Nuclear catastrophe in Fukushima

WHO data predicts between 22,000 and 66,000 incidences of cancer in Japan

By Henrik Paulitz, Winfrid Eisenberg, and Reinhold Thiel, 14 March 2013

On 28 February 2013, the World Health Organization (WHO) announced its conclusion that there was no “measurable” increase in cancer risk to be expected as a result of the nuclear catastrophe at Fukushima.[1,2] Soon afterwards, on 6 March 2013, the IPPNW, a medical organization critical of nuclear power and weapons, reported that between 20,000 and 80,000 incidences of cancer from external radiation exposure were to be expected, as well as a further 18,000 to 37,000 cancer cases due to the consumption of contaminated food.[3,4]

For both the public and decision-makers, such contradictory announcements quickly became a matter of faith. However, the availability of reliable information and comparable assessments on the consequences of such a nuclear catastrophe are essential for the political policy making process. This IPPNW information is therefore intended to show that utilizing the WHO data and assumptions, one arrives at comparable figures for the incidence of illness as those arrived at by the IPPNW.[5]

[1] World Health Organization (WHO): Global report on Fukushima nuclear accident details health risks. News release. 28 February 2013. Geneva. S. 35. http://www.who.int/mediacentre/news/releases/2013/fukushima_report_20130228/en/index.html. Letzter Zugriff 12.03.2013.

[2] Vgl. hierzu kritisch: Rosen, Alex: Critical Analysis of the WHO’s health risk assessment of the Fukushima nuclear catastrophe. German Section of the International Physicians for the Prevention of Nuclear War (IPPNW). March 1 2013. http://www.ippnw.de/commonFiles/pdfs/Atomenergie/Fukushima/WHO_Fukushima_Report2013_Criticism_en.pdf. Letzter Zugriff 13.03.2013.

[3] IPPNW: Gesundheitliche Folgen von Fukushima. IPPNW-Presseinformation vom 6.3.2013. http://www.ippnw.de/startseite/artikel/5c295cd947/gesundheitliche-folgen-von-fukushima-2.html. Letzter Zugriff 12.03.2013.

[4] Paulitz, Henrik; Eisenberg, Winfrid; Thiel, Reinhold: Atomkatastrophe in Japan. Gesundheitliche Folgen von Fukushima. IPPNW Informationen zu Atomenergie und Energiewende. 6. März 2013. Report der Deutschen Sektion der Internationalen Ärzte für die Verhütung des Atomkrieges, Ärzte in sozialer Verantwortung e.V. (IPPNW). http://www.ippnw.de/commonFiles/pdfs/Atomenergie/Fukushima/Gesundheitliche_Folgen_Fukushima_dt.pdf. Letzter Zugriff 12.03.2013.

[5] Das methodische Vorgehen wurde in Absprache mit Dr. Alfred Körblein aus Nürnberg entwickelt.

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Note to payee: „IPPNW-Information“

Dose exposure for the Japanese population in the first year

Employing the preliminary dose estimation published in 2012[6], the WHO "Health risk assessment" report begins with the following dose exposure for the Japanese population in the first year after the nuclear catastrophe:[7]

- "Group 1: the two locations within Fukushima prefecture with effective doses of 12–25 mSv;
- Group 2: locations in Fukushima prefecture where effective doses are between 3 and 5 mSv;
- Group 3: the less-affected locations of Fukushima prefecture and the rest of Japan, where effective dose values are around 1 mSv;"

Group 1 comprises only the city of Namie and the community of Iitate (Fukushima Prefecture), which together had a population of around 28,900 residents (before the nuclear catastrophe).

Group 2 comprises a further 12 cities and communities in the Fukushima Prefecture with a total of around 929,000 residents before the nuclear catastrophe, including the city of Koriyama (over 300,000 residents) and Fukushima City (close to 300,000 residents).[8]

Group 3 comprises the remaining regions of the Fukushima Prefecture, the neighbouring prefectures[9] of Chiba, Gunma, Ibaraki, Miyagi, and Tochigi, as well as the rest of Japan.[10]

Despite the information that a dose exposure of 1 mSv for the first year following the accident should be assumed for the whole of the rest of Japan (Group 3), this analysis takes results from other locations, according to which the dose exposure in Japan – with the exception of Fukushima and its neighbouring prefectures – was calculated at between only 0.1 und 1 mSv (geometric mean: 0.32 mSv):[11]

- "In prefectures neighbouring Fukushima, the estimated effective doses are within a dose band of 0.1–10 mSv.
- In all other Japanese prefectures, the effective doses are estimated to be within a dose band of 0.1–1 mSv."

