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# What the Fukushima Health Management Survey has revealed about the risk of thyroid cancer

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# This presentation

- The Full-Scale Survey (the fifth-round survey) of the Thyroid Ultrasound Examination is currently underway in the Fukushima Health Management Survey.
- The relationship between the average thyroid absorbed dose by municipality estimated in the UNSCEAR 2020 report and the detection rate of nodules cytologically diagnosed as malignant or suspicious for malignancy will be presented.
- A case-control study using estimated dose of internal exposure (thyroid equivalent doses) for each individual will also be presented.

# Flow chart of Thyroid Ultrasound Examination program

for residents in Fukushima aged 18 years or younger at the accident

## Primary examination (with portable US machines)

By visiting all towns and schools in Fukushima

and examination in all prefectures in Japan



## Interpretation of US images

Others

Nodule  $\geq 5.1\text{mm}$  or cyst  $\geq 20.1\text{mm}$

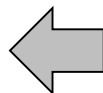
## Secondary confirmatory examination (US, blood and urine exam., FNAC)



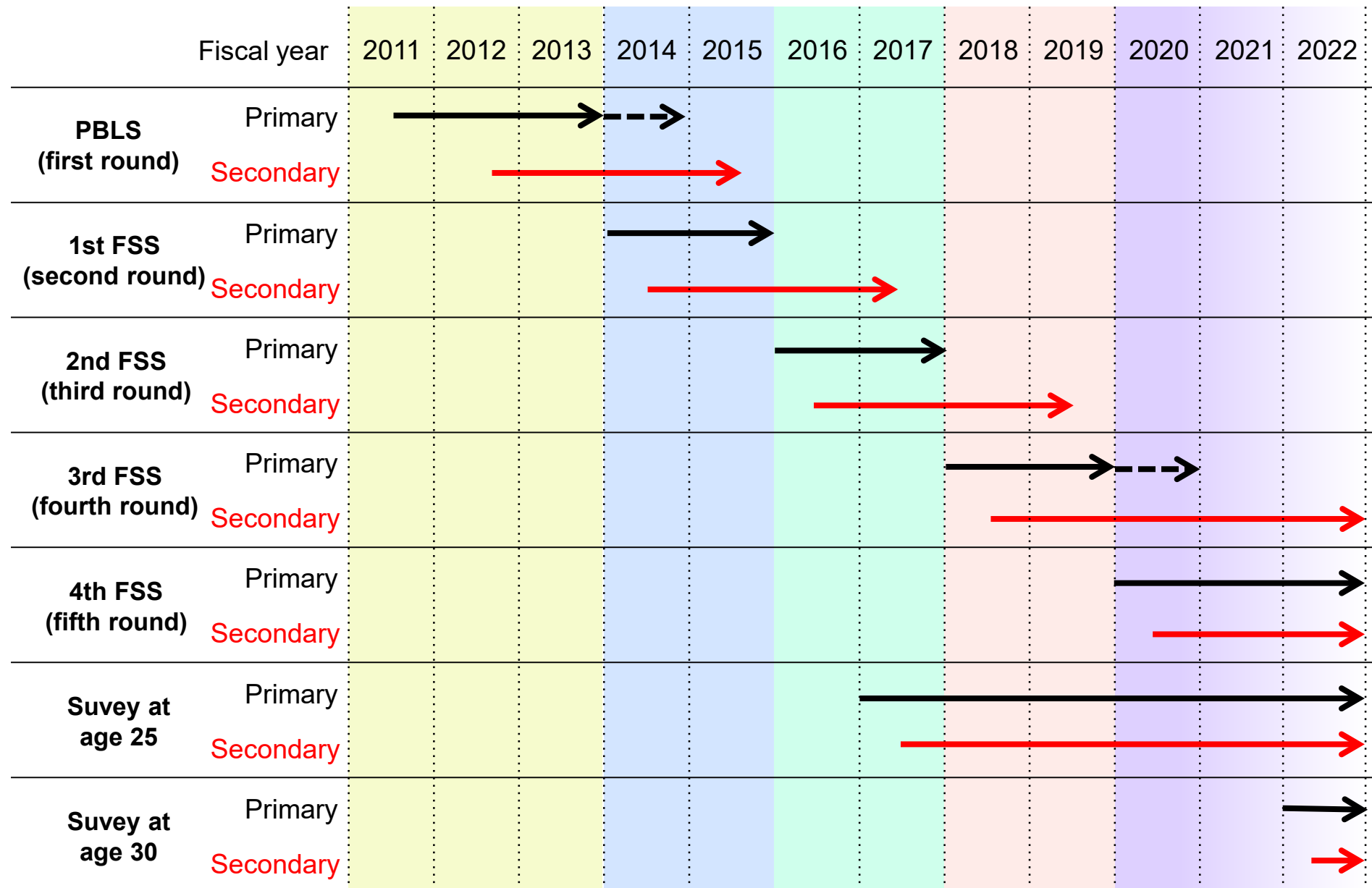
## Next examination

(2 years-interval in childhood,  
5 years-interval in  $> 20$  y/o)

Surgical treatment or  
medical follow-up



# Progress of Thyroid Ultrasound Examination



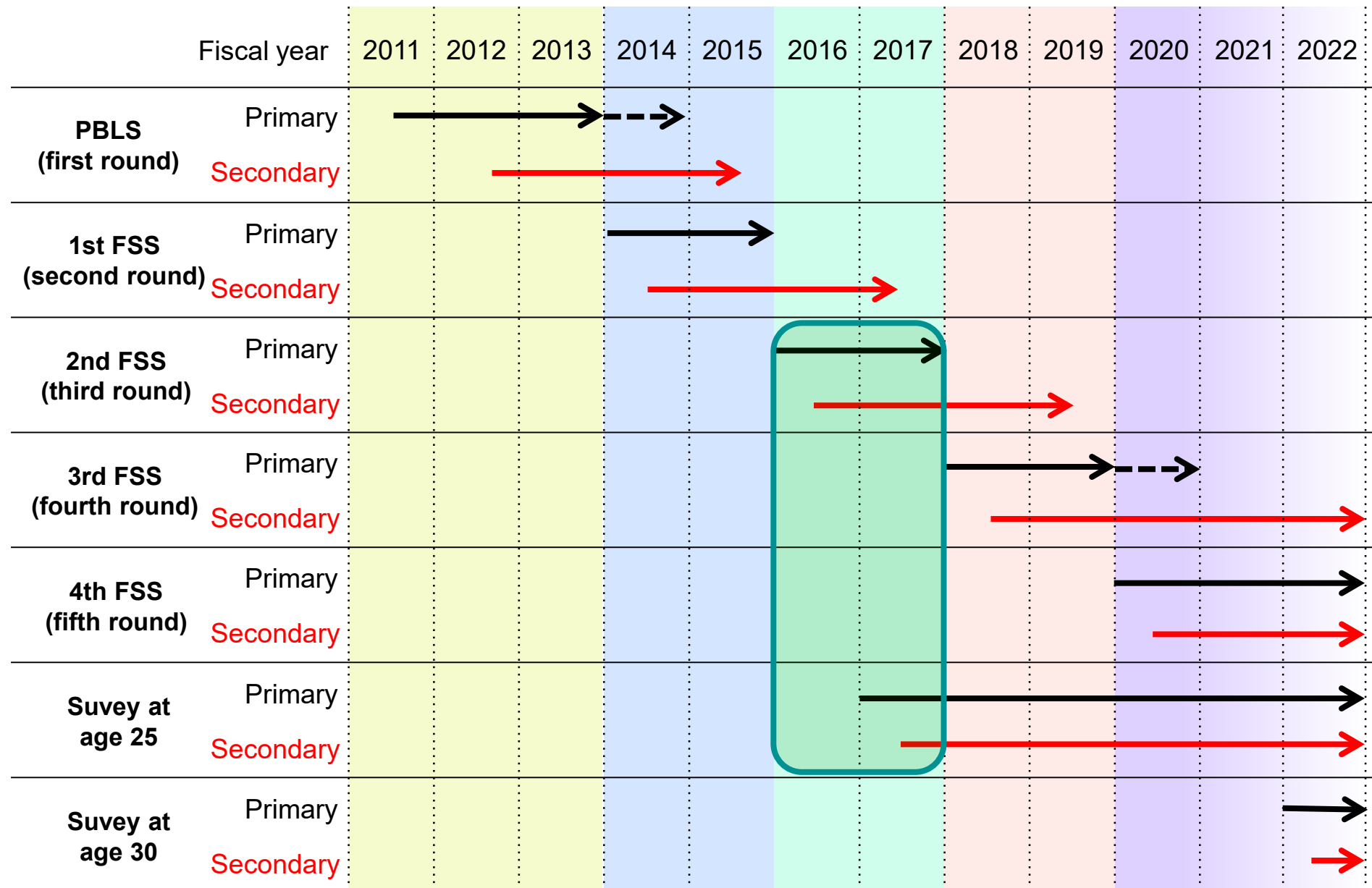
PBLS: Preliminary Baseline Survey, FSS: Full-Scale Survey

