

Radioactive Contamination: Italian Programme To Monitor The Radiocesium Levels In The Urine And Thyroid Status Of Exposed Children From Chernobyl

C. Fontana¹, F. Valeriani¹, R.G. Musumeci¹, G. Salimei¹, I. Giannotti² and N. Marinosci¹

¹ Italian Red Cross - Central Laboratory - Dep. of Environmental Radioactivity, Via Ramazzini 15, Rome, Italy

² National Health Service, Grosseto, Italy

INTRODUCTION

In the explosion at Chernobyl in April 1986, large quantities of radioactive substances were emitted into the atmosphere with an activity exceeding 1018 Bq. The activity released included radionuclides of iodine, caesium, cerium, barium, strontium, plutonium and other elements. After the release, the radioactivity was transported and dispersed by air particles that reached several European countries, mainly through rainfall (1).

As a result of the Chernobyl accident an area of approximately 120,000 km² in Ukraine (4,8%), Belorussia (23%) and in the Russian Federation (0,5%) was contaminated (2). In particular in the contaminated area of Belorussia there were 27 cities and 2,736 villages with a population of over 2,000,000 people (3).

The radionuclides of iodine and caesium are the basic contributors to the doses received by the population of the districts of these regions. The radionuclides deposited in these areas have a long-term impact on the environment and on the food chain, due to intake via both ingestion and inhalation.

Radionuclides assumed through ingestion are very dangerous, especially Cs-137 because of its considerable halftime (30.17 years). They caused a chronic radioactive internal contamination, due to its chemical characteristics, (as an alkaline metal) which facilitate an easy diffusion in all the body through the food chain and spread into the muscular tissue and are mainly excreted through urine. I-131, per inhalation, brought the highest quantity to the thyroid gland, the most critical organs, in the first few weeks following the nuclear accident (4).

The distribution of the concentration of artificial radionuclide Cs-137 reached the highest values of 185 kBq/m² and 40 kBq/m² in North and Central Italy (5).

Since 1995 the Italian Red Cross has hosted about 2,000 children from the contaminated areas of Belorussia and Ukraine in different regions of Italy. The purpose of the project was to ensure, with a temporary removal of the children from the contaminated areas, an improvement in their general well-being with both physical and psychological benefits (6).

In 1997 the Department of Environmental Radioactivity of the Central Laboratory of the Italian Red Cross started a series of spectrometric analyses of the urine samples of these children (7). Other samples were examined in 1998 and 1999. During the course of the research 103 children, boys and girls, between the ages of 6 and 16 were examined. The children from Belorussia were hosted by families in the region of Tuscany and the children from Ukraine were hosted in the Corpomiles Centre of the Italian Red Cross in the region of Latium. The children were hosted for a period of 30 days, many have returned since then and the same analyses were repeated.

In this paper a radiometric analysis was carried out on 206 children's urine samples looking for Cs-137 and Cs-134. The concentration of the two radionuclides was measured at the beginning and at the end of the children's stay in Italy. The two radionuclides were collected over a period of 24 hours.

Every year moreover, a scan of the thyroid was carried out on the same 25 children arrived in 1997 to assess the potential presence of pathological glandular tumours caused by I-131 (8).

In particular, the results reported in this paper were carried out taken from to evaluate the radioactive contamination levels and the medical check on the thyroid of children exposed to the fall-out of Chernobyl.

The results of the spectrometric analyses give indications about the degree of radioactivity contamination of Cs-137 in the children according to their different home countries. These results confirm the existence of a chronic radioactive contamination due to a balanced diet of contaminated food. The analyses of the thyroid also seem to demonstrate the absence of tumoral pathology.

