NRPA Bulletin

Statens strålevern

Radioactive contamination in reindeer herders

When the Chernobyl fallout reached Norway in spring 1986, national radiation protection authorities had over 20 years of experience in monitoring of reindeer herders in Kautokeino, northern Norway. This monitoring was initiated as surveillance of radiation doses to population groups being vulnerable to the fallout from the nuclear weapons testing in the 1950s and 1960s. After the Chernobyl fallout the monitoring was extended to also include reindeer herders from the heavily contaminated areas in central Norway.

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As early as the start of the 1960s it was shown that persons with high consumption of reindeer meat contained particularly high concentrations of radioactive caesium. Therefore, monitoring of caesium-137 in reindeer herders in Kautokeino, northern Norway was initiated in 1965 (Figure 1). The monitoring of this vulnerable group is still ongoing.

Measurement of body content of caesium-137 in a Kautokeino lady in the 1970s

The Chernobyl accident

The 1986 Chernobyl accident resulted in fallout of considerable amounts of radioactive substances, including caesium-137, over large parts of Europe, including Scandinavia. In Norway, the mountainous areas in southern and central Norway, were particularly contaminated. The consequences were extensive, since uncultivated forest and mountain areas in these parts of the country are important grazing areas for various livestock, e.g. reindeer. In comparison the 1986 fallout in the Kautokeino areas was small, and the Chernobyl accident therefore had only minor effects on reindeer herding in the northernmost parts of Norway.

Participants

The pre-Chernobyl monitoring only included reindeer herders in Kautokeino. In 1987 the monitoring programme was extended by four additional population groups. The reindeer herders in central Norway were the most contaminated of these groups, and this group is still being monitored. As indicated in Figure 1 the survey participants in Kautokeino were recruited from a geographically relatively limited area, whereas the surveys in central Norway includes persons from the whole South Saami area in the counties Nordland, Nord-Trøndelag, Sør-Trøndelag and Hedmark.

Figure 1. *Map of reindeer herding areas in Norway (green areas). The red circles indicate the areas included in the monitoring of reindeer herders.*

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Radioactive caesium in reindeer herders

Radiocaesium concentrations in reindeer herders in Kautokeino have decreased continuously since the monitoring started in 1965, only interrupted by a doubling of concentrations from 1986 to 1987 as a consequence of the Chernobyl fallout. However, during the whole post-Chernobyl period the concentrations of caesium-137 in reindeer herders in Kautokeino have been much lower than in central Norway (Figure 2).

Although the Chernobyl fallout in magnitude was much larger than the atmospheric nuclear weapons test fallout, average concentration levels in the reindeer herders in the South Saami area have not exceeded those in Kautokeino in the 1960s. This is due to use of a wide range of countermeasures, such as slaughtering of reindeer in autumn instead of winter, clean feeding (i.e., feeding livestock uncontaminated fodder the last weeks prior to slaughter), selection of less contaminated reindeer for domestic consumption, and particularly dietary advice. Many reindeer herders changed their traditional ways of living due to the Chernobyl accident. Without these measures the radiation doses would have been up to 10 times higher.

Contrary to the decrease in concentrations in Kautokeino during the last years, there was no significant decrease in average concentrations of caesium-137 in reindeer herders in central Norway during the period 1996-2005. This is probably due to less intensive countermeasure application, since caesium-137 concentrations in reindeer meat from most reindeer herding districts have complied with the national intervention limit of 3000 Bq/kg during the last years. Furthermore, caesium-137 concentrations in reindeer meat have also declined more slowly from the late 1990s onwards.

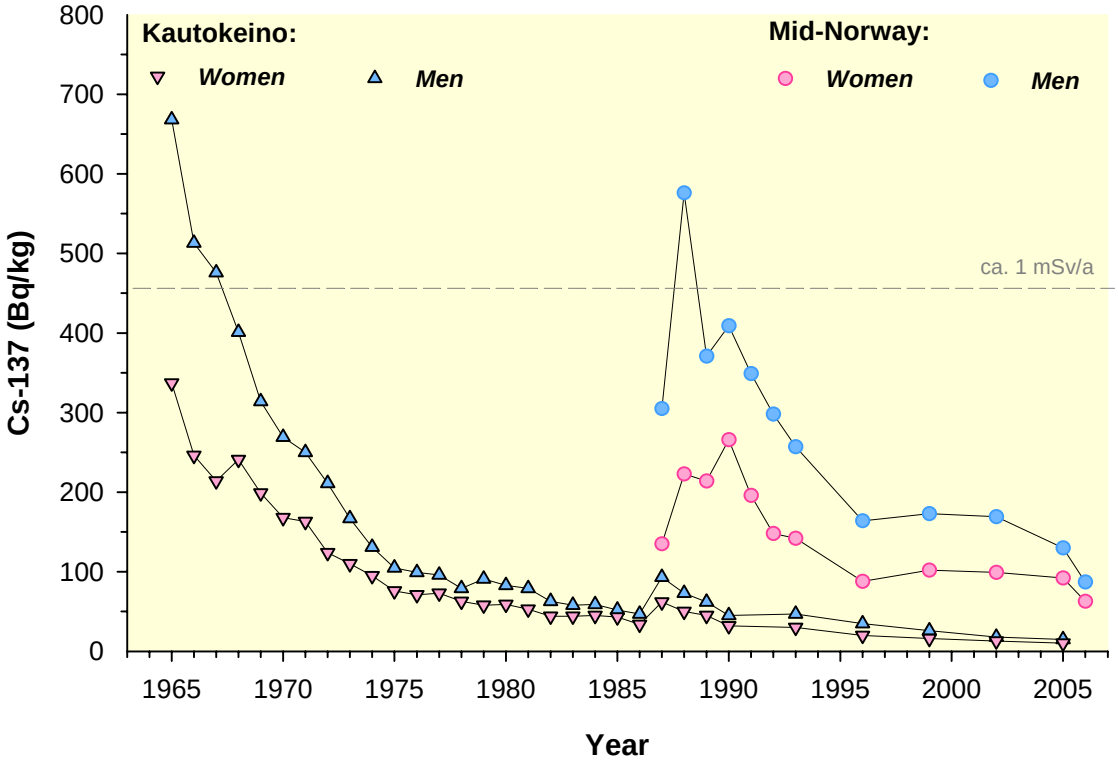

Figure 2. *Average caesium-137 concentrations in reindeer herders from different areas in Norway. The highest concentrations in Kautokeino were observed in 1965, since then concentrations have continuously declined with the exception of the post Chernobyl increase. The South Saamis have only been monitored after the Chernobyl accident, and their maximum concentrations were observed in 1988 (the highest individual concentration was 3500 Bq/kg).*

The last monitoring of reindeer herders, so far, was carried out in central Norway 3 – 7 April 2006. The survey indicated that contamination levels now are declining again, although a considerable fraction of the decrease from 2005 to 2006 can be attributed to larger participation of persons from less contaminated areas.

The distribution of individual concentration values is shown in Figure 3.

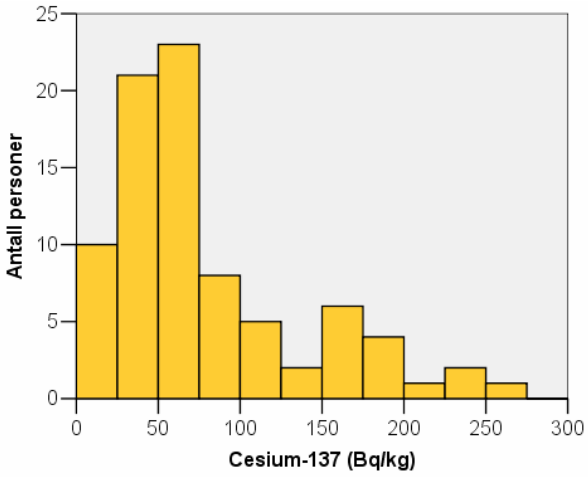

Figure 3. *Distribution of caesium-137 concentrations among reindeer herders in central Norway in 2006. Maximum concentration was 252 Bq/kg, minimum 9 Bq/kg. 90 % of the participants had concentrations below 175 Bq/kg.*

Dietary surveys

In connection with and as a supplement to the monitoring of radioactivity in reindeer herders, several dietary surveys have also been carried out among these population groups in Kautokeino and central Norway. These surveys have focussed on "local" products like reindeer, game, freshwater fish, wild mushrooms, and berries – the sources that contribute most to the ingested radiocaesium. The dietary surveys have confirmed that the main source of radiocaesium in reindeer herders is reindeer meat, contributing about 90 % of the radiocaesium intake in central Norway.

Health consequences

The radiation doses received from radiocaesium by the reindeer herders, as a result of fallout from the nuclear weapons testing and the Chernobyl accident are not large enough to imply any provable health effects (e.g. increased frequency of cancer). A study of cancer frequency in the North Saami population in Norway could not identify any increase in cancer incidence[1]. On the contrary, the study identified lower cancer incidence among the Saamis than the rest of the population (in the same area and in the rest of Norway). This is in agreement with corresponding studies in Sweden and Finland, and is probably explained by the Saamis relatively healthy lifestyle and diet.

Several reindeer herders in central Norway have received larger radiation doses than the North Saamis, since they were exposed to significant Chernobyl fallout in addition to the nuclear weapons test fallout. A study in Sweden[2] indicated a higher cancer incidence in the areas receiving most Chernobyl fallout. A weak point of this study is that is does not separate different population groups, as it is known that diets influence radiation doses more than does the deposition pattern (the importance of diet in dose formation has for instance been demonstrated in a Norwegian post-Chernobyl study[3]).

Although no provable increase in cancer incidence is expected, the Chernobyl accident has had consequences for reindeer herding and Saami culture and lifestyle that must be taken seriously.

References

[1] Haldorsen T, Tynes T (2005). Cancer in the Sami population of North Norway, 1970–1997. Eur. J. Cancer Prev. 14: 63-68.

[2] Tondel et al. (2004). Increase in regional total cancer incidence in north Sweden due to the Chernobyl accident? J. Epidemiol. Community Health 58: 1011-1016.

[3] Strand et al. (1992). Area and time distribution of external and internal doses from Chernobyl fallout: the lack of correlation in Norway. Health Phys. 62: 512-518.

Facts about

Equipment

The Norwegian Radiation Protection Authority (NRPA) has recently equipped a standard container with instruments for monitoring radioactivity in humans. This mobile laboratory is shown in Figure 4, and the monitoring equipment is shown in Figure 5. The container is also equipped with other monitoring equipment that will be necessary in a fallout mapping situation. The mobile laboratory is stationed at NRPA's headquarter near Oslo. In an emergency situation it will be transported to where it is found necessary.

Measurements

The monitoring is carried out in a chair were the persons sit for 10-20 minutes[1] while the body content of radiocaesium is measured (Figure 5). Our surroundings, the environment and also our body will always contain natural radioactive material independent of contamination e.g. from Chernobyl. The detector will however separate radiation from different radioactive nuclides, and the body content of radioactive caesium can therefore be relatively precisely determined.

Recommended limits

Norwegian authorities recommend that doses from radioactive contamination should not exceed 1 mSv/year. This corresponds to caesium-137 concentrations in the body of about 400 Bq/kg.

An annual intake of about 80 000 Bq of radioactive caesium will give an additional dose of ~ 1 mSv.

Figure 4. *NRPA's mobile laboratory applied in the monitoring of reindeer herders*

Figure 5. *Measurement of body content of caesium-137 in a Kautokeino lady in 2005*

[1] Time of measurement will depend on the concentration of radioactive caesium in the body.