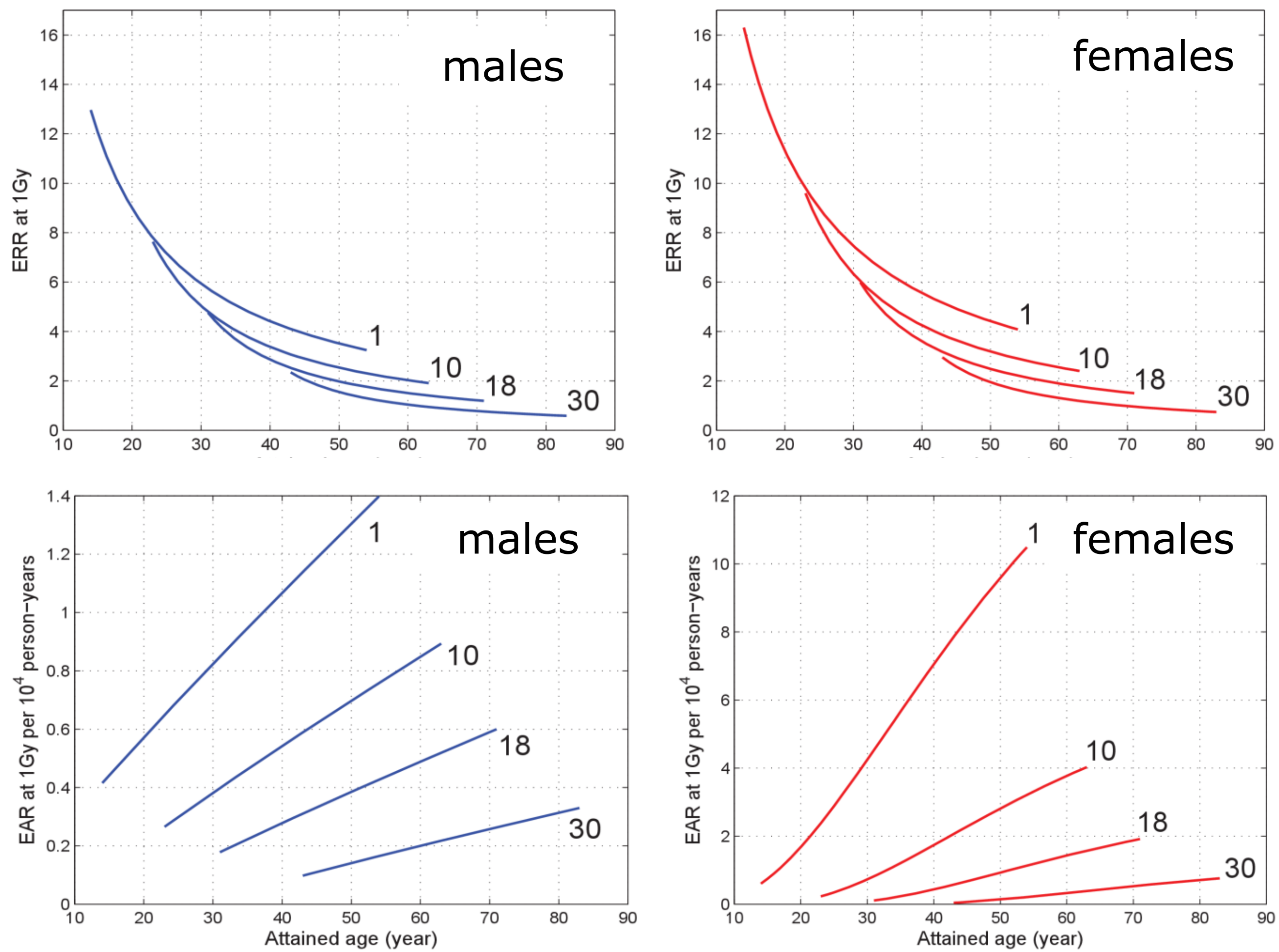
Presented in Section 5

5. Incidence due to exposure from accident

5.1 Risk model for LSS members not participating in AHS

Relative risk decreases with increasing age at exposure and age attained

Excess rate decreases with increasing age at exposure and increases with increasing time since exposure



5. Incidence due to exposure from accident

5.2 Excess absolute rate per unit dose

Transfer of relative risk from LSS to the Fukushima Prefecture

$$EAR_{Fp}(s,e,a) = F_{scr}\, F_L(a\text{-}e)\, F_{DDREF}\, ERR_{LSS}(s,e,a)\, \lambda_{Japan}(s,a)$$

F_{DDREF}	Uncertainty due to transfer to low dose and low dose rate
$F_L(a\text{-}e)$	Minimal latency period of 3 years
F_{scr}	Screening factor