# Summary of results

		PBLS (1st round)*	1st FSS (2nd round)**	2nd FSS (3rd round)**	3rd FSS (4th round)***
Fiscal year		<b>2011-2013</b>	<b>2014-2015</b>	<b>2016-2017</b>	<b>2018-2019</b>
Eligible persons		<b>367,637</b>	<b>381,237</b>	<b>336,667</b>	<b>294,237</b>
Participation rate		<b>81.7%</b>	<b>71.0%</b>	<b>64.7%</b>	<b>62.3%</b>
Judgement in the primary examination	A1	<b>51.5%</b>	<b>40.2%</b>	<b>35.1%</b>	<b>33.6%</b>
	A2	<b>47.8%</b>	<b>59.0%</b>	<b>64.2%</b>	<b>65.6%</b>
	B	<b>0.8%</b>	<b>0.8%</b>	<b>0.7%</b>	<b>0.8%</b>
	C	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>	<b>0.0%</b>
Eligible persons for the secondary exam		<b>2,293</b>	<b>2,230</b>	<b>1,502</b>	<b>1,391</b>
Participation rate of 2nd exam		<b>92.9%</b>	<b>84.2%</b>	<b>73.5%</b>	<b>73.4%</b>
Malignant or suspicious (FNAC)		<b>116</b>	<b>71</b>	<b>31</b>	<b>36</b>
Examinees surgically treated		<b>102</b>	<b>55</b>	<b>29</b>	<b>29</b>
Pathological diagnosis	PTC	<b>100</b>	<b>54</b>	<b>29</b>	<b>29</b>
	PDTC	<b>1</b>			
	Others	<b>1</b>	<b>1</b>		

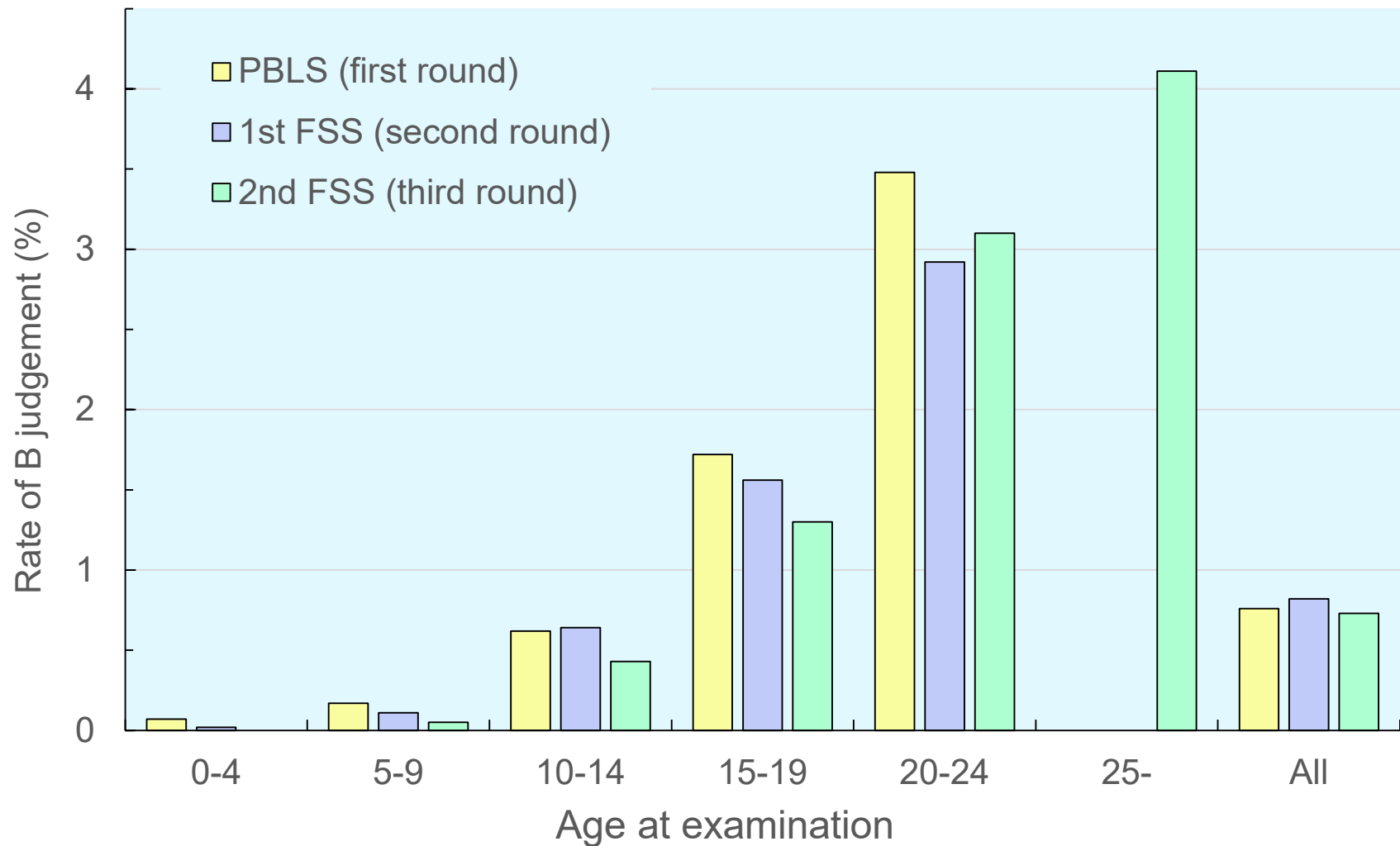
\*As of March 31, 2018, \*\*As of March 31, 2021, \*\*\*As of June 30, 2021

# Progress of Thyroid Ultrasound Examination



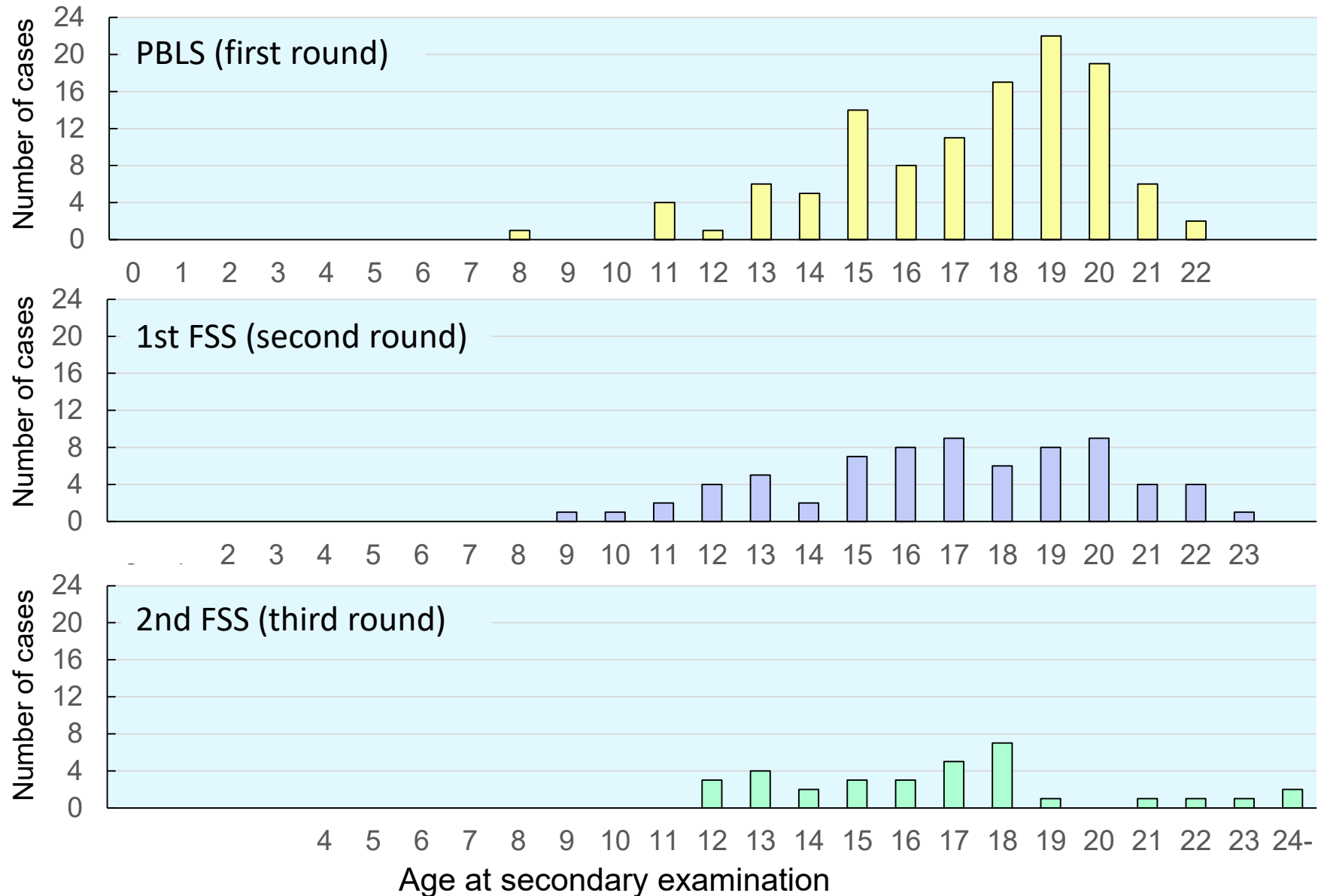
PBLS: Preliminary Baseline Survey, FSS: Full-Scale Survey

# Rate of Grade B (nodule > 5mm or cyst > 20mm)

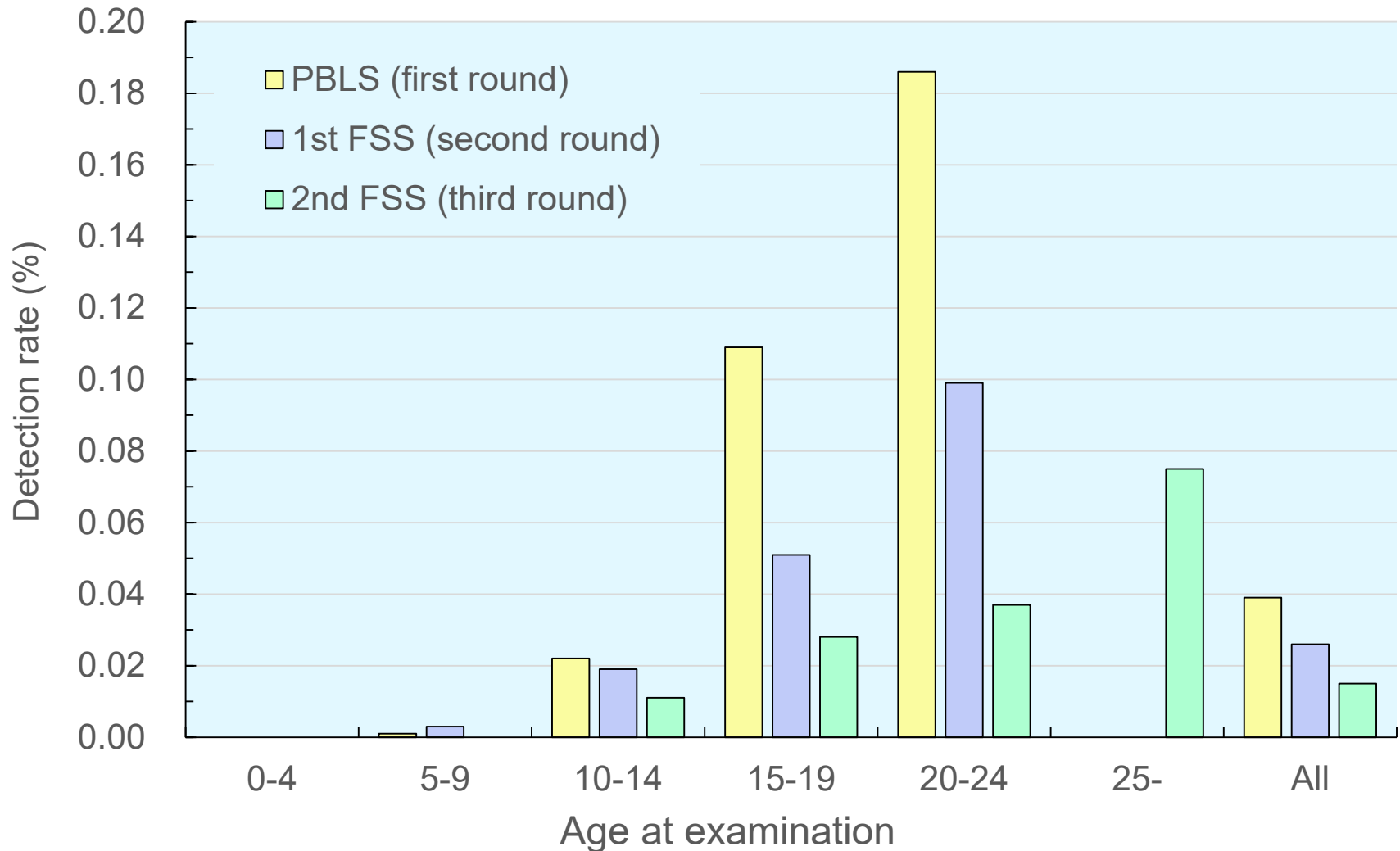




# Number of cases diagnosed as malignant or suspicious for malignancy



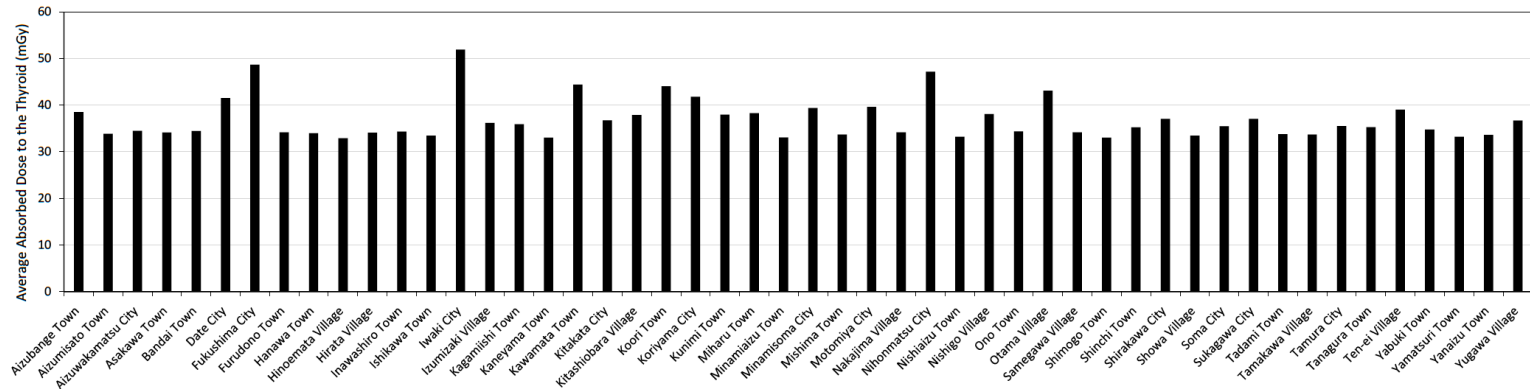
# Detection rate of nodules diagnosed as malignant or suspicious for malignancy



# Absorbed doses to the thyroids of 1-year-old infants estimated in the UNSCEAR reports (excluding evacuated area)

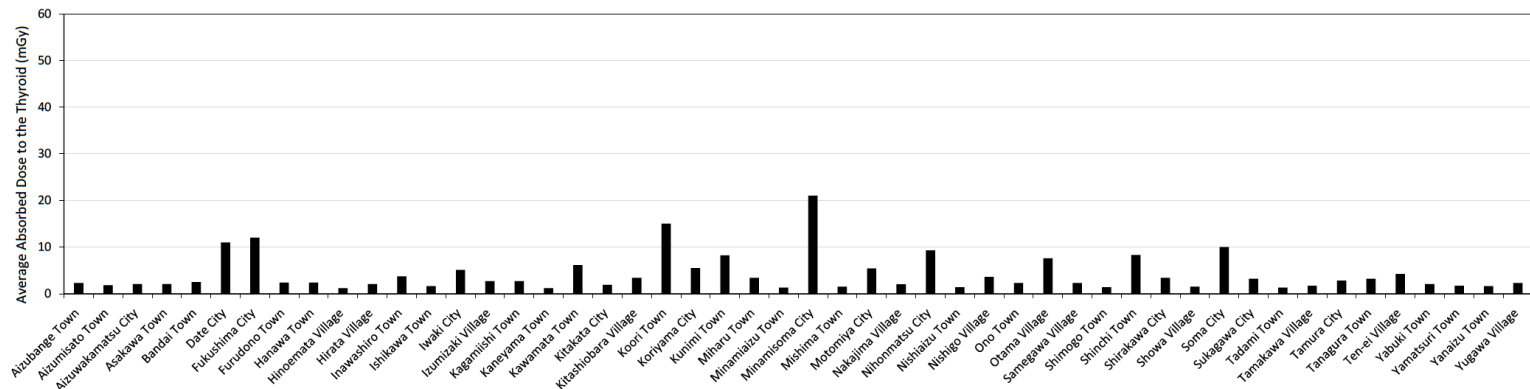
## UNSCEAR 2013

Estimated absorbed doses to the thyroids of 1-year-old infants in the first year after the accident for Fukushima Prefecture (excluding evacuated areas)

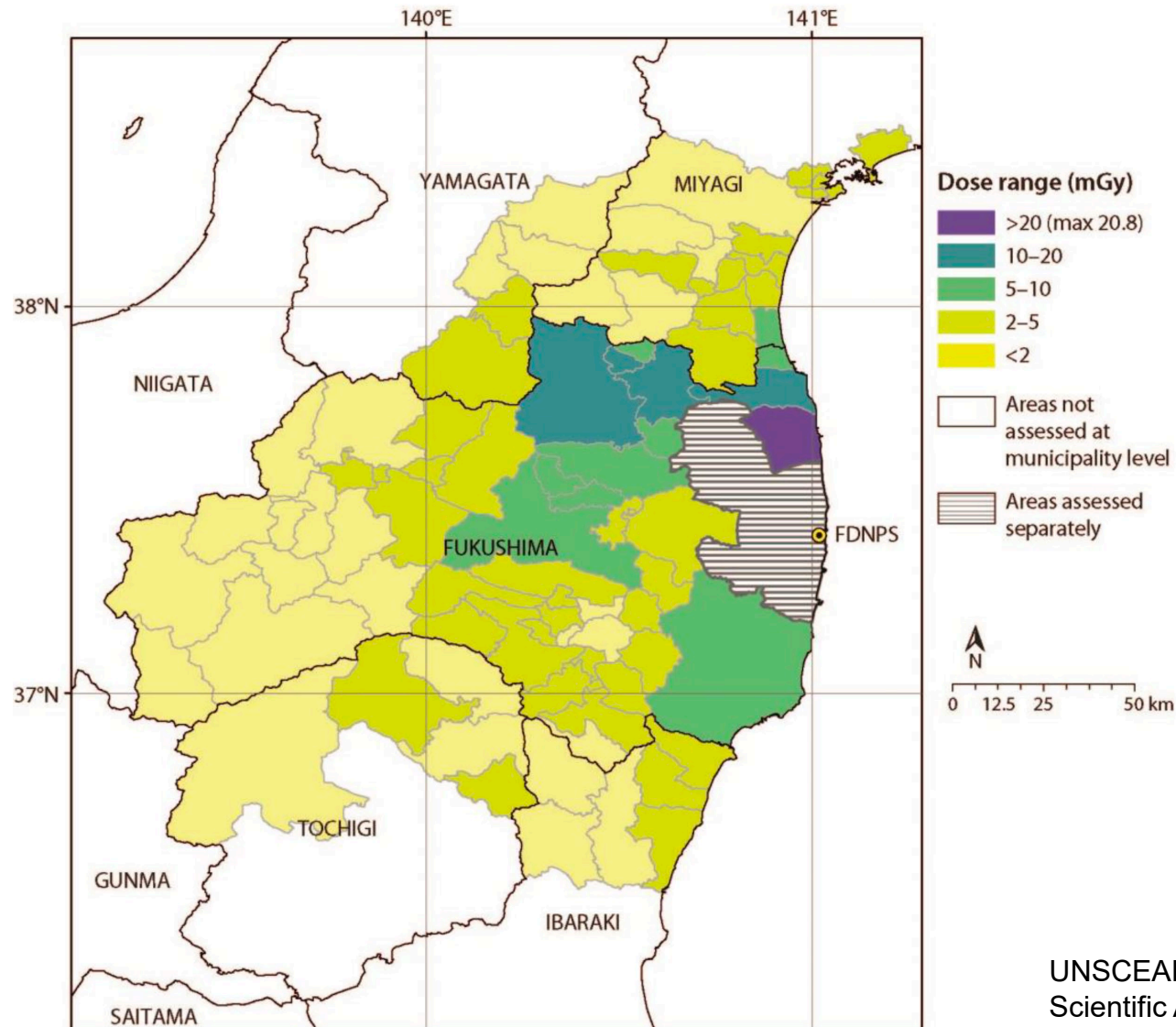


## UNSCEAR 2020

Estimated absorbed doses to the thyroids of 1-year-old infants in the first year after the accident for Fukushima Prefecture (excluding evacuated areas)

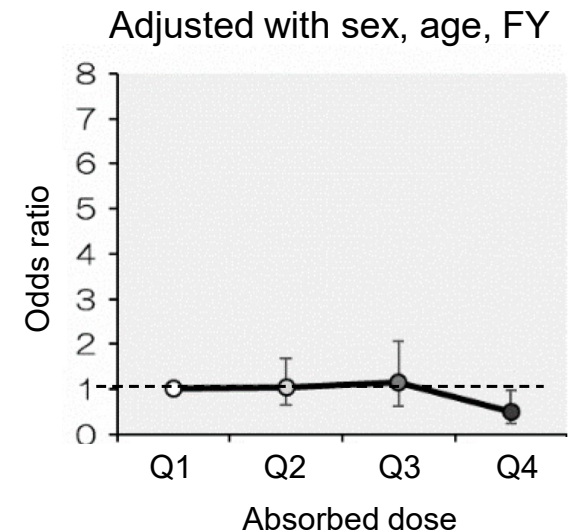
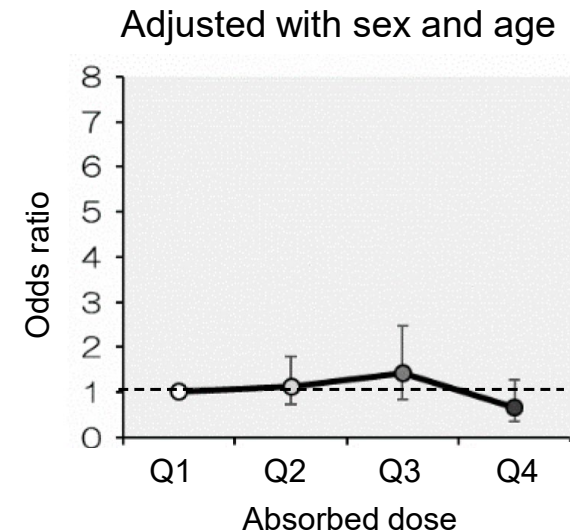


# Absorbed doses to the thyroids of 1-year-old infants estimated in the UNSCEAR 2020 Report (excluding evacuated area)



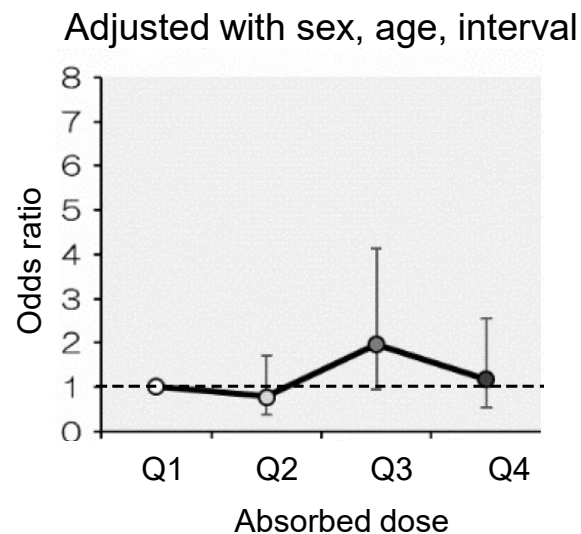
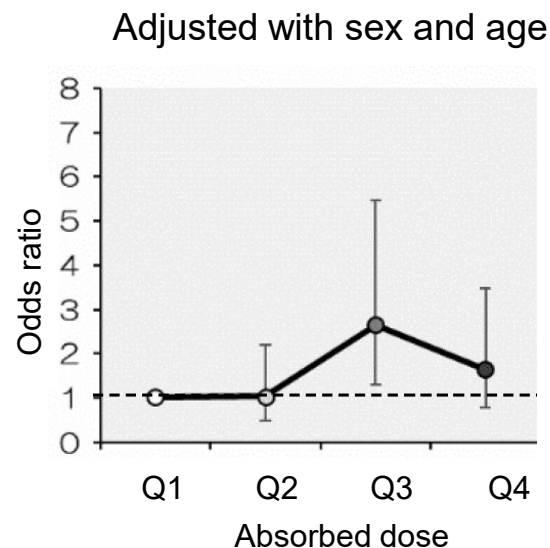
Relationship between absorbed doses to the thyroids estimated in the UNSCEAR 2020 Report and the detection rate of nodules cytologically diagnosed as malignant or suspicious for malignancy in the **PBLS** (cross-sectional analysis)

	Q1 0.5-2.6 mGy	Q2 2.7-4.3 mGy	Q3 4.5-7.0 mGy	Q4 7.0-15 mGy
Female (%)	50.2	49.9	49.0	49.3
Age at the primary exam (mean)	12.1	12.5	9.2	9.8
% of examinees in fiscal years				
FY 2011	9.5	6.5	12.8	21.2
FY 2012	9.2	31.6	62.6	70.7
FY 2013-	81.2	61.9	24.6	8.0
M or SM (n)	29	47	25	14
Detection rate (per 100,000)	50.1	59.5	31.9	17.4



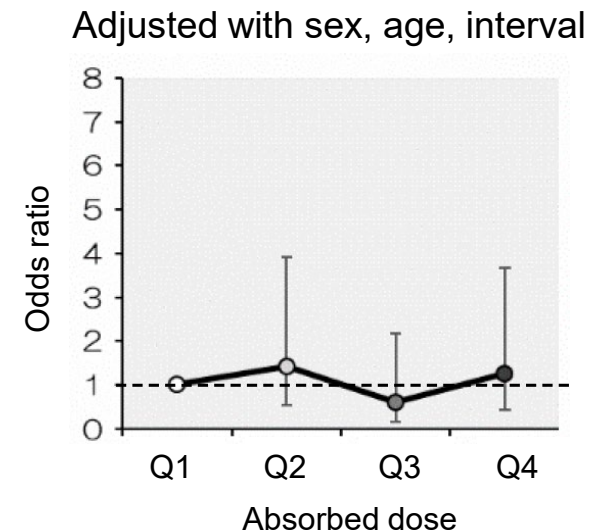
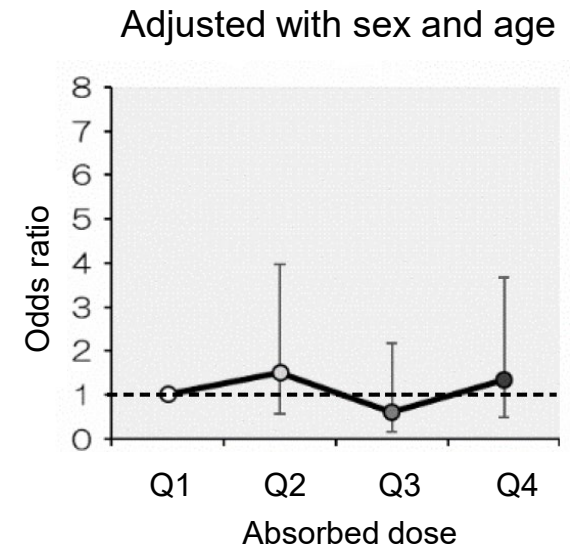
Relationship between absorbed doses to the thyroids estimated in the UNSCEAR 2020 report and the detection rate of nodules cytologically diagnosed as malignant or suspicious for malignancy in **1st Full-Scale Survey** (cross-sectional analysis)

	Q1 0.5-2.6 mGy	Q2 2.7-4.3 mGy	Q3 4.5-7.0 mGy	Q4 7.0-15 mGy
Female (%)	50.3	49.9	49.1	49.6
Age at the primary exam (mean)	12.9	13.6	10.7	11.3
Examination Interval (%)				
No PBLs	10.2	5.6	6.4	5.2
< 2 years	52.9	22.4	21.5	17.3
≥ 2 but < 2.5 years	33.6	59.6	61.3	67.8
≥ 2.5 years	3.3	12.5	10.9	9.7
M or SM (n)	11	17	24	18
Detection rate (per 100,000)	22.2	25.9	33.6	24.5



Relationship between absorbed doses to the thyroids estimated in the UNSCEAR 2020 Report and the detection rate of nodules cytologically diagnosed as malignant or suspicious for malignancy in **2nd Full-Scale Survey** (cross-sectional analysis)

	Q1	Q2	Q3	Q4
	0.5-2.6 mGy	2.7-4.3 mGy	4.5-7.0 mGy	7.0-15 mGy
Female (%)	50.1	50.1	49.4	49.6
Age at the primary exam (mean)	13.1	14.2	11.6	12.3
Examination Interval (%)				
No PBLs	3.8	1.3	2.7	1.3
< 2 years	78.4	37.5	47.7	30.8
≥ 2 but < 2.5 years	10.0	47.7	34.3	60.8
≥ 2.5 years	7.8	13.5	15.3	7.2
M or SM (n)	6	13	4	10
Detection rate (per 100,000)	14.9	26.6	6.4	16.5

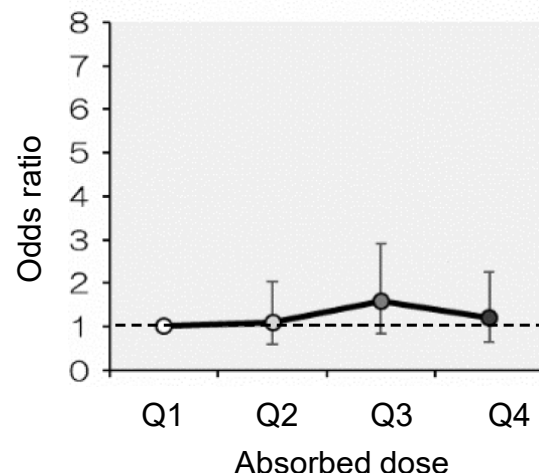




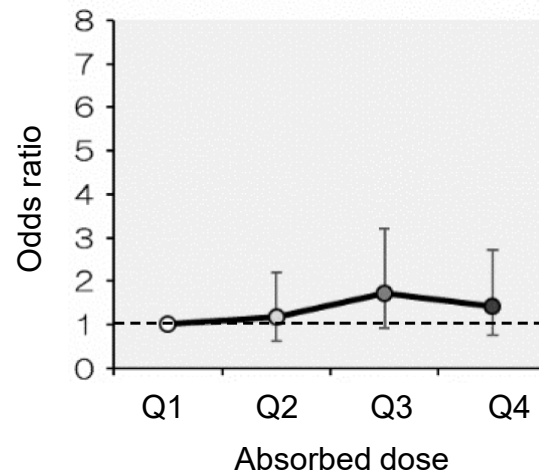
Relationship between absorbed doses to the thyroids estimated in the UNSCEAR 2020 Report and the detection rate of nodules cytologically diagnosed as malignant or suspicious for malignancy in **Full-Scale Survey (longitudinal analysis)**

	Q1	Q2	Q3	Q4
	0.5-2.6 mGy	2.7-4.3 mGy	4.5-7.0 mGy	7.0-15 mGy
Female (%)	50.3	50.0	49.1	49.6
Age at the primary exam (mean)	8.3	9.3	6.7	7.9
Examination Interval (%)				
< 3 years	25.3	26.9	18.1	19.4
≥ 3 but < 3.5 years	12.5	4.2	3.7	2.1
≥ 3.5 but < 4 years	50.9	11.8	19.0	13.4
≥ 4 but < 4.5 years	8.3	38.4	42.1	52.7
≥ 4.5 years	3.0	18.6	17.0	12.4
M or SM (n)	16	28	28	27
Detection rate (per 100,000)	34.0	43.5	39.9	37.5

Adjusted with sex and age

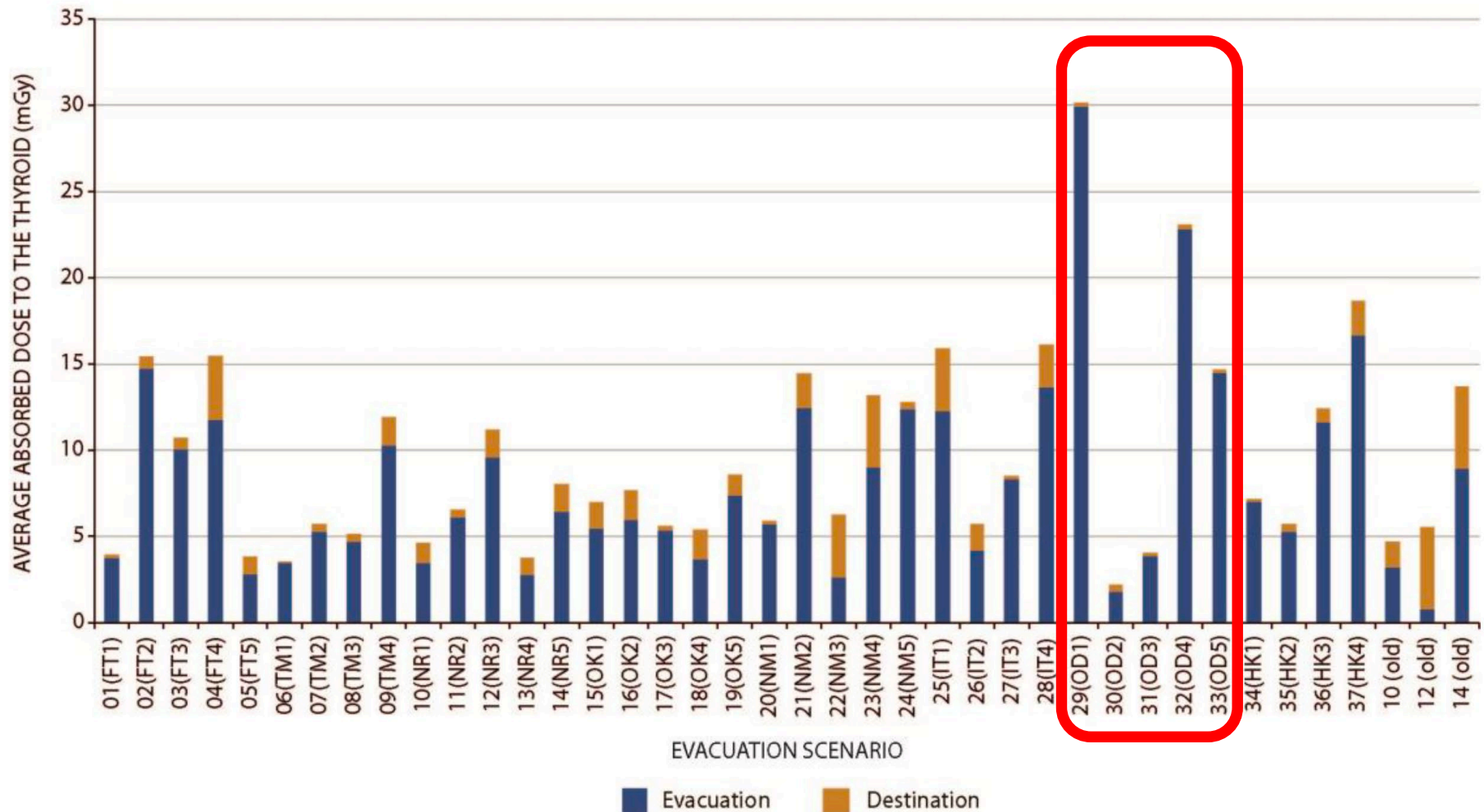


Adjusted with sex, age, interval





# Absorbed doses to the thyroids of 1-year-old infants estimated in UNSCEAR 2020 Report (evacuated area)



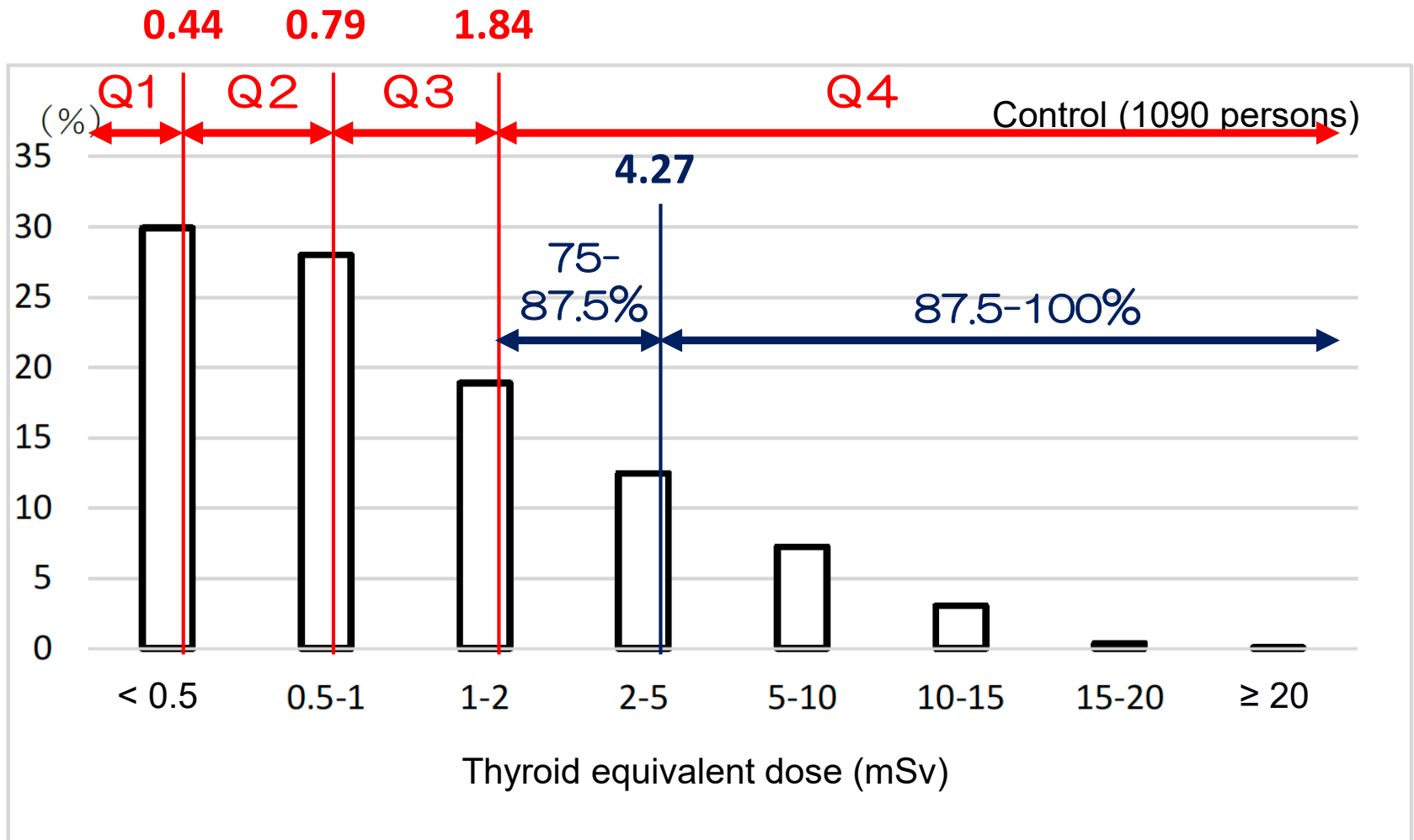
# Estimation of personal internal exposure dose (thyroid equivalent dose)

1. Thyroid equivalent dose (mSv) exposed from tap water + inhalation for 14 days after the nuclear power plant accident was estimated based on the detailed version of behavior report in the Basic Survey form from March 12 to March 25, 2011.
2. Cases were those with nodules cytologically diagnosed as malignant or suspicious for malignancy in the first- to third-round surveys and the survey at 25 years (born in FY1992) who have behavior records of the Basic Survey.
3. Controls were matched to cases by sex, age at the time of the earthquake, and fiscal year of each examination (only those with behavioral records), and randomly selected at a ratio of 1:10 cases to controls.

## Characteristics of cases and controls analyzed by case-control study within the cohort

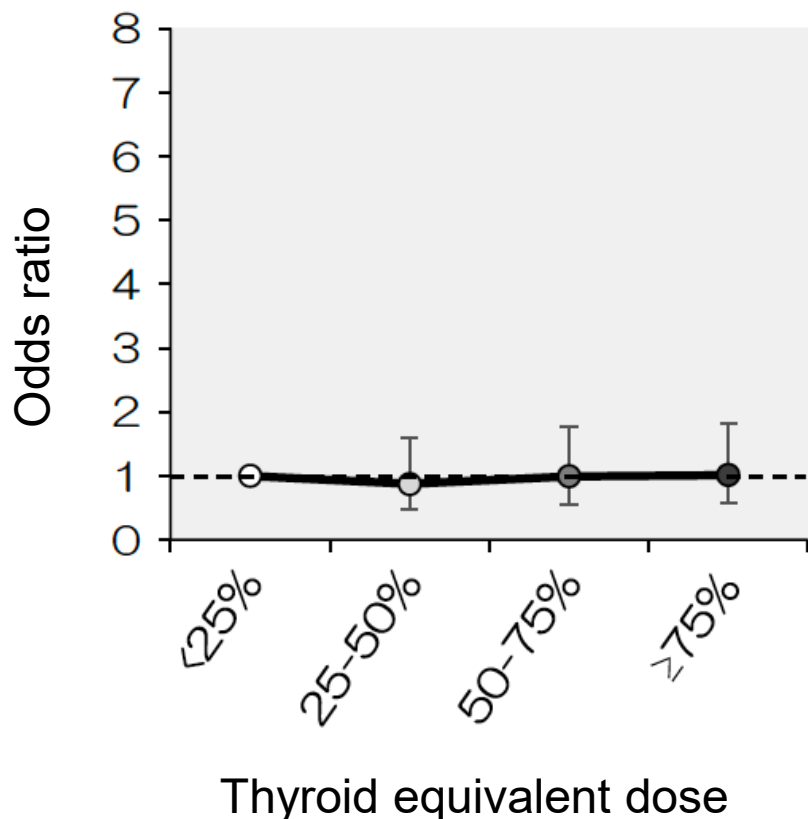
	Cases	Controls	Total
Cases (M or SM) (n)	109	0	109
Controls (n)	0	1090	1090
Age at earthquake (mean)	13.7	13.7	13.7
Thyroid equivalent dose (mSv)			
Median	0.8	0.8	0.8
Min – Max	0.00–22.04	0.00 – 135.56	0.00 – 135.56
Grade B or C (%)	100	2.4	11.3

# Distribution of thyroid equivalent dose in the control group

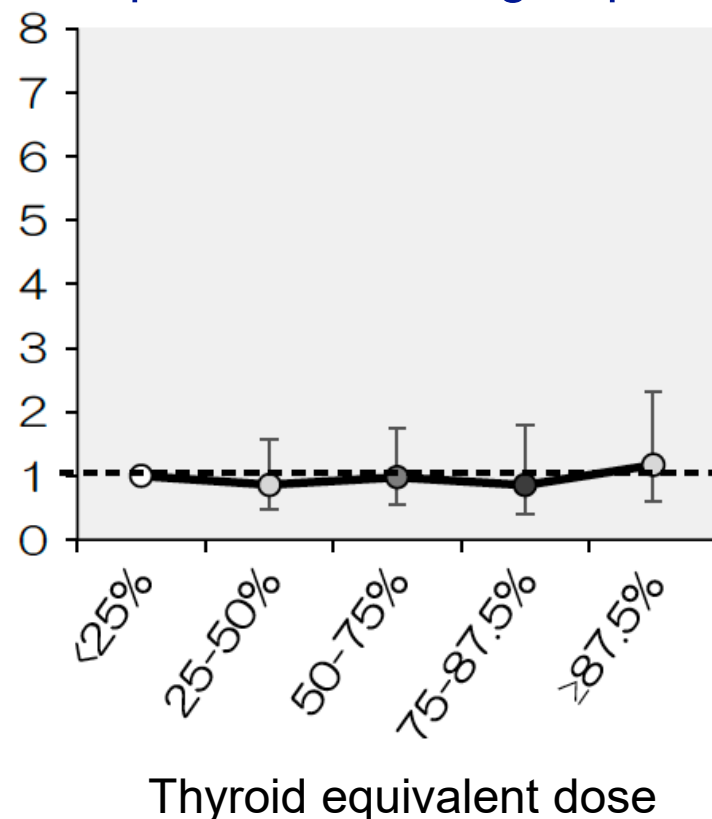


Odds ratio for detection of nodules diagnosed as malignant or suspicious for malignancy in each thyroid equivalent dose group

Results classified by quartile



Result from further classifying the fourth quartile into two groups



# Future challenges in case-control studies

- Analysis with additional estimates of thyroid equivalent dose for those who did not submit their behavior records
- Analysis with external exposure dose in addition to internal dose
- Analysis with newly identified thyroid cancer cases from cancer registry information

# Conclusions

- Until the third-round survey, nodules diagnosed as malignant or suspicious for malignancy are detected in **the same age group as before**.
- **No dose-effect relationship** has been observed between **the average absorbed thyroid doses by municipality estimated in the UNSCEAR 2020 Report** and the detection rate of nodules diagnosed as malignant or suspicious for malignancy until the third-round survey.
- In a case-control study using **estimated internal exposure doses** (thyroid equivalent doses) for each individual, **no dose-effect relationship was observed**.



# Acknowledgements

## Fukushima Medical University

### Radiation Medical Science Center

Satoru Suzuki  
Satoshi Suzuki  
Takashi Matsuzuka  
Tetsuya Ohira  
Seiji Yasumura  
Hitoshi Ohto  
Kenji Kamiya  
All Dept. of TUE staff

### Department of Thyroid and Endocrinology

Shinichi Suzuki  
Manabu Iwadate

### Thyroid Endocrine Center

Susumu Yokoya



Doctors and medical technologists cooperating TUE program



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