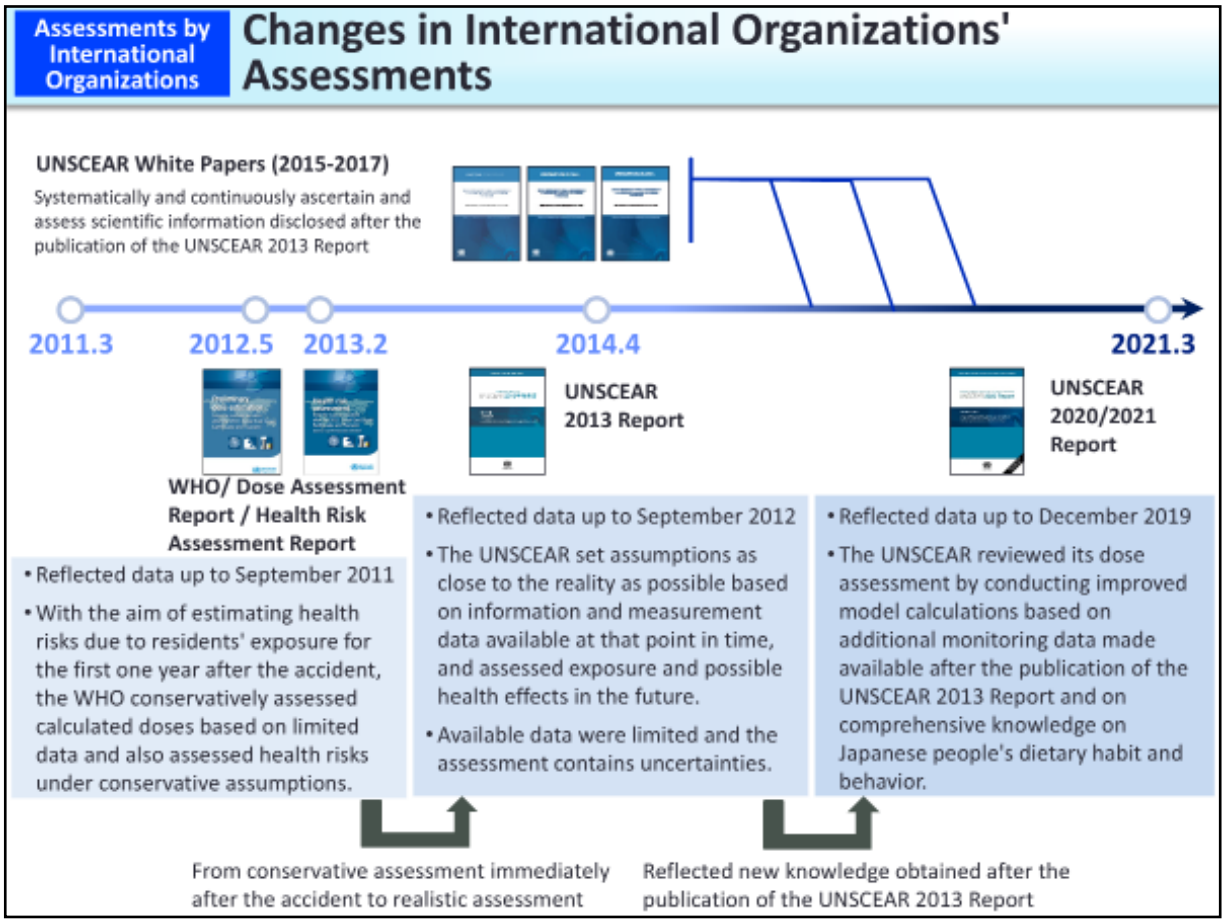

After the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, the World Health Organization (WHO) and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) published reports on assessment of exposure doses due to the accident and on health effects of radiation exposure.

The WHO published a report on provisional exposure dose assessment in May 2012, and a report on provisional health risk assessment in February 2013. The assessment by the WHO aimed to estimate people's exposure doses for the first one year after the accident and identify areas requiring emergency measures. Accordingly, based on limited information and by setting conservative assumptions in order to avoid underestimation, the WHO assessed the maximum exposure doses that could be possible.

The UNSCEAR 2013 Report aimed to achieve the most realistic assessment of exposure levels and radiation risks due to the accident to the extent possible. However, the Report also states that all the results of such assessment contain certain uncertainties due to the incompleteness of knowledge or information and depending on setting of assumptions.

Therefore, the UNSCEAR conducted ongoing follow-ups to systematically collect and assess new information published after the publication of the UNSCEAR 2013 Report. The results of the follow-ups were compiled into three White Papers from 2015 to 2017, and the UNSCEAR 2020/2021 Report, which reflects new knowledge obtained after the publication of the UNSCEAR 2013 Report, was published in March 2021.

In the UNSCEAR 2020/2021 Report, doses are estimated using new knowledge on exposure dose assessment in order to reduce the uncertainties in the dose estimation in the UNSCEAR 2013 Report.

1. WHO Reports on preliminary dose estimation and health risk assessment:
- Preliminary dose estimation from the nuclear accident after the 2011 Great East Japan Earthquake and Tsunami (2012)
- Health risk assessment from the nuclear accident after the 2011 Great East Japan earthquake and tsunami, based on a preliminary dose estimation (2013)

2. 2013 Annual Report by the UNSCEAR:
- SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION UNSCEAR 2013, Report, Volume I, REPORT TO THE GENERAL ASSEMBLY SCIENTIFIC ANNEX A: Levels and effects of radiation exposure due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami (2013)

3. 2020 Annual Report by the UNSCEAR:
- SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION UNSCEAR 2020/2021, Report, SCIENTIFIC ANNEX B: Levels and effects of radiation exposure due to the accident at the Fukushima Daiichi Nuclear Power Station: Implications of information published since the UNSCEAR2013Report (2020)

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Updated on March 31, 2024

Assessments by International Organizations

Major Conclusions of the Reports of International Organizations

	Major conclusions
WHO Reports	• Even in the area where the highest exposure dose was estimated, no significant increase would be observed in risks of childhood thyroid cancer and other types of cancer or leukemia and increased incidence of these diseases exceeding natura variation is hardly expected. • The results suggest that increases in the incidence of diseases attributable to the additional radiation exposure are likely to remain below detectable levels.
UNSCEAR 2013 Report	• It is not likely that any significant changes attributable to radiation exposure due to the accident would arise in future cancer statistics. • There is the possibility that thyroid cancer risks may theoretically increase among the group of children whose estimated exposure doses were at the highest level. Therefore, their situations need to be closely followed up and assessed.
UNSCEAR 2020/2021 Report	• **No adverse health effects among Fukushima residents directly attributable to radiation exposure have been observed, and future health effects directly related to radiation exposure are unlikely to be discernible.** • **Increases in incidence of thyroid cancer in the Thyroid Ultrasound Examination that has been conducted in Fukushima after the nuclear accident are considered to be the result of sensitive ultrasound screening procedures.**

The WHO Reports published in 2012 and 2013, along with the UNSCEAR 2013 Report, state that their assessments of exposure doses contain certain uncertainties due to uncertainties inherent to basic data. However, the UNSCEAR 2020/2021 Report shows conclusions with less uncertainties on many issues as a broader range of knowledge became available.

The UNSCEAR 2020/2021 Report compiles all pieces of scientific information concerning levels and effects of radiation exposure due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS that were published by the end of 2019 and assesses the influence on the knowledge and conclusions of the UNSCEAR 2013 Report.

Based on new knowledge, etc. on exposure dose assessment that became clear after the publication of the UNSCEAR 2013 Report, it became possible for the UNSCEAR to conduct improved and more realistic assessment of levels and effects of radiation exposure after the accident in its 2020/2021 Report. Based on the fact that public exposure doses that were reviewed based on new knowledge were lower or at the same level compared with those in the 2013 Report, the UNSCEAR concluded that "future health effects directly related to radiation exposure are unlikely to be discernible." With regard to many cases of thyroid cancer detected in Thyroid Ultrasound Examination, which was conducted as part of the Fukushima Health Management Survey, the UNSCEAR assessed that "these cases are not stem from the result of radiation exposure but rather arise from the result of sensitive ultrasound screening procedures." Furthermore, the UNSCEAR concluded that "there has been no evidence of excess congenital anomalies, stillbirths, preterm deliveries related to radiation exposure among general public."