MATERIALS AND METHODS

In 1997 the Department of Environmental Radioactivity of the Central Laboratory of the Italian Red Cross did radiometric analyses to reveal Cs-137 and Cs-134 in urine samples of 25 children between the ages of 6 and 16. The children (6 girls and 4 boys) from southern Belorussia were hosted by families in Tuscany (Grosseto, Castiglione della Pescaia, Roccastrada) and 15 children (9 girls and 6 boys) from Ukraine were hosted in the Corpomiles Centre of the Italian Red Cross in Latium. 30% of the children from Belorussia came from the region of Gomel, 70% from nearby villages (Fig.1).



Figure 1 Belorussia.

In 1998 the same radiometric analyses were carried out on the children's urine samples looking for Cs-137. 56 children (31 girls and 25 boys), between the ages of 9 and 15 were examined.

Also in 1999, radiometric analyses looking for Cs-137 in the urine samples of 22 children (17 girls and 5 boys), between the ages of 7 and 15 were done. In 1998 and 1999 all the children from southern Belorussia stayed with families in Tuscany.

All the 103 children were hosted in summer (June, July and August) and in winter (December and January). The first urine samples were taken 24 within hours after the children's arrival in Italy. The second set of samples was taken 30 days later at the end of the children's stay.

Gamma spectrometric analyses of the 206 samples were done using a coaxial Germanium Detector (GeHP) with a relative efficiency of 30% and energy resolution (FWHM) of 1.8 keV for the energy of 1332 keV. Marinelli beakers were used to measure the samples. The error of the concentration of activity is defined at the level of 1.

Moreover, a scan of the thyroid was carried out on the same 25 children from Belorussia in 1997 to assess the potential presence of pathological glandular tumours caused by I-131. The same group of 25 children from Belorussia was thyroid scanned again in 1998 and 1999 at the Grosseto Hospital.

RESULTS AND DISCUSSION

The results of the gamma spectrometric analyses done on the urine samples of the children from Ukraine (Group A) taken 24 within hours after their arrival in Italy in 1997 show levels of concentration of Cs-137 between 13 Bq/l and <1 Bq/l.

The concentration of Cs-137 in the urine samples taken at the end of the children's stay in Italy was between 9 Bq/l and < 1 Bq/l. The Cs-134 levels were all below the minimum detectable activity (M.D.A.) (9).

The maximum concentration of Cs-137 in the urine samples of the children from Belorussia (Group B), relative to the gamma spectrometric analyses in the same year 1997 was 140 Bq/l with a minimum value of 5 Bq/l. The maximum concentration of Cs-137 in the urine of the children after 30 days in Italy was between 45 Bq/l and 2 Bq/l. The levels of Cs-134 were lower than the M.D.A. with the exception of two samples from Belorussian children taken on arrival. The data of one child were not included because the sample taken at his departure wasn't sent to the laboratory.

The results of the gamma spectrometric analyses done on the urine samples of the children from Belorussia taken 24 within hours after their arrival in Italy in 1998, in four different groups (C-D-E-F) show a very high variability of the levels of concentration of Cs-137. For 4 children of group F (December - January) it was their second stay (the first one was in the summer).

All arrive at the maximum concentration of Cs-137 of 48.7 Bq/l (Group E) and a minimum value of 0.81 Bq/l (Gruppo C). The concentration of Cs-137 in the urine of the children after 30 days in Italy was between 30.3 Bq/l and the levels were lower than the M.D.A.

Finally in 1999 the same analyses done on another group of children from some areas in Belorussia (Group G), show a concentration of Cs-137 between 32.7 Bq/l and a level lower than the minimum detectable activity and a maximum concentration of Cs-137 of 22 Bq/l at departure.

The standard deviation of the measures done is between 0.1 and 0.7. The results of the gamma spectrometric analyses of all the urine samples examined within 24 hours on the children's arrival in Italy show that the level of Cs-137 concentration in 15 of them was lower than the minimum detectable activity. The graphs show the average Cs-137 Bq/l concentration values of the groups examined both on arrival and departure. The value of 0.60 Bq/l was given to M.D.A. in order to calculate the evaluation of the mean (Fig. 2, 3, 4, 5, 6, 7, 8).