Heidenreich et al. Radiat Res 1999 (F_L)
Jacob et al. Occup Environ Med 2009 (F_{DDREF})
Jacob et al. Radiat Environ Biophys 2014 (F_{scr}, ERR_{LSS})
National Cancer Center, http://ganjoho.jp/pro/statistcs/en/table_download.html (λ_{Japan})

Predicts zero excess rate for young age attained

=> mixed transfer more plausible

5. Incidence due to exposure from accident

5.3 Predicted incidence during two time periods

Baseline and attributable to ***assumed*** thyroid dose of 20 mGy

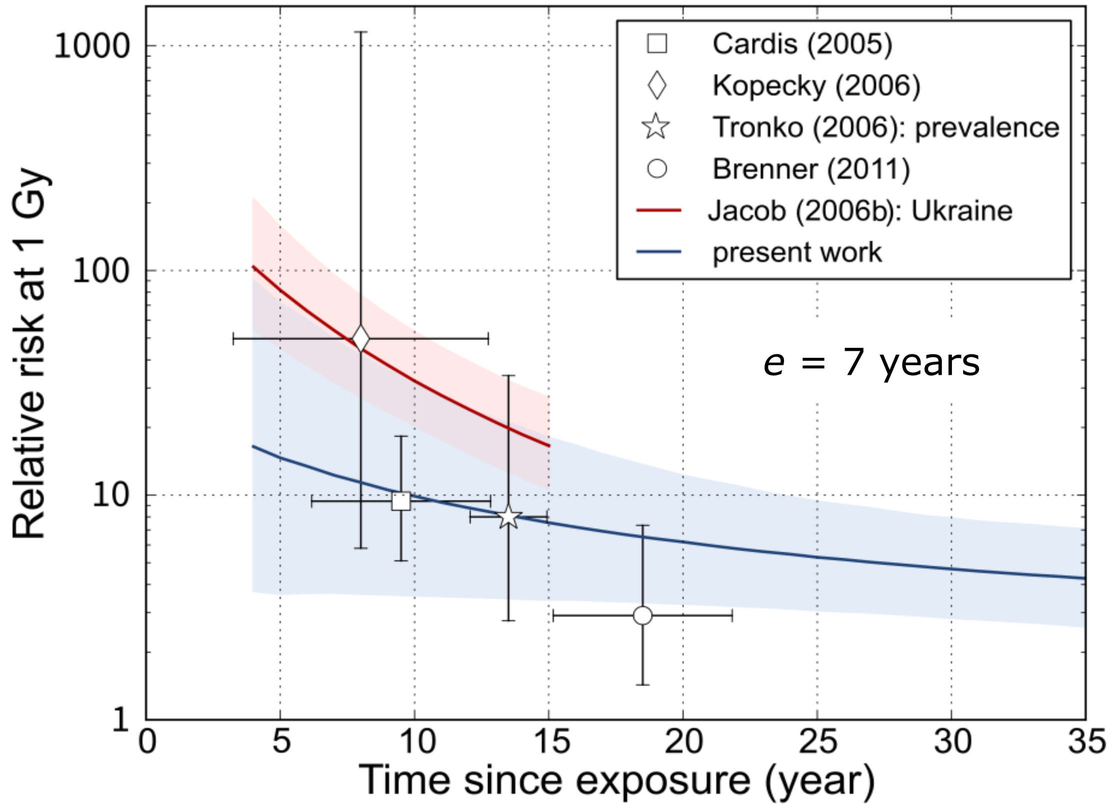
Thyroid cancer	Incidence (%)	
	10 years	50 years
Baseline	0.06 (0.006; 0.14)	2.2 (0.27; 5.3)
Excess	0.006 (0.0002; 0.025)	0.13 (0.005; 0.40)