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Assessments by International Organizations

Comparison of Reports (Assessment Results)

- Estimated ranges of average effective doses for groups of evacuees for the first one year after the accident (The unit is mSv.)

UNSCEAR 2020/2021 Report

	20 years old (adults)	1 year old (infants*3)
(Group 1) Residents in Fukushima Prefecture who were evacuated：	0.046 - 5.5	0.15 - 7.8
(Group 2) Residents in Fukushima Prefecture who were not evacuated：	0.079 - 3.8	0.12 - 5.3
(Group 3) Prefectures neighboring Fukushima Prefecture*1：	0.10 - 0.92	0.15 - 1.3
(Group 4) The rest of Japan：	0.004 - 0.36	0.005 - 0.51

UNSCEAR 2013 Report

	20 years old (adults)	1 year old (infants*3)
① Precautionary evacuation areas：	1.1 - 5.7	1.6 - 9.3
② Deliberate evacuation areas：	4.8 - 9.3	7.1 -13
③ Non-evacuated areas in Fukushima Prefecture：	1.0 - 4.3	2.0 - 7.5
④ Prefectures neighboring Fukushima Prefecture*2：	0.2 - 1.4	0.3 - 2.5
⑤ The rest of Japan：	0.1 - 0.3	0.2 - 0.5

WHO Reports

	20 years old (adults)	1 year old (infants*3)
① Fukushima Prefecture：	1 - 50	1 - 50
② Prefectures neighboring Fukushima Prefecture：	0.1 - 10	0.1 - 10
③ The rest of Japan：	0.1 - 1	0.1 - 1

*1: Miyagi, Yamagata, Ibaraki and Tochigi Prefectures (Group 3)
The radionuclide deposition density information in parts of these prefectures was sufficient for estimates of doses to be made from inhalation and external exposure pathways at the municipality-average level on a 1-km square basis. As a result, prefectures making up Group 3 are different from those considered in the UNSCEAR 2013 Report.
*2: Iwate, Miyagi, Ibaraki, Tochigi, Gunma, and Chiba Prefectures
*3: The original text in English, the term "infant" is used for young children and babies. This table uses the descriptions in the original texts of Japanese versions of the Reports. As the WHO Reports are not translated into Japanese, the same expressions as used in the UNSCEAR 2020/2021 Report are used here.

The estimated effective doses to the public for the first year after the accident in Reports of the UNSCEAR and the WHO are as shown in the table above. The ranges of doses here show those of average values for prefectures, municipalities in the targeted areas, or evacuation scenarios for targeted groups.

The results of dose assessment in the UNSCEAR 2020/2021 Report are lower or at the same level compared with those presented in the UNSCEAR 2013 Report (p.196 of Vol. 1, “UNSCEAR 2020/2021 Report (3/8): Update from the UNSCEAR 2013 Report upon Assessing Public Exposure Doses”). The UNSCEAR 2020/2021 Report also assesses the uncertainties in dose assessment.

The WHO Reports and the UNSCEAR 2013 Report state that their assessments of exposure doses contain certain uncertainties due to uncertainties inherent to basic data. However, in the UNSCEAR 2020/2021 Report, dose estimation with less uncertainties became possible as a broader range of knowledge was made available.

[Relevant parts in the Reports]

- WHO’s Preliminary dose assessment (prepared based on pages 40 to 45 (3. Results))
- UNSCEAR 2013 Report (prepared based on paragraphs 209 to 214 on pages 86 to 87, Annex A)
- UNSCEAR 2020/2021 Report (prepared based on paragraphs 166 to 169 on pages 64 to 66, ANNEX B)

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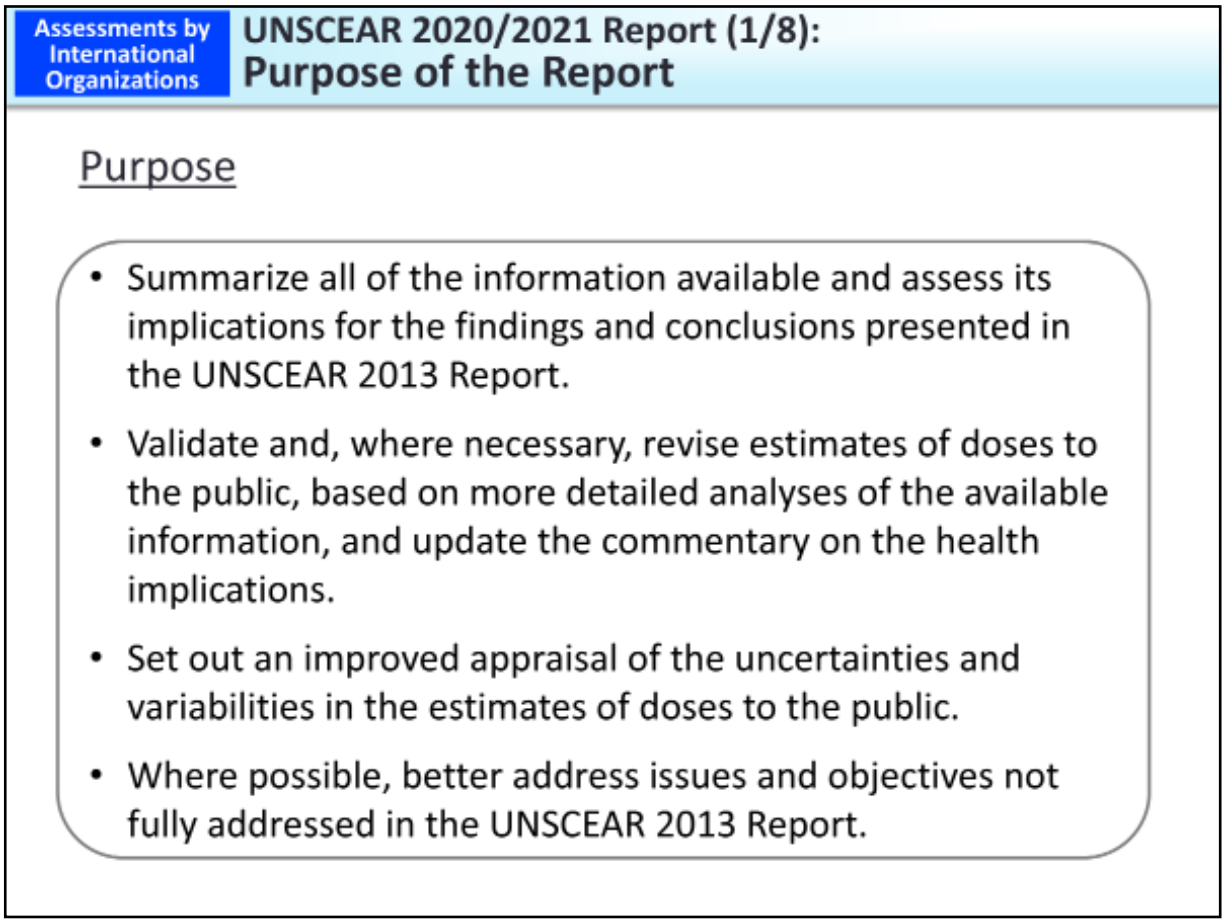

The UNSCEAR 2020/2021 Report Scientific Annex B titled “Levels and effects of radiation exposure due to the accident at the Fukushima Daiichi Nuclear Power Station: implications of information published since the UNSCEAR 2013 Report” was prepared for the purpose of compiling all scientific knowledge concerning levels and effects of radiation exposure due to the accident at Tokyo Electric Power Company (TEPCO)’s Fukushima Daiichi NPS that was available by the end of 2019, and for the purpose of assessing the influence on the content of the UNSCEAR 2013 Report. More specifically, the purpose is described as shown in the above figure.

On the other hand, the following three points are indicated as being out of the Report’s intended purpose.