WHO assumptions on lifetime doses subject to considerable uncertainties

The dose exposure assumed by WHO is based on official data collected until mid-September 2011. It is on the basis of this data that an estimation was made of the first-year dose exposure for the Japanese population.[12]

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[6] World Health Organization (WHO): Preliminary dose estimation from the nuclear accident after the 2011 Great East Japan earthquake and tsunami. Geneva. 2012. Accessed 28 December 2012. http://www.who.int/ionizing_radiation/pub_meet/fukushima_dose_assessment/en/index.html.

[7] World Health Organization (WHO): Health risk assessment from the nuclear accident after the 2011 Great East Japan Earthquake and Tsunami based on a preliminary dose estimation. 2013. S. 37. http://www.who.int/iris/bitstream/10665/78218/1/9789241505130_eng.pdf. Letzter Zugriff 12.03.2013.

[8] Weiterhin zählen zur Gruppe 2 der WHO die Städte Minami Soma, Naraha, Date, Nihonmatsu, Kawamata, Hirono, Tamura und Soma, sowie die Gemeinden Katsurao und Kawauchi.

[9] WHO 2013, aaO. S. 43.

[10] WHO 2013, aaO. S. 39.

[11] WHO 2013, aaO. S. 39.

[12] WHO 2013, aaO. S. 40.

WHO concedes that after the first year following the accident, the determination of lifetime doses is subject to considerable uncertainties. Experience in the wake of Chernobyl has shown that the dose exposure after the first year is significantly dependent on long-lived isotopes such as radiocesium and their migration into the soil. In addition, WHO refers to possible protective measures such as decontamination or a ban on the sale or distribution of contaminated food.[13]

According to the theoretical model employed by WHO, the lifetime dose from external radiation exposure corresponds to seven times the first-year dose.[14] However, on the basis of 20 years of experience after Chernobyl, the UNSCEAR calculates the lifetime dose as being three times the first-year dose.[15]

WHO refers to “a number of measures” that were taken in Japan following the nuclear catastrophe in order to lower radiation exposure, yet it is unable to quantify the reduction.

Despite this extremely vague set of conditions, WHO consequently chose to estimate the lifetime dose at merely twice that of the first-year dose (factor 2).[16]

Linear dose-response relationship for low radiation exposure

In ascertaining the expected incidence of cancer, WHO assumes a dose-response relationship with no threshold.

According to the so-called “Linear No Threshold (LNT) model,” the WHO report explains, cancer must be expected even from low doses of radiation, which leads to a considerable number of cases when a large population is exposed:[17]

> *“For the purposes of radiological protection, the assumption is made that the risk of inducing cancer by low doses of radiation is proportional to the dose. The underlying dose-response relationship is linear with no threshold. In other words, radiation exposure is always considered to pose some level of risk (albeit very small at low doses), and the sum of several very small exposures is assumed to have the same effect as one larger exposure of the same overall magnitude.”*

Interestingly, there is no use in the WHO report of any reduction factor (DDREF) for the effects of radiation at low doses or dose rates. The assumed risk factor of 0.1/Sv is thereby twice as high as that employed by the ICRP-60:[18]

> *“The question therefore arises as to whether the risk estimates for the atomic bomb survivors are applicable to populations that have accumulated radiation doses on the order of 100 mGy or below over a long time. Thus far, radiobiological research has provided ambiguous answers to this question. Based on the findings of the two meta-analyses discussed above (74,92), which showed similar risks for protracted and acute exposures, the HRA Expert Group considered it prudent to base risk calculations on models derived from the atomic bomb survivors cohort without applying any modification factor for low dose or low dose rate.”*

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[13] WHO 2013, aaO. S. 40 f.

[14] WHO 2013, aaO. S. 44.

[15] Vgl. UNSCEAR 2008 report to the General Assembly, with scientific annexes. Health effects due to radiation from the Chernobyl accident, 2011.

[16] WHO 2013, aaO. S. 44.

[17] WHO 2013, aaO. S. 25.

[18] WHO 2013, aaO. S. 32.

WHO thereby assumes a risk factor of EAR/Sv=0.1/Sv for the expected number of cancer deaths (mortality).

Determining the expected number of cancer cases

The number of expected cases of cancer resulting from the Fukushima nuclear catastrophe is estimated using the given first-year dose exposure, which, according to the assumptions made by WHO, result in a lifetime dose at merely twice that amount and a risk factor of 0.1/Sv for cancer mortality and 0.2/Sv for cancer incidence.