Main sources of uncertainty: F_{scr}, ERR_{LSS}, F_{DDREF}

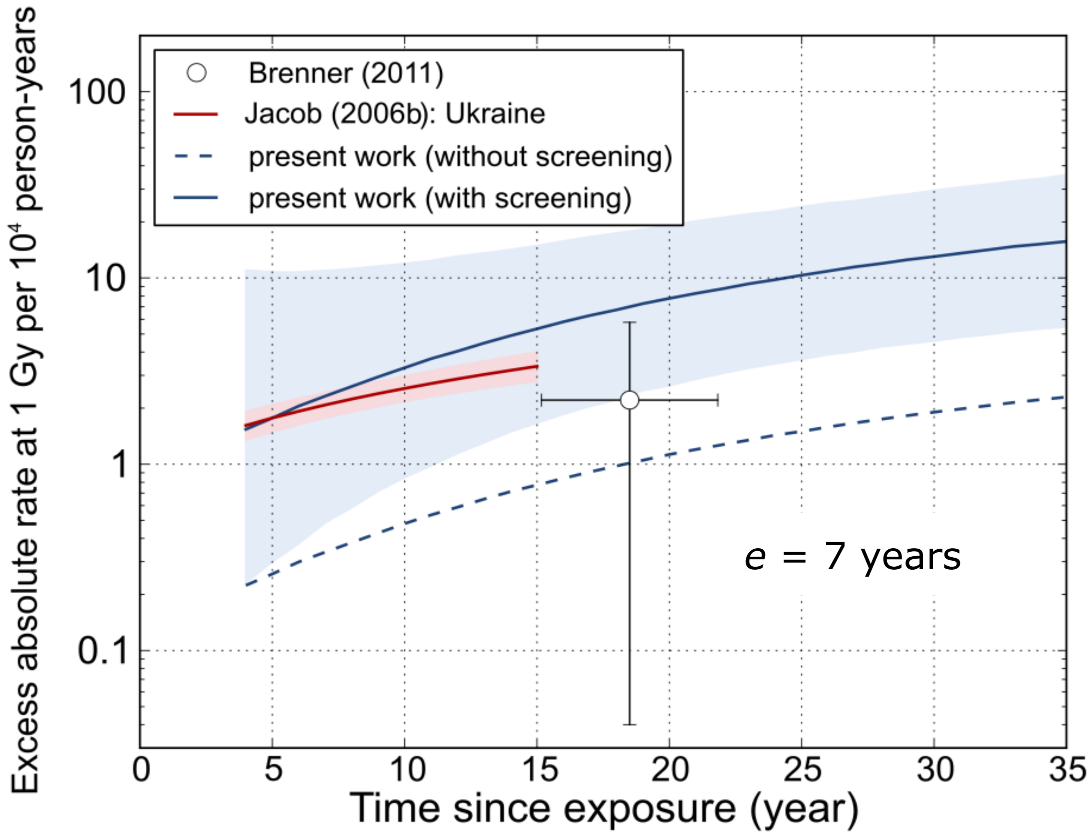
Jacob et al. Radiat Environ Biophys 2014

6. Comparison with other studies

6.1 Relative risk for thyroid cancer in post-Chernobyl studies



6.2 Excess rate of thyroid cancer in post-Chernobyl studies



6. Comparison with other studies

6.3 Thyroid cancer risk predictions for 100 mGy by WHO (2013)

Females, 10y at exposure	WHO (2013)	Jacob et al. (2014)	Ratio
LAR	0.25%	1.6%	6.5
RR, lifetime	0.33	0.24	0.7
AR_{15}	0.03%	0.09%	2.9
RR, 15 years	1.1	0.53	0.5

Compared to WHO (2013), Jacob et al. (2014) predict

- higher thyroid cancer rates, because of ultrasonography survey
- slightly lower relative risks especially for first few decades after exposure of girls, because of differences in radiation risk function

Summary of predictions for continued ultrasonography (1)

Predictions based on prevalence and screening factor in UkrAm study, and thyroid cancer risk function in LSS members not participating in the AHS

Prevalence during first screening: 0.034% (95% CI: 0.009%; 0.085%)

Screening factor for incidence rate: 7 (95% CI: 1; 17)

Thyroid cancer incidence over 50 years: 2% (95% CI: 0.3%; 5%)

Excess 50y-incidence from thyroid dose 20 mGy: 0.1% (95% CI: 0.005%; 0.4%)

Summary of predictions for continued ultrasonography (2)

Excess 50y-incidence from thyroid dose 20 mGy: 0.1% (95% CI: 0.005%; 0.4%)

Less than 5% of 50y-excess accumulate during first 10 years

Large uncertainties related to F_{scr} , ERR_{LSS}, F_{DDREF} and thyroid dose

Good agreement with post-Chernobyl studies

Compared to WHO higher rates,

but slightly lower relative risks (especially in first decades after exposure of girls)

Summary of predictions for continued ultrasonography

Predictions based on prevalence and screening factor in UkrAm study, and thyroid cancer risk function in LSS members not participating in the AHS

Prevalence during first screening: 0.034% (95% CI: 0.009%; 0.085%)

Screening factor for incidence rate: 7 (95% CI: 1; 17)

Thyroid cancer incidence over 50 years: 2% (95% CI: 0.3%; 5%)

Excess 50y-incidence from thyroid dose 20 mGy: 0.1% (95% CI: 0.005%; 0.4%)

Less than 5% of 50y-excess accumulate during first 10 years

Large uncertainties related to F_{scr}, ERR_{LSS}, F_{DDREF} and thyroid dose

Good agreement with post-Chernobyl studies

Compared to WHO higher rates,
but slightly lower relative risks (especially in first decades after exposure of girls)

Thank you for your attention !