- The annex does not address policy issues with respect to human rights, public health protection, environmental protection, radiation protection, emergency preparedness and response, accident management, nuclear safety, radioactive waste management, prospective releases, and related issues.
- It does not intend to provide advice to local governments, the Government of Japan or to national and international bodies.
- The annex also does not address other effects (not associated with exposure to radiation) that can arise as a result of accidents, such as that at TEPCO’s Fukushima Daiichi NPS, including distress and anxiety from, among other things, disruption of life, loss of homes and livelihoods, and social stigma, which can have major impacts on mental and social well-being.

The UNSCEAR 2020/2021 Report is an independent report, but is intended to be read together with the UNSCEAR 2013 Report and White Papers published thereafter. Accordingly, the Report does not contain information in full that can be obtained from these other documents.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraphs 7 to 8 on pages 6 to 7, ANNEX B)

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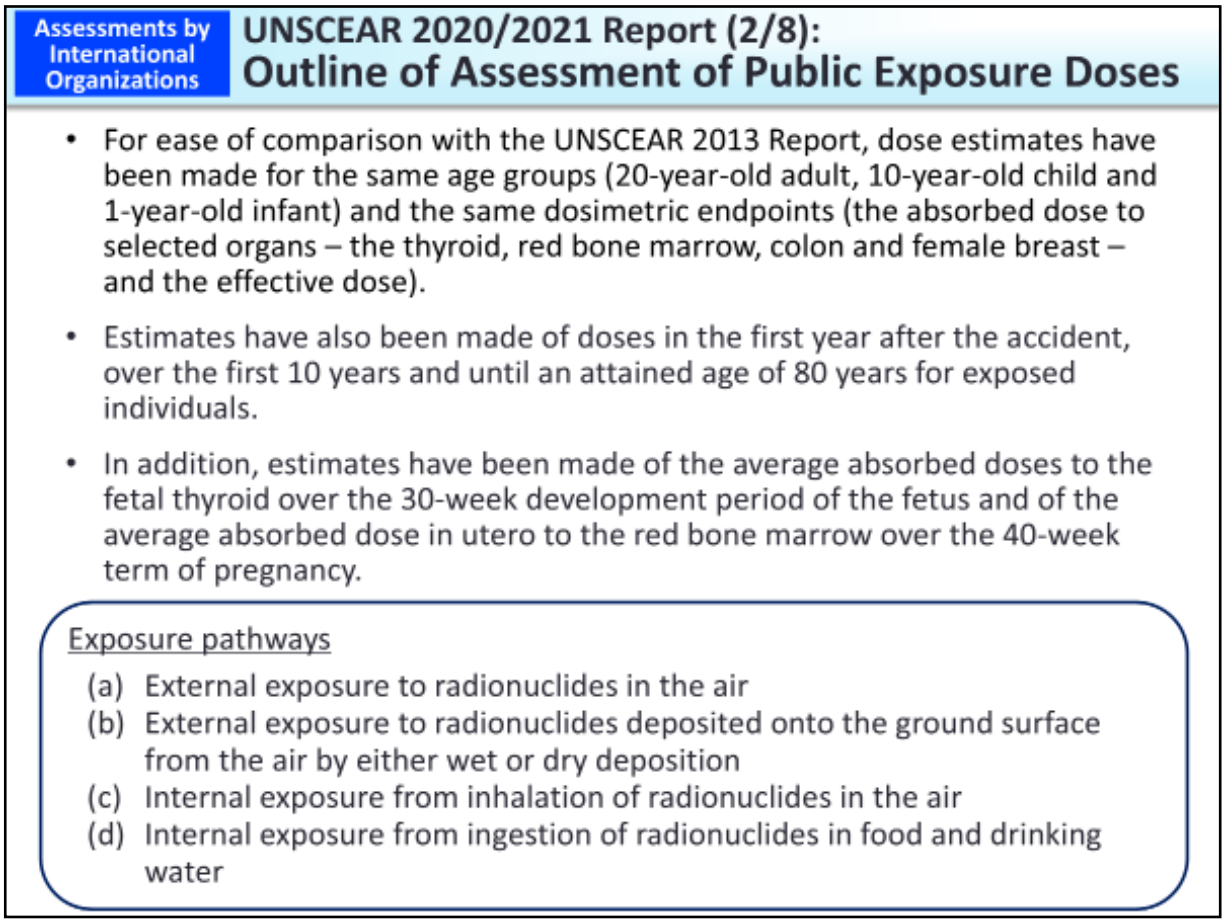

For ease of comparison with the UNSCEAR 2013 Report, dose estimates in the UNSCEAR 2020/2021 Report have been made for the same age groups and the same dosimetric endpoints. Concrete conditions are as shown above.

Dose assessment was conducted based on actual measurement data, while reflecting the latest scientific knowledge and progress that were published after the publication of the UNSCEAR 2013 Report up to the end of 2019 (p.196 of Vol. 1, “UNSCEAR 2020/2021 Report (3/8): Update from the UNSCEAR 2013 Report upon Assessing Public Exposure Doses”).

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraphs A4 to A5 on page 110, ANNEX B)

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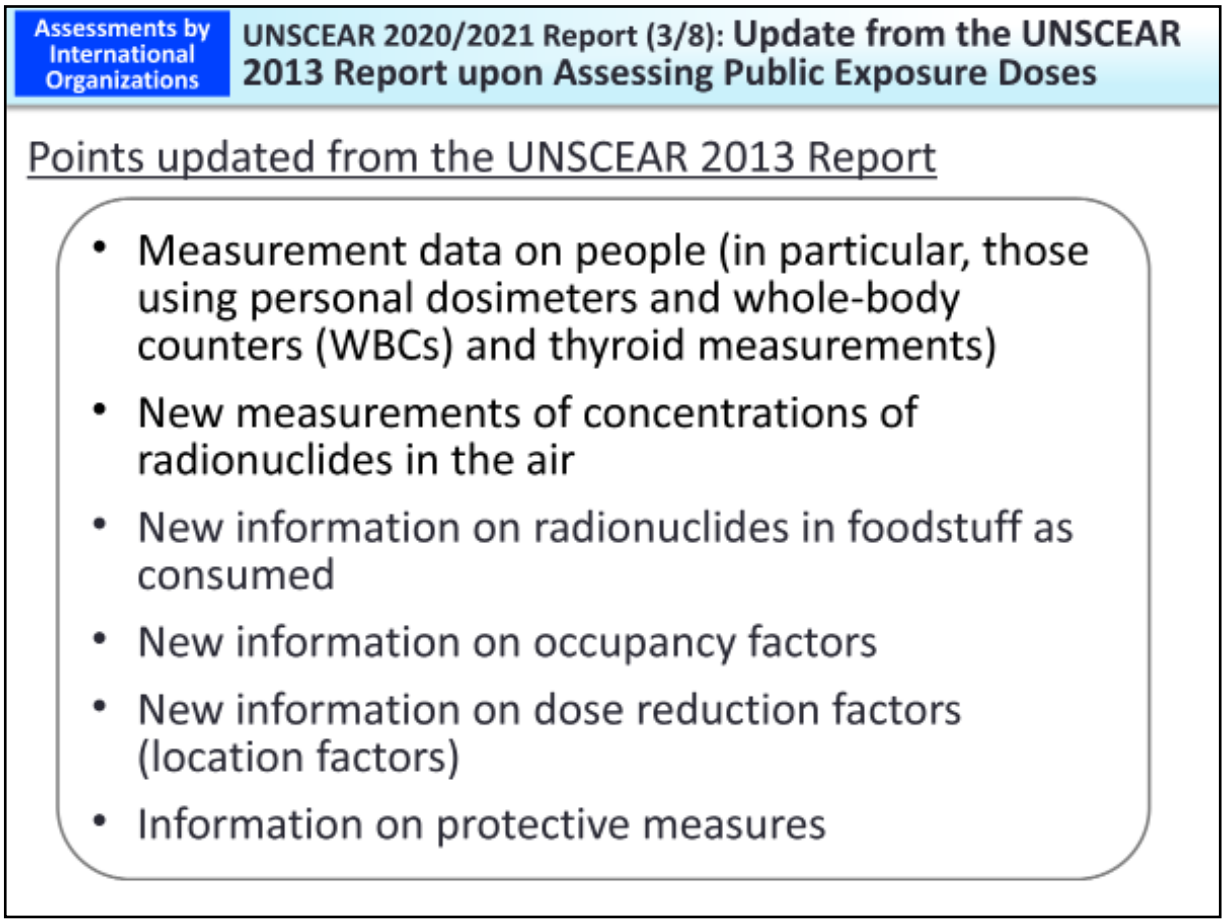

It became possible to estimate doses based on enhanced measurement-based information by the use of the latest knowledge up to the end of 2019 that became available, following the publication of the UNSCEAR 2013 Report.