Table 1: Expected cases of cancer due to Fukushima on the basis of data and assumptions from the World Health Organisation (WHO)

Region	Population [number]	Individual 1-year dose according to WHO [mSv]	Geometric mean of individual doses [mSv]	Collective dose [PSv]	Cases [number]
2 locations in Fukushima Prefecture (Group 1)	28,926	12 - 25	17.32	501	
12 locations in Fukushima Prefecture (Group 2)	929,423	3 - 5	3.87	3597	
Rest of Fukushima Prefecture	1,002,174	1	1	1002	
Chiba Prefecture	6,195,643	1	1	6196	
Gunma Prefecture	1,992,143	1	1	1992	
Miyagi Prefecture	2,326,957	1	1	2327	
Tochigi Prefecture	1,993,479	1	1	1993	
Ibarki Prefecture	2,946,020	1	1	2946	
Total for Fukushima and neighbouring prefectures	17,414,765			20,554	
Rest of Japan	109,244,918	0.1 - 1	0.316	34,546	
Total	126,659,683				
First-year collective dose				55,101	
Lifetime dose (2 x 1-year dose)				**110,201**	
Expected cancer deaths (mortality), with EAR/Sv=0.1/Sv					11,020
Expected cases of cancer (incidence)					**22,040**
Data and assumptions from WHO, calculations by Dr. Alfred Körblein and Henrik Paulitz/IPPNW					

The collective doses (person-sieverts) were thereby calculated for the four zones with differing radiation contamination[19], and the upper average values for individual radiation doses were multiplied with the corresponding population figure. The number of expected cancer cases is arrived at by multiplying the collective doses with the risk factor (see Table 1).

Employing the WHO data and its assumptions, the lifetime dose for the Japanese population is calculated at 110,201 person-sieverts, resulting in an expected 11,020 deaths due to cancer (mortality) and 22,040 cancer illnesses (incidence).

Modification of the lifetime dose and the risk factor

As mentioned above, the experiences of Chernobyl indicate that it is entirely realistic to calculate the lifetime dose as the equivalent of three times the first-year dose.

With this in mind, an alternative estimation has been calculated employing a factor of 3, as was the case following the Chernobyl disaster.

It should also be borne in mind that the risk factor of 0.1/Sv for mortality in all probability underestimates the risk involved. More recent studies indicate a higher risk that is greater by around a factor of two, resulting in a doubling of the figure of estimated illnesses.[20,21]

Table 2: Expected number of cancer based on the WHO data and adjustments of the lifetime dose and risk factor

Collective first-year dose [PSv]	55,101
Lifetime dose (3 x 1-year dose) [PSv]	165,302
Expected cases of cancer death (mortality), with EAR/Sv=0.2/Sv	33,060
Expected cases of cancer (incidence)	**66,121**
Data from WHO, calculations by Dr. Alfred Körblein and Henrik Paulitz/IPPNW	

As Table 2 indicates, applying these potentially more realistic assumptions to the data provided by WHO, calculations indicate that 66,121 cases of cancer (incidence) can be expected in the Japanese population.

Conclusion

It has been demonstrated that under the assumptions and data of the WHO report, some 22,000 cases of cancer should be expected in the Japanese population as a result of external radiation and the consumption of contaminated food.

However, when the factor to determine the lifetime dose is based on the experience of Chernobyl and the most recent scientific research, the number of expected cancer cases calculated with the WHO data rises to around 66,000.

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[19] Vgl. Körblein, Alfred: Strahlentelex Nr. 610-611. 7. Juni 2012. Fußnote 4. S. 2. http://www.strahlentelex.de/Stx_12_610_S01-02.pdf. Letzter Zugriff 12.03.2013.

[20] Bauer S, Gusev BI, Pivina LM, Apsalikov KN, Grosche B. Radiation exposure due to local fallout from Soviet atmospheric nuclear weapons testing in Kazakhstan: solid cancer mortality in the Semipalatinsk historical cohort, 1960-1999. Radiat Res. 2005 Oct;164(4 Pt 1):409-19. PubMed PMID: 16187743. http://www.ncbi.nlm.nih.gov/pubmed/16187743. Letzter Zugriff 04.03.2013.

[21] Körblein A, Hoffmann W. Background radiation and cancer mortality in Bavaria: an ecological analysis. Arch Environ Occup Health. 2006 May-Jun;61(3):109-14. PubMed PMID: 17672352.

Employing other official sources of data and data from recognized scientific journals, the IPPNW study “Health consequences resulting from Fukushima” calculated between 38,000 and 60,000 expected cases of cancer due to external and internal (contaminated food) radiation exposure.

Employing a risk factor corresponding to the most recent research, IPPNW has calculated between 75,000 and 120,000 expected cases of cancer.

In total, the results calculated by the IPPNW are approximately twice as high as the figures based on the WHO data.

The differences in the final figures are logically derivable and can be understood to depend on

- the database (dose exposure from external and internal radiation)
- the factor used to determine the lifetime dose
- the risk factor employed in the calculations (determination of illness figures based on the lifetime dose).

All of the data, factors in determining the lifetime dose, and the chosen risk factors that have been used in these calculations are realistic and scientifically verifiable on the basis of the most current (publically available) findings.

Both the WHO report as well as that published by IPPNW concur in the conclusion that tens of thousands of cancer cases must be expected in Japan as a result of the Fukushima nuclear catastrophe. The range lies between 20,000 and 120,000 cases of cancer.