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The whole body incorporation of radioactive caesium in Switzerland during the last 30 years: A survey of young persons in Geneva and some measurements of Russian children

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Radioactive caesium incorporation in Europe is due to the atmospheric tests which took place from 1950 to the early 1960s and to the fallout caused by the Chernobyl accident. Due to its relatively long half-life of 30 years, caesium-137 makes the largest contribution to the radiation dose delivered to man in all countries except the USSR, where the iodine-131 (half-life: 8.1 days) released by the power plant has been mainly responsible for the dose to the population [1].

In addition to caesium-137, the isotope caesium-134 was also found to be present in humans after the Chernobyl accident, but because of its much shorter half-life (2.4 years), the Cs-134/Cs-137 ratio decreased rapidly, allowing the contamination due to bomb fallout to be differentiated from that caused by the power plant accident.

During the last 30 years the incorporation of radioactive caesium has been followed in Geneva in students aged 17–19 years by performing annual measurements using the whole body counter facility of the Division of Nuclear Medicine of the University Hospital of Geneva.

Material and methods

A steel room weighing over 50 tons, 2.70 meters long, 1.90 m wide, 2.34 m high, and with walls 18 cm thick, was built in the early 1950s by casting railway lines which had not been used since the late 1920s. The room contains a large detector in the form of a cylindrical crystal of NaI(Tl) (diameter 203 mm, thickness 102 mm) connected to a 4000-channel spectrometer and a VAX-computer. The person for whom the measurement is to be made sits on a tilted chair placed in a position which brings all parts of his body to within about 40 cm of the detector; only the distance between the lower extremities and the crystal is greater, but the use of a phantom allows this geometrical error to be corrected. A counting time of 20 minutes reduces the statistical error to less than 1%.

Since 1962, groups of 40 to 50 healthy volunteers, aged between 17 and 19 years, have been measured each year in this whole body counter, with at least 20 boys and 20 girls on each occasion. The spectrometer allows caesium-137 and caesium-134 to be differentiated from all natural radioisotopes contained in the human body.

A group of 11 year old children from the city of Pinsk in Byelorussia were invited to spend a few weeks in Switzerland during summer 1990. Three of the children and one of their teachers were measured in this same whole body counter, as well as a two year-old child from Kiev who visited his grandparents in Switzerland at about the same time.

Results

The values for caesium-137 found in the boys were higher than in the girls. The mean values for the Geneva youngsters (Figure 1) peaked in 1965, immediately after the atmospheric atomic test ban, and thereafter diminished regularly to barely measurable levels; following the accident of Chernobyl they once again increased to about a third of the 1965 values, and then decreased rapidly. Today the level of caesium-137 is again practically unmeasurable.

The result for the levels of caesium-137 found for the Russian children shows a much wider scatter (Table 1), with the 1990 value definitely higher than the levels found in the Swiss youngsters. The result is even more significant when corrected for body weight, but is still lower than the levels measured in 1965 in the Swiss population.

Discussion

The values found in boys lie about one third higher than those found in girls, but this difference is not really surprising considering that caesium is essentially absorbed within the muscle cells, and since boys have a more developed musculature than girls and a greater lean body mass, it is normal to find higher levels of radioactive caesium in males compared to females. Potassium shows an identical pattern of distribution, so that the caesium-137/potassium ratio remains constant and the difference due to sex disappears. For this reason, the results for the boys and the girls have been combined, and the evolution of the mean value as a function of time is shown in Figure 1.

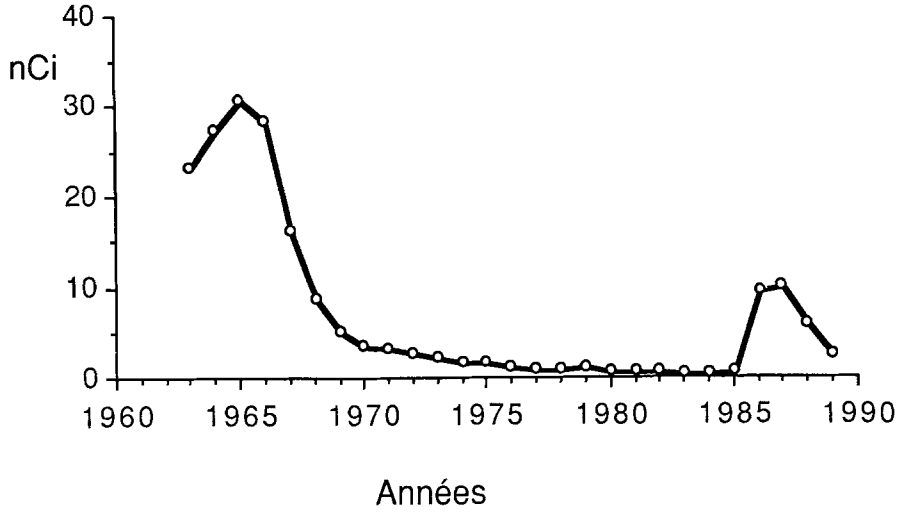

Fig. 1. Body concentration of Cs-137 in Swiss youngsters during the last 30 years.

Tab. 1. Body concentration of Cs-137 in 3 Russian children and 1 adult

Age (years)	Potassium-40 (Bq)	Caesium-137 (Bq)	Radiation dose due to Cs-137 (mSv/y)
10	2146	229	0.011
10	2353	529	0.026
10	2553	866	0.043
31	5084	1795	0.080

Potassium-40 and Caesium-137 incorporation in 1 adult and 3 children from Pinsk measured on Aug. 24th, 1990.
Whole body counter – University Hospital Geneva

Radioactive caesium enters the body with the ingestion of food. The most immediate pathway is the drinking of water and the ingestion of fresh, leafy vegetables and fruits contaminated by direct deposition. Other pathways involve the movement of radionuclides from soil to plants and from plants to animals, thus contaminating milk and meat. Once incorporated, the biological half-life of radioactive caesium in humans is around 3 months, but since everything in the environment will be contaminated, and the ingestion of radioactive caesium is continuous, the overall decrease is somewhat slower. Four to five years after the Chernobyl accident, the level of radioactive caesium has reached the pre-Chernobyl concentration and it is now hardly detectable the Swiss population[2]. At no time was there any restriction on foodstuffs (with the exception of some mushrooms, fish from the lake of Lugano and the giving of fresh milk to newborn infants during the weeks following the accident). The calculation of the radioactive dose due to the Chernobyl accident, including iodine-131 and the two radioisotopes of caesium, yields around 0.2 mSv, amounting to about 4% of the annual natural radiation. It may, however, be of interest to mention that a few people who live in the mountains of Switzerland and eat their own produce have shown concentrations of radioactive caesium ten times higher than the mean value for Switzerland.

In Geneva, and throughout western Europe in general, the radioactive caesium concentration in the human body was about 3 times higher in 1965 than it was in 1986 after the Chernobyl accident. However the fallout from the power plant catastrophe received considerable publicity, influencing the European population in a manner in no way comparable with the situation after the atmospheric testing, which had taken place regularly for many years, and towards the end was hardly mentioned at all by the media[3].

The children from Byelorussia show values which seem relatively low, although they came from one of the most contaminated regions close to Chernobyl, where the consumption of uncontrolled foodstuffs is still forbidden[4]. Their radioactive caesium concentration was much lower than the values reported in the Russian literature[5]. Conclusions similar to ours have been reached by an International Advisory Committee set up by the International Atomic Energy Association. Their results are 3 to 10 times lower than the official estimates of Soviet scientists[6]. Measurements currently being performed by a Swiss group using a whole body counter mounted on a truck also seem to indicate that the Russian evaluation of Caesium incorporation is too pessimistic.

Summary

In a cross-sectional study, each year at least twenty young men and twenty young girls about 18 years old were selected, and the body concentration of Cs-137 was measured in a whole body counter. This radioisotope, with a half-life of 30 years, originates from the atom bomb explosions in the atmosphere, which were stopped in 1963, or from the accident of Chernobyl. The concentrations due to the emissions from this reactor remained below one third of the values due to atomic bombs. The results in children from Byelorussia who spent a few weeks in Switzerland last summer are lower than what would have been expected according to the literature from Russia, but correspond to those recently obtained in situ by international scientific teams.

Résumé

Incorporation de radiocésium en Suisse au cours des 30 dernières années: Étude sur des jeunes gens genevois et quelques mesures sur des enfants russes.
Une étude transversale, impliquant chaque année au moins une vingtaine de jeunes gens et autant de jeunes filles âgés de 18 ans environ, porte sur la mesure à l'aide d'un anthropogammamètre de la teneur de leur corps en césium-137, un radioélément d'une période de 30 ans provenant soit des explosions atomiques dans l'atmosphère, qui ont pris fin en 1963, soit de l'accident de Tchernobyl. Les concentrations dues aux émissions de ce réacteur n'ont pas dépassé le tiers des valeurs dues aux bombes atomiques. Chez des enfants de Byelorussie en vacances l'été passé en Suisse, les valeurs mesurées sont nettement moins élevées que ce qu'annonce la littérature en provenance d'URSS, mais correspondent aux récents résultats obtenus sur place par des équipes scientifiques internationales.

Zusammenfassung

Radiocaesium-Inkorporation in der Schweiz während den letzten 30 Jahren: Messungen von jungen Leuten in Genf und von einigen russischen Kindern.
In einer Querschnittsstudie, die jährlich mindestens zwanzig junge Männer und ebensoviele junge Frauen im Alter von etwa 18 Jahren umfasst, wird dank eines Ganzkörperzählers die Konzentration von Caesium-137 im Körper gemessen. Dieses Isotop, dessen Halbwertszeit 30 Jahre beträgt, stammt entweder von Atombombenexplosionen in der Atmosphäre, die bis 1963 stattfanden, oder vom Tschernobylunfall. Die durch die Emissionen dieses Reaktors verursachten Konzentrationen erreichten kaum ein Drittel der Werte, die auf die Atombombenexplosionen zurückzuführen waren. Bei Ferienkindern aus Weissrussland, die letzten Sommer in der Schweiz verweilten, waren die Resultate deutlich unter den nach der russischen Literatur zu erwartenden Werten, aber sie stimmten mit den von internationalen Forschergruppen neulich am Ort ermittelten Resultaten überein.

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