Numerous measurement campaigns have been carried out to assess individual doses from external exposure through surveys of daily activity patterns of residents, measurements of ambient dose rates and individual measurements using personal dosimeters. The UNSCEAR has made use of some of these data and other scientific results published in peer-reviewed journals to validate its estimates of doses from external exposure and in the development of a revised model to apply to the wider population. Furthermore, the UNSCEAR has validated its estimates of thyroid doses from internal exposure based on the results of the thyroid measurements covering more than 1,500 persons in total that were conducted in 2011.[1] Whole-body monitoring campaigns have also been carried out by national institutes, such as the Japan Atomic Energy Agency (JAEA) and the National Institute of Radiological Sciences (NIRS), and by universities, hospitals and municipalities, and the measured levels of radioactive cesium in the body were used to estimate doses from its intake by inhalation and ingestion.

Regarding environment monitoring data, part of the results of the monitoring conducted in Japan from March 2011 to March 2018 (data on dose rate in air, radionuclide ground deposition density, and radionuclide concentrations in air and in food and drinking water) was used to estimate doses. For example, measurement data regarding radionuclide concentrations in air while radionuclides were being discharged from Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS were limited for the initial stage of the accident and for the areas damaged by the tsunami, in particular, but data on radionuclide concentrations in suspended particles in air at seven locations in Japan from March to May 2011, which had not been available, were newly made available.

Regarding food and drinking water, in addition to their monitoring data, information on measurements of the radioactive cesium content in the whole daily diet sampled by the duplicate-diet or market-basket methods was updated.

1. The data for around 1,300 persons that are reported in papers etc., while omitting such data as those under conditions with high background levels, were analyzed.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraphs A11 and A13, A16, A17, A19, A20, A23, A29, and A31 on pages 112 to 122, ANNEX B)

Included in this reference material on March 31, 2023
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Assessments by International Organizations

UNSCEAR 2020/2021 Report(4/8): Estimation of Public Exposure Doses for Each of the Four Groups

Area classification for dose assessment

Group	Geographical area	Spatial resolution
1	Locations where people were evacuated in the days to months after the accident	Representative areas used for each location identified in 40 evacuation scenarios
2	Municipalities and parts of municipalities of Fukushima Prefecture not evacuated	Municipality level for external and inhalation pathways, based on the estimates for each of the 1-km grid points, averaged over the municipality Prefecture level for ingestion pathway
3	Selected prefectures (Miyagi, Tochigi, Ibaraki and Yamagata) in eastern Japan that are neighboring to Fukushima Prefecture	Municipality level for external and inhalation pathways, based on the estimates for each of the 1-km grid points, averaged over the municipality Average for the four prefectures (Miyagi, Tochigi, Ibaraki and Yamagata) for ingestion pathway
4	All remaining prefectures of Japan	Prefecture level for external and inhalation pathways Average of the rest of Japan (i.e., the 42 prefectures, excluding Fukushima, Miyagi, Tochigi, Ibaraki and Yamagata) for ingestion pathway

Public exposure radiation due to the accident differs by location, and evacuees changed their locations over time. Therefore, in the UNSCEAR 2020/2021 Report, areas were classified into four groups for assessing public exposure doses, and the targets were further narrowed down depending on the exposure pathways.

For ease of comparison with the UNSCEAR 2013 Report, the classification is basically the same. However, the neighboring prefectures in Group 3 were changed from six (Iwate, Miyagi, Ibaraki, Tochigi, Gunma, and Chiba Prefectures) for the UNSCEAR 2013 Report to four (Miyagi, Yamagata, Ibaraki, and Tochigi Prefectures). This is due to differences in the spatial coverage of the most recent radionuclide deposition density information used in the dose assessment.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on Table 7 in paragraph 129 on pages 49 to 50, ANNEX B)

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Assessments by International Organizations

UNSCEAR 2020/2021 Report(5/8): Results of the Assessment of Public Exposure Doses

Table 1. Average effective doses by area for the first one year and for the first ten years following the accident (mSv)*1

Group		For the first one year following the accident		For the first ten years following the accident	
		20 years old (adults) *2	1 year old (infants)	20 years old (adults) *2	1 year old (infants)
1[a]	Fukushima Prefecture (evacuated municipalities)	0.046-5.5	0.15-7.8		
2	Fukushima Prefecture (other than evacuated municipalities)	0.079-3.8	0.12-5.3	0.16-11	0.22-14
3	Prefectures neighboring Fukushima Prefecture [b]	0.10-0.92	0.15-1.3	0.25-2.5	0.34-3.4
4	The rest of Japan	0.004-0.36	0.005-0.51	0.009-1.0	0.007-1.3

Table 2. Estimated absorbed doses to the thyroid for the first one year following the accident (mGy)*1

Group		For the first one year following the accident	
		20 years old (adults)*2	1 year old (infants)
1[a]	Fukushima Prefecture (evacuated municipalities)	0.79-15	2.2-30
2	Fukushima Prefecture (other than evacuated municipalities)	0.48-11	1.2-21
3	Prefectures neighboring Fukushima Prefecture [b]	0.31-3.3	0.62-6.3
4	The rest of Japan	0.034-0.48	0.087-0.74

mSv: millisievert
mGy: milligray

a. Estimate evacuees' doses using 40 evacuation scenarios
b. Miyagi, Yamagata, Ibaraki, and Tochigi Prefectures

*1: Ranges of the average values by evacuation scenario for Group 1, by municipality for Groups 2 and 3, and by prefecture for Group 4
*2: Estimated doses for 10-year-old children are omitted here.

Table 1 shows the effective doses of residents in evacuated municipalities and residents in Fukushima Prefecture other than evacuated municipalities or in other prefectures, for both the first one year and the first ten years following the accident. Table 2 shows estimated absorbed doses to the thyroid of the same targeted residents for the first one year following the accident. For all these four groups, the average regional effective doses were lower than the estimated doses in the foregoing UNSCEAR 2013 Report (p.193 of Vol. 1, “Comparison of Reports (Assessment Results)”).

Doses in the tables show those added to background doses due to natural sources of radiation, that is, estimated exposure doses from the radionuclides released into the environment due to the accident at Tokyo Electric Power Company (TEPCO)’s Fukushima Daiichi NPS.

Ranges of doses show those of the average values among targeted groups by prefecture or by municipality in the targeted areas, or by evacuation scenario.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraph 158 on page 58 and paragraphs 166 to 169 on pages 64 to 66, ANNEX B)

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Assessments by International Organizations

UNSCEAR 2020/2021 Report (6/8): Comparison with Direct Measurements

1. When comparing the UNSCEAR's estimate of municipality-average absorbed doses to the thyroid from internal exposure and the corresponding values derived from direct monitoring of the same targeted groups, the ratio varies from about 0.4 to 1.3. Thus, the comparison shows very good agreement between the two sets of data.

Table. Comparison between estimated absorbed doses to the thyroid (median values) and measured doses (mGy)

Area	20 years old (adults) *1		1 year old (infants)	
	Estimated doses	Measured doses	Estimated doses	Measured doses
Iwaki City	1.2		2.6	4.6(55) *2
Kawamata Town	0.95		2.1	4.5(286) *2
Iitate Village	1.4		2.8	7.1(79) *2
Namie Town[a]	22	21(6) *2	41	
Minamisoma City[a]	5.8	6.5(15) *2	12	10(1) *2
Tamura City	0.50	1.2(1) *2	1.2	

a: Excluding evacuees immediately after the accident
*1: Estimated doses for 10-year-old children are omitted here.
*2: Figures in the parentheses are the numbers of the subjects for the measurements.