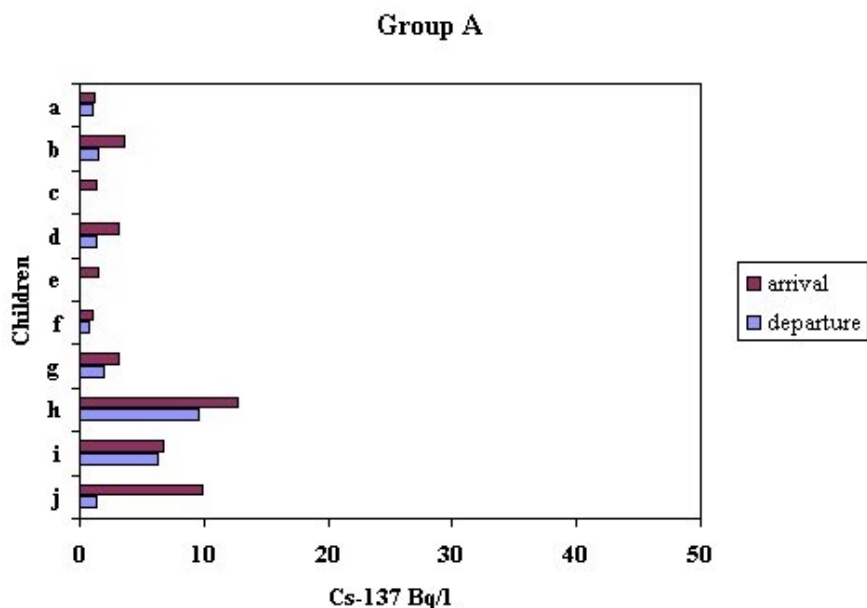


Figure 2. Values of the means of Cs-137 Bq/l in urine samples of children from the Ukraine (1997).

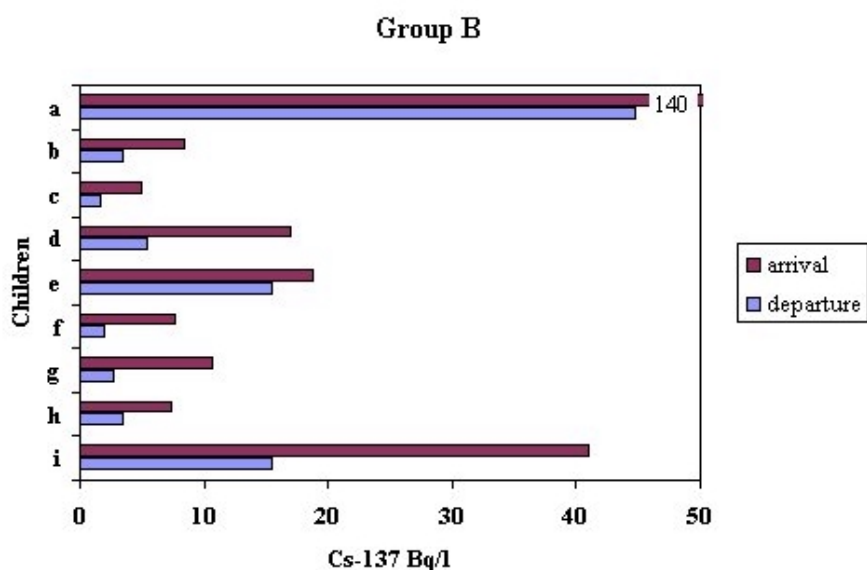


Figure 3. Values of the means of Cs-137 Bq/l in urine samples of children from the Belorussia (1997).

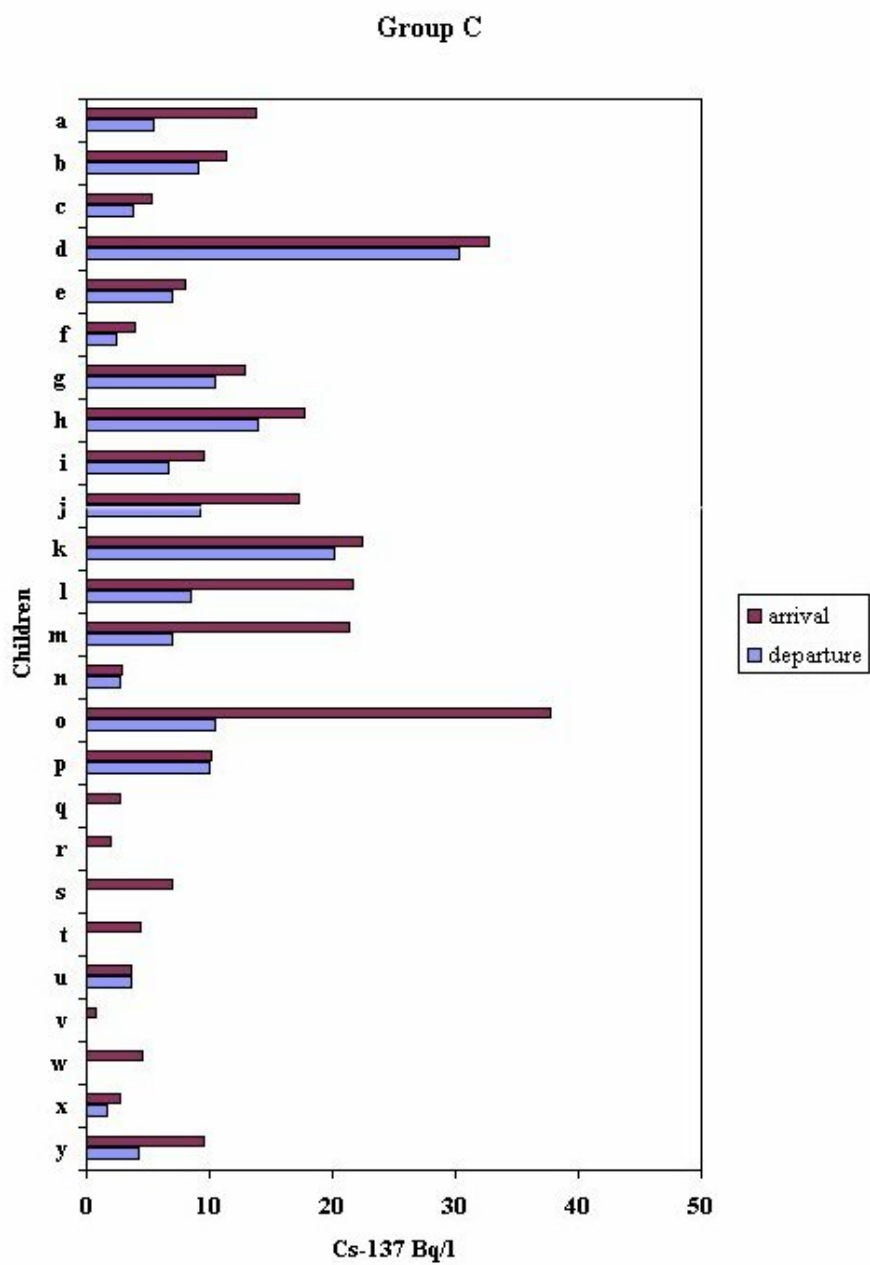


Figure 4. Values of the means of Cs-137 Bq/l in urine samples of children from the Belorussia (1998).