2. The sums of the doses from inhalation and ingestion intakes of Cs-134 and Cs-137 estimated by the UNSCEAR are broadly in agreement with the committed effective doses obtained through the WBC measurements targeting residents in Fukushima Prefecture.

A comparison has been made between estimated doses in the UNSCEAR 2020/2021 Report and measured doses through thyroid measurements conducted in Fukushima Prefecture immediately after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. Additionally, a comparison with the results of the WBC measurements of Cs-134 and Cs-137 has also been made.

As shown in the Table above, these measured data and estimates by the UNSCEAR are almost the same.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraph A136 on pages 180 to 181 and paragraph A140 on page 183, ANNEX B)

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Assessments by International Organizations

UNSCEAR 2020/2021 Report (7/8): Assessment of Health Effects on the General Public

- In the years since the publication of the UNSCEAR 2013 Report, no adverse health effects among Fukushima Prefecture residents have been documented that are directly attributable to radiation exposure from the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS.
- No acute health effects that could have been attributed to radiation exposure had been reported.
- Currently available methods would most likely not be able to demonstrate an increased incidence in the future disease statistics due to irradiation.
- The UNSCEAR's updated statistical power analyses suggest that excess thyroid cancer risk that could be inferred from radiation exposure was most likely not discernible in any of the age groups considered.
- These observations suggest that the increased incidence rates may be due to over-diagnosis (i.e., detection of thyroid cancer that would not have been detected without the screening and would not have caused symptoms or death during a person's lifespan).

The UNSCEAR assessed public health effects as indicated above based on its exposure dose assessment.

A substantial number of thyroid cancers have been detected among exposed children. However, the excess does not appear to be associated with radiation exposure, but rather a result of the application of highly sensitive ultrasound screening procedures. The reasons are as follows:

(a) no excess of thyroid cancer has been observed in those exposed before age 5 in Fukushima Prefecture, in contrast to the large excess observed in the same age group exposed as a result of the Chornobyl accident; and

(b) thyroid cancers were observed within 1 to 3 years after exposure following the accident in Fukushima Prefecture rather than beginning 4 to 5 years after exposure as in Chornobyl and other radiation studies.

There has been no credible evidence of excess congenital anomalies, stillbirths, preterm deliveries or low birthweights related to radiation exposure. Increases in the incidence of cardiovascular and metabolic conditions have been observed among those evacuated following the accident but are probably associated with concomitant social and lifestyle changes and are not attributable to radiation exposure.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraphs 213, 215, and 225 on pages 84 to 88 and paragraphs 244 to 248 on pages 96 to 97, ANNEX B)

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Assessments by International Organizations

UNSCEAR 2020/2021 Report (8/8): Comparison between Various Attributes and Consequences of the Accidents at Chornobyl and Fukushima Daiichi NPSs

	Chornobyl NPS Accident	Fukushima Daiichi NPS Accident
Thyroid doses of evacuees for the first one year following the accident	Around 500 mSv	Around 0.8 – 15 mSv (adults)
Effective doses of evacuees for the first one year following the accident	Around 50 mSv	Around 0.05-6 mSv (adults)
Thyroid cancers	Substantial fraction of the 19,000 thyroid cancers observed (up to 2016) among people who were children or adolescents at the time of the accident is attributable to radiation exposure.	• Greater incidence of thyroid cancer and abnormalities was observed in those screened than were expected based on national statistics. • It is most likely the result of using high resolution ultrasound in the screening. • There is an increasing body of evidence that the observed thyroid cancers are not attributable to radiation exposure.
Other effects (e.g., other cancers, birth defects, fetal deaths, non-cancer diseases, etc.)	There is no persuasive evidence of any other health effect attributable to radiation exposure at Chornobyl NPS or Fukushima Daiichi NPS.	

The UNSCEAR 2020/2021 Report compiles major characteristics and features of the accidents at Fukushima Daiichi NPS and Chornobyl NPS, as well as estimated exposure doses and health effects due to these accidents regarding radiation workers and the general public. Results of the comparison concerning some items are shown in the table above.

The Report states that the consequences of the accident at Fukushima Daiichi NPS were much milder than those at Chornobyl NPS. As one of the reasons, it points out that the reactors at Fukushima Daiichi NPS had specifically designed containments within which most of the radionuclides released from the molten fuel were retained; by contrast, the reactor at Chornobyl NPS did not have a containment and the core was directly exposed to the atmosphere as a result of the explosion that occurred at the beginning of the accident. Additionally, cited major reasons include the rates of dispersed radionuclides deposited over the ocean and those deposited over the land mass, the transfer of radionuclides to agricultural products, the binding or fixation of radioactive cesium in soil, protective measures in respect of people and foodstuffs after the accidents, and differences in the regulations.

[Relevant parts in the Report]

- UNSCEAR 2020/2021 Report (prepared based on paragraph B1 on pages 189 to 198, ANNEX B)

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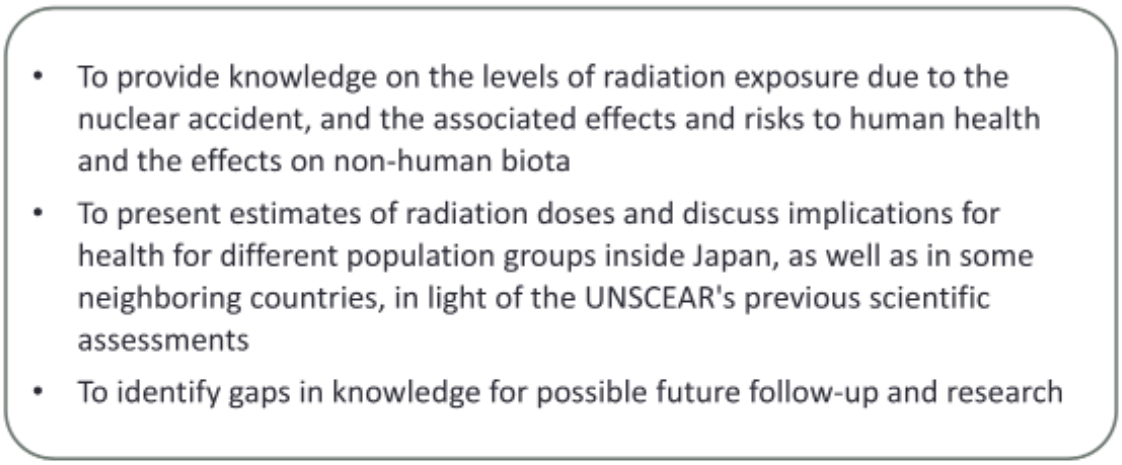
Assessments by International Organizations

UNSCEAR 2013 Report (1/3): Purpose of the Report [Reference]



The UNSCEAR 2013 Report "Volume I, Scientific Annex A: Levels and Effects of Radiation Exposure due to the Nuclear Accident after the 2011 Great East-Japan Earthquake and Tsunami" was prepared for the following three purposes as shown above.

As stated in the Introduction of the Report, at its fifty-eighth meeting (in May 2011), the UNSCEAR decided to carry out, once sufficient information was available, an assessment of the levels of exposure and radiation risks attributable to the nuclear power plant accident following the great east-Japan earthquake and tsunami, and published the Report in April 2014.

The Report is based on prefectural data and government organizations' data released in Japan up to September 2012, and other data and documents provided by UN member countries other than Japan and by international organizations such as the International Atomic Energy Agency (IAEA) and the WHO. Additionally, new important information obtained by the end of 2013 was also taken into consideration to the extent possible.

The outline of the assessment of exposure doses in the UNSCEAR 2013 Report is as follows.

- The assessment was based on measurement data as far as possible.
- Doses that the public received for the first one year after the accident were assessed.
- The assessment targeted 20-year-old adults, 10-year-old children and 1-year-old infants
- Projections were also made of doses to be received over the first 10 years and up to age 80 years.
- Models were used, with realistic assumptions, to provide an objective evaluation of the situation.
- Protective actions taken during the first year were considered and the doses averted by them were estimated.

[Relevant parts in the Report]

- UNSCEAR 2013 Report (prepared based on paragraph 8 on page 27, paragraphs 3 to 4 on pages 25 to 26, and paragraph 12 on page 27, Scientific Annex A)

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Assessments by International Organizations

UNSCEAR 2013 Report (2/3): Data Used for Assessment of Public Exposure Doses [Reference]

Used measurement values, etc.

1. Internal exposure through inhalation and external exposure
   - (i) Deposition densities of radioactive materials on the ground surface measured on earth and from aircraft
   - (ii) Radioactivity concentrations in the air and on the ground surface estimated based on types and estimated amount of radioactive materials released from the reactor and through diffusion simulation
2. Internal exposure through ingestion
   - Radioactivity concentrations in foods and drinking water
     - (i) First year: Measurement data for concentrations of radionuclides in distributing foods and drinking water
     - (ii) Second year onward: Radioactivity concentrations in foods estimated through simulation based on soil contamination data; For marine products, radioactivity concentrations in seawater estimated based on measurement data in the sea area off Fukushima Prefecture and through diffusion simulation of radionuclides
   - Japanese people's food intake (based on the National Health and Nutrition Survey)

Out of the radioactive materials released due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, Iodine-131, Cesium-134, and Cesium-137 are considered to have mainly contributed to people's exposure.

Doses can be assessed most reliably through the measurement using personal dosimeters in the case of external exposure and the measurement using whole-body counters in the case of internal exposure. Such data was partially available regarding the accident at the NPS but was not sufficient for calculating internal exposure doses for all people in Fukushima Prefecture as a whole and in other prefectures.

Therefore, the UNSCEAR conducted dose estimation based on the data indicated above and used other measurement data for verifying the calculation results.

[Relevant parts in the reports]

- UNSCEAR 2013 Report (prepared based on paragraphs 67 to 78 on pages 48 to 50, Scientific Annex A, Appendix A, and "IV. TRANSPORT AND DISPERSION IN THE OCEAN" of Appendix B)

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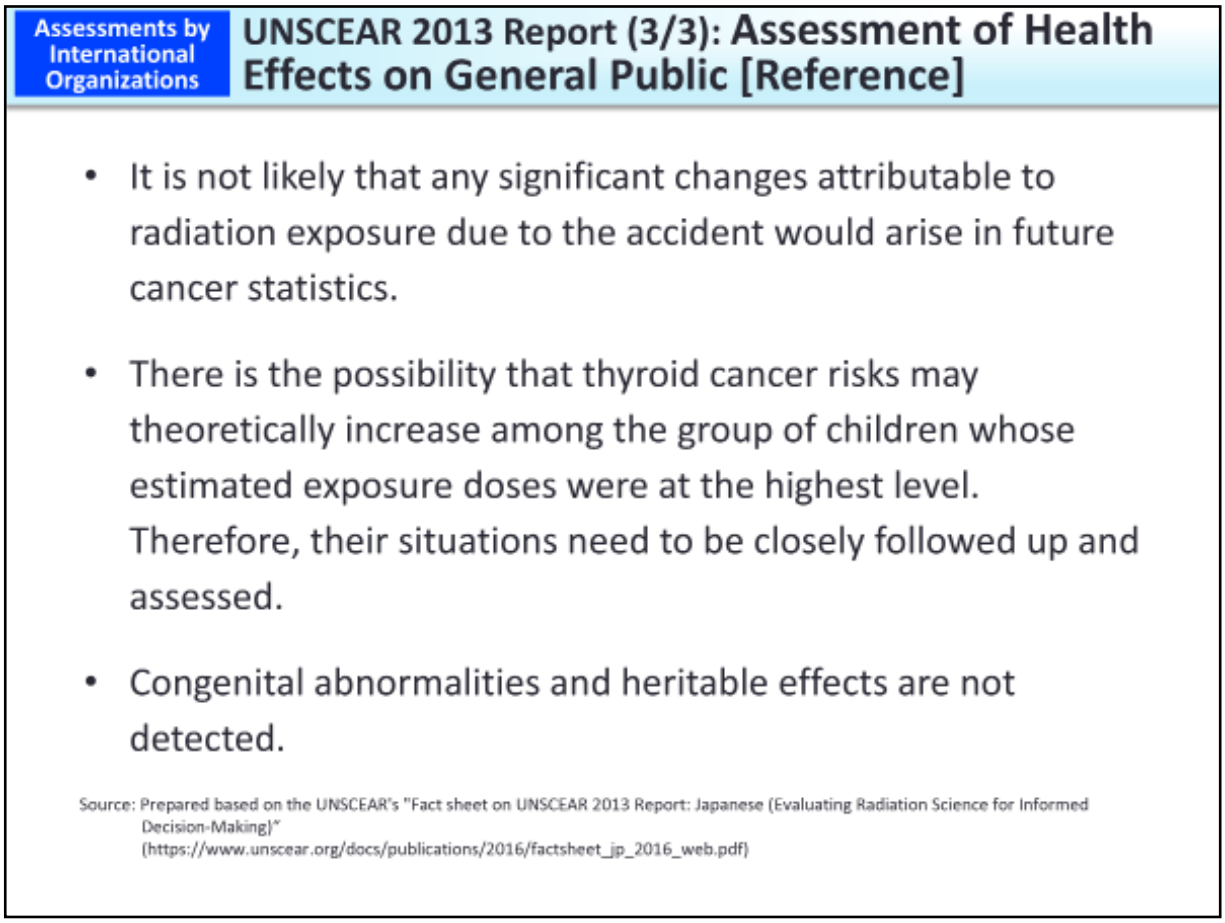


The UNSCEAR assessed public health effects as indicated above based on its exposure dose assessment.

Assessment concerning risks of specific types of cancer and other diseases is as follows.