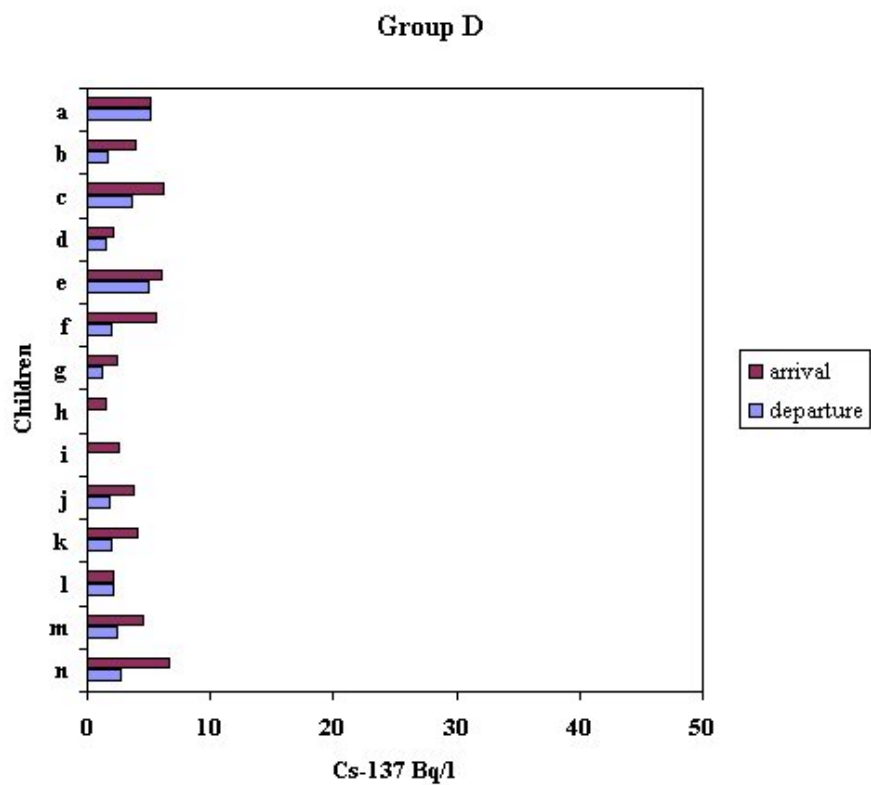


Figure 5. Values of the means of Cs-137 Bq/l in urine samples of children from the Belorussia (1998).

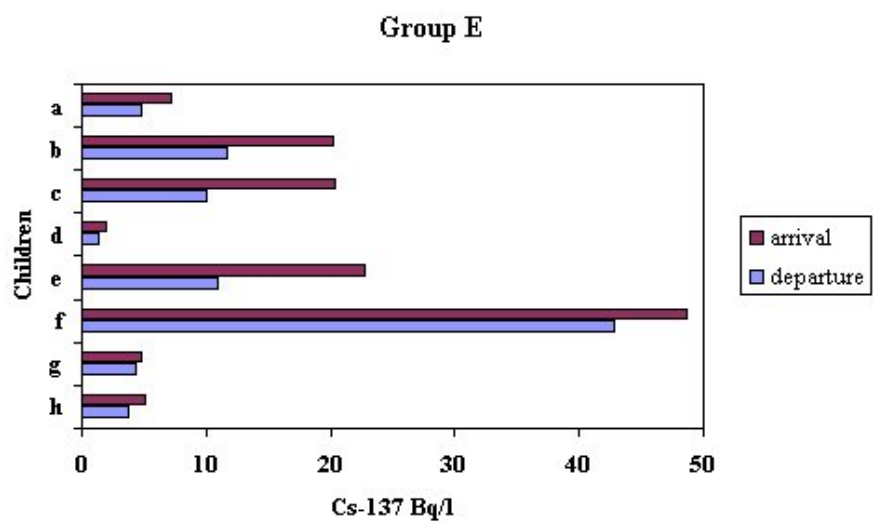


Figure 6. Values of the means of Cs-137 Bq/l in urine samples of children from the Belorussia (1998).