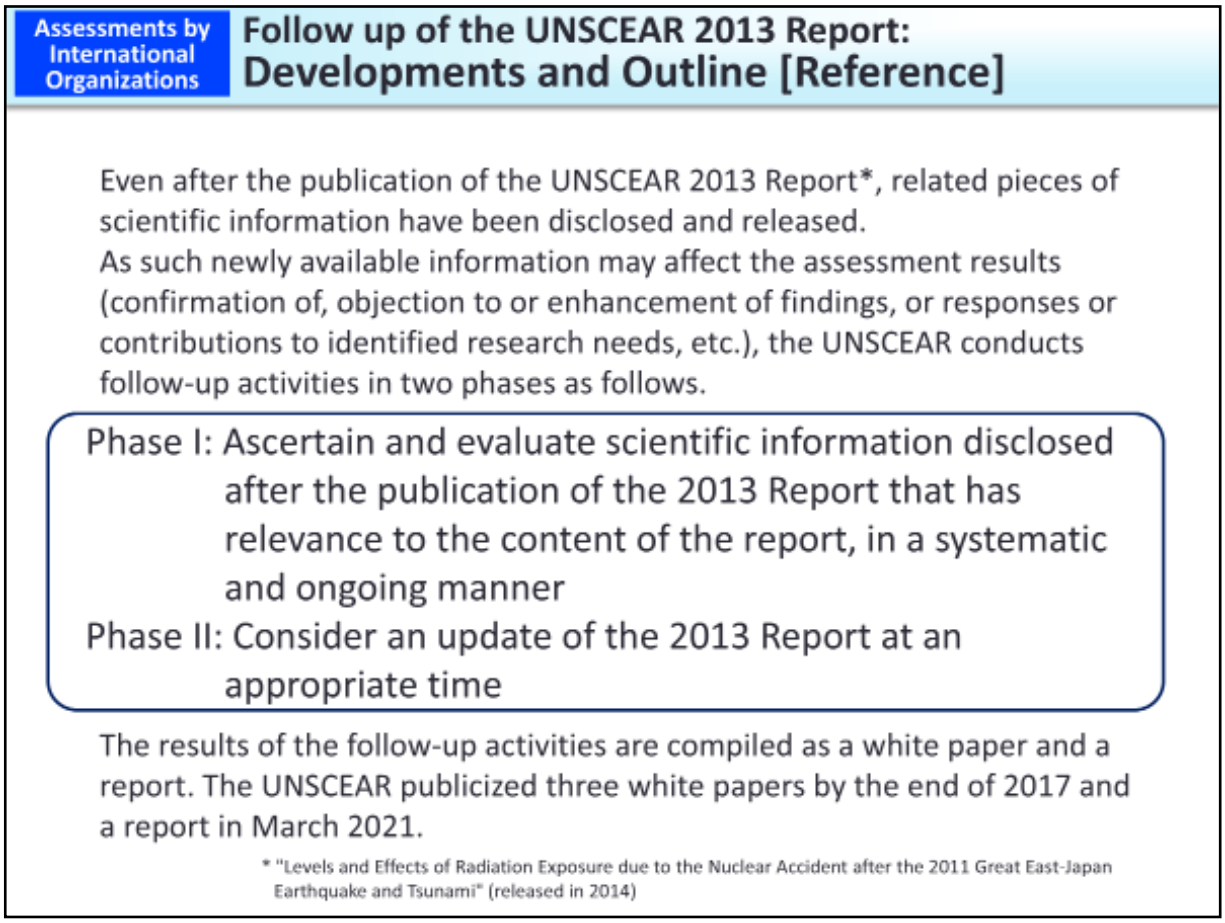
- Thyroid cancer: Most of the doses were in a range for which an excess incidence of thyroid cancer due to radiation exposure has not been confirmed. However, absorbed doses to the thyroid towards the upper bounds could lead to a discernible increase in the incidence of thyroid cancer among sufficiently large population groups. Nevertheless, the occurrence of a large number of radiation induced thyroid cancers in Fukushima Prefecture—such as occurred after the Chornobyl NPS Accident—can be discounted, because absorbed doses to the thyroid after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS were substantially lower than those after the Chornobyl NPS Accident.
- Leukemia: The UNSCEAR considered the risk to those exposed as fetus embryo during pregnancy, and during infancy and childhood, and concluded that no discernible increases in the incidence of leukemia among those groups are expected.
- Breast cancer: The UNSCEAR considered the risk to those exposed at the stage of youth, and concluded that no discernible increases in the incidence of breast cancer among those groups are expected.
- Exposure during pregnancy: The UNSCEAR does not expect any increases in spontaneous abortion, miscarriages, perinatal mortality, congenital effects or cognitive impairment resulting from exposure during pregnancy, nor does it expect any discernible increases in heritable diseases among the descendants of those exposed from the accident at TEPCO's Fukushima Daiichi NPS.

The UNSCEAR states that their assessment of public exposure doses due to radioactive materials from the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS contains uncertainties because the assessment was premised on certain assumptions based on insufficient knowledge and information.

[Relevant parts in the Report]

- UNSCEAR 2013 Report (prepared based on paragraphs 220 and 222 to 224 on page 89, Scientific Annex A)

Included in this reference material on March 31, 2015
Updated on March 31, 2024



New pieces of information released since the publication of the UNSCEAR 2013 Report may affect the assessment results of the UNSCEAR (confirmation of, objection to or enhancement of findings, or responses or contributions to identified research needs, etc.). Therefore, the UNSCEAR conducted ongoing follow-up activities to collect and evaluate such pieces of information systematically. The results of the follow-up activities have been compiled as three white papers published by the end of 2017 and as the 2020/2021 Report published in March 2021 (p.191 of Vol. 1, "Changes in International Organizations' Assessments").

These White Papers fairly analyze new pieces of scientific information from the perspective of whether they materially affect the conclusions of the 2013 Report or whether they respond to research needs identified in the 2013 Report. A total of over 300 publications released since October 2012 was reviewed in these three White Papers.

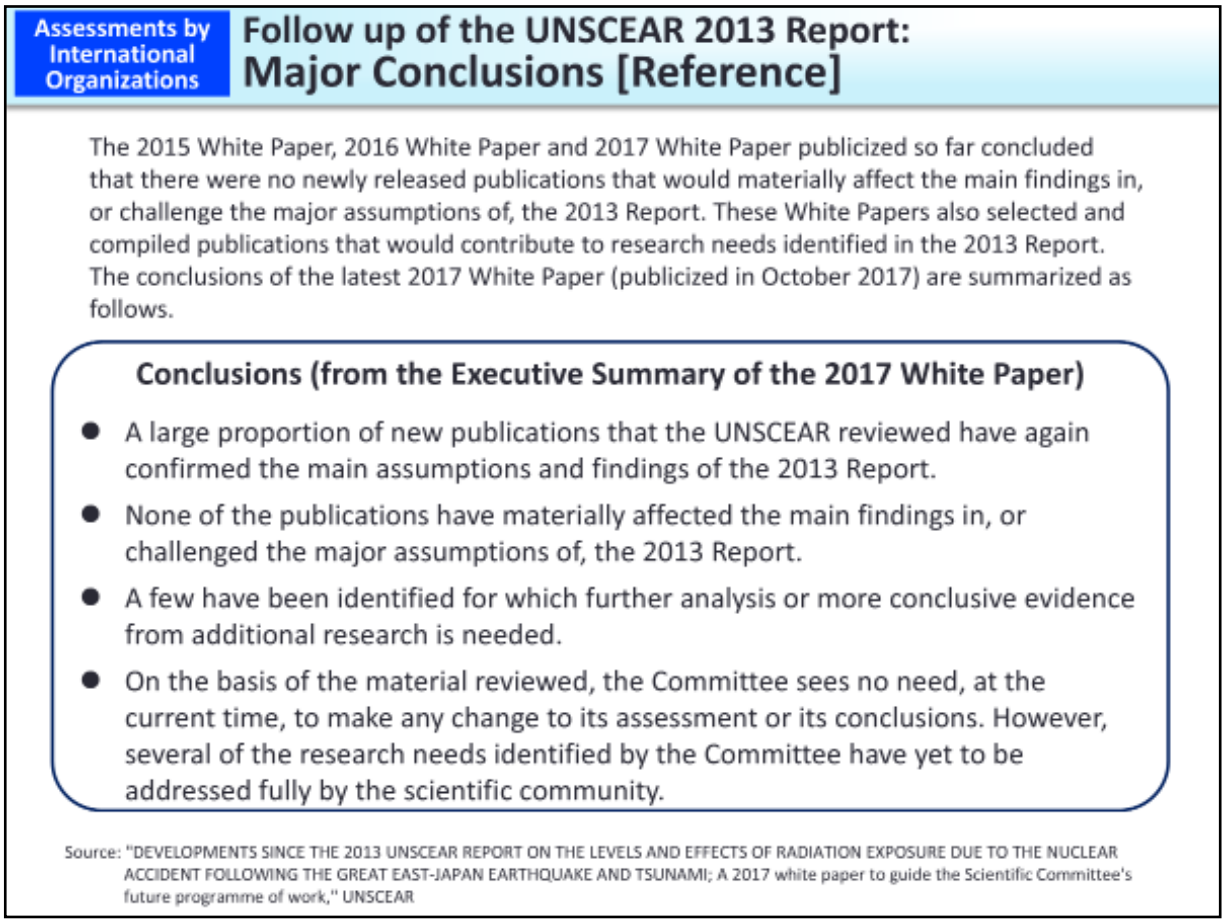
Major subjects include the following.

- Release and diffusion of radioactive materials in the air and in water areas
- Transfer of radionuclides in land areas and freshwater environment (newly added in the 2016 White Paper)
- Evaluation of public exposure and occupational exposure
- Health effects on radiation workers and general public
- Doses and effects for non-human biota

Source

- "Fukushima 2015 White Paper," UNSCEAR
  https://www.unscear.org/unscear/uploads/documents/publications/UNSCEAR_2015_WP.pdf
- "Fukushima 2016 White Paper," UNSCEAR
  https://www.unscear.org/unscear/uploads/documents/publications/UNSCEAR_2016_WP.pdf
- "Fukushima 2017 White Paper," UNSCEAR
  https://www.unscear.org/unscear/uploads/documents/publications/UNSCEAR_2017_WP.pdf
- "UNSCEAR 2020/2021 FUKUSHIMA REPORT," UNSCEAR
  https://www.unscear.org/unscear/uploads/documents/publications/UNSCEAR_2020_21_Annex-B-CORR.pdf

Included in this reference material on March 31, 2017
Updated on March 31, 2024



The 2015 White Paper and 2016 White Paper concluded that there were no newly released publications that would materially affect the main findings in, or challenge the major assumptions of, the 2013 Report.

The 2017 White Paper publicized in October 2017 also concluded that a large proportion of new publications that the UNSCEAR reviewed have again confirmed the main assumptions and findings of the 2013 Report and that none of the publications have materially affected the main findings in, or challenged the major assumptions of, the 2013 Report.

On the other hand, the 2017 White Paper suggests that some publications may potentially challenge the findings of the 2013 Report but states that there are questions over some of the data presented therein that need to be resolved before definitive conclusions can be drawn.

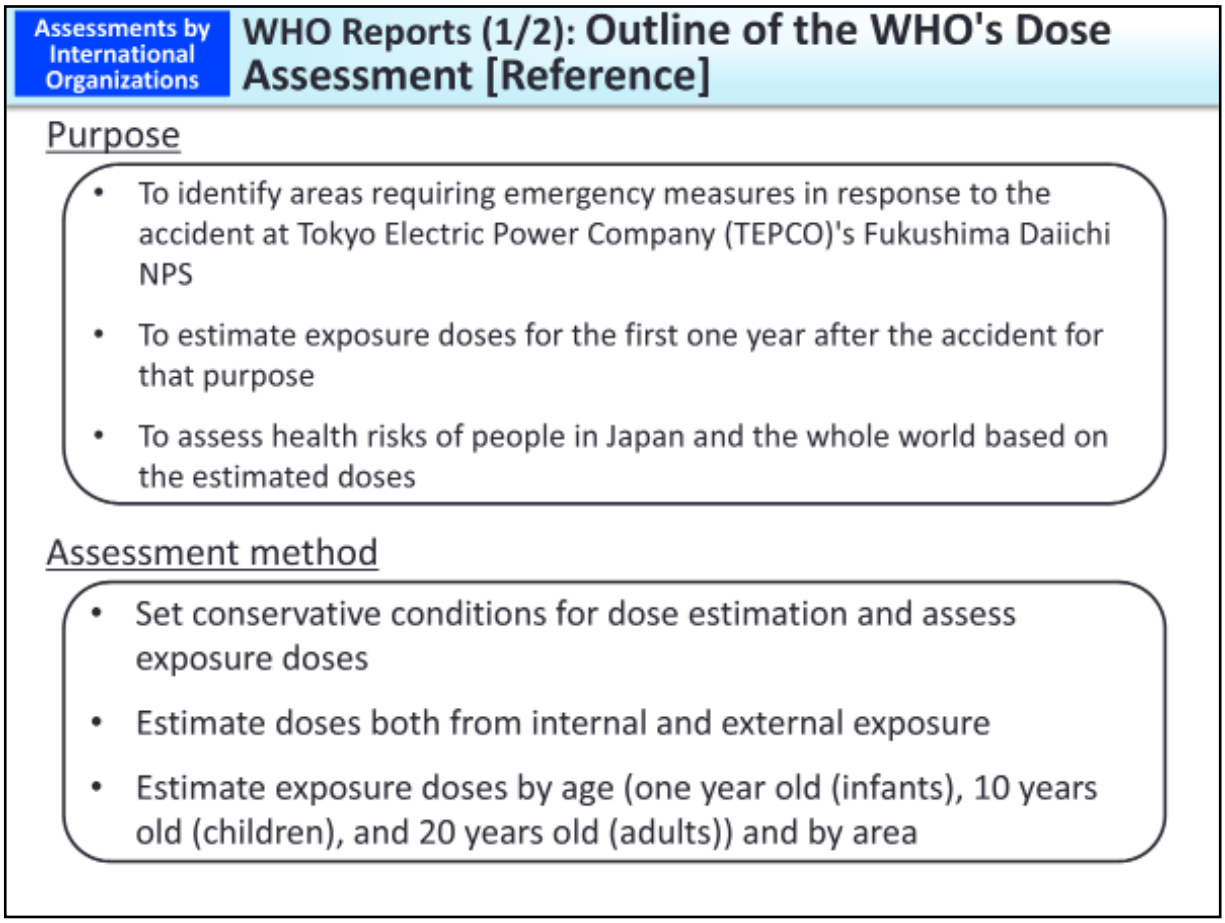
Additionally, it is pointed out that several of the research needs identified in the 2013 Report have yet to be addressed fully as peer-reviewed documents by the scientific community.

On the basis of the material reviewed, the Committee found no need to make any change to its most important conclusions of its 2013 Report, as of the time of the publication of the 2017 White Paper.

[Relevant parts in the reports]

• UNSCEAR 2017 White Paper (extracted from paragraphs 137 to 143 on pages 34 to 38)

Included in this reference material on March 31, 2017
Updated on March 31, 2024



The WHO is an organization responsible for assessing health risks posed by radiation in an emergency. Therefore, after the accident at TEPCO's Fukushima Daiichi NPS, it conducted assessment of exposure doses for the first one year regarding people in Japan and the whole world for the purpose of identifying areas and groups of people for which emergency measures should be taken.

The WHO assessed doses due to exposure to radiation via four pathways: (i) external exposure from the ground surface, (ii) external exposure from radioactive plumes (p.29 of Vol. 1, "Effects of Reactor Accidents"), (iii) internal exposure through inhalation, and (iv) internal exposure through ingestion. Doses due to external exposure via (i) and (ii) and internal exposure via (iii) were estimated through simulation based on information on contamination density on the soil surface as of September 2011, while doses due to internal exposure via (iv) were estimated based on the measurement values for foods and drinking water.

People's exposure doses are to be calculated by summing up estimated values for (i) to (iv), but in order to avoid underestimation, the WHO set conservative assumptions and calculated the largest exposure doses imaginable. Concretely, the WHO adopted the preconditions that protective measures such as deliberate evacuation, sheltering indoors, or shipping restrictions on foods were not at all taken.

As exposure doses vary by area and age, the WHO estimated doses by dividing areas into Fukushima Prefecture, neighboring prefectures (Chiba, Gunma, Ibaraki, Miyagi and Tochigi Prefectures), the rest of Japan, neighboring countries and the rest of the world, and by dividing people by age into those aged one year old (infants), 10 years old (children), and 20 years old (adults) at the time of the accident.

Included in this reference material on March 31, 2015
Updated on March 31, 2023

Assessments by International Organizations

WHO Reports (2/2): Summary of Health Risk Assessment [Reference]

Assumptions for risk assessment

- Assuming that there is no threshold dose for radiation carcinogenesis, the linear model and the linear quadratic model were adopted for dose-response relationships for solid cancer and leukemia, respectively.
- Dose and dose-rate effectiveness factors (DDREF) were not applied.

Results

- People's exposure doses were below all thresholds of deterministic effects (tissue reactions).
- When using a method to avoid underestimation of risks, among people of either gender in a specific age group in the most affected area, the lifetime risk of developing some types of tumors is estimated to increase slightly. However, this merely shows a relative increase against the baseline (lifetime risk of naturally occurring tumors) and does not show an increase of the absolute risk of developing tumors.
- Risks of heritable effects due to radiation exposure are further smaller than the risks of generating cancer.
- The results suggest that increases in the incidence of diseases attributable to the additional radiation exposure are likely to remain below detectable levels.

Conclusion

- Values in this Report are for roughly ascertaining current risk levels and are not intended to predict future health effects.

The WHO's health risk assessment was conducted for the purpose of examining the scopes of people to be subject to health management and diseases whose incidence should be monitored. This assessment was based on exposure doses estimated under considerably conservative assumptions in order to avoid underestimation. Accordingly, resulting values in this Report are for roughly ascertaining current risk levels and are not intended to predict future health effects.

[Relevant parts in the reports]
• WHO Report on preliminary dose estimation (Tables 3 and 4 on pages 44 to 47)
• WHO Report on health risk assessment (pages 8 and 92 to 93, and Table 43 on page 156)

Included in this reference material on March 31, 2015
Updated on March 31, 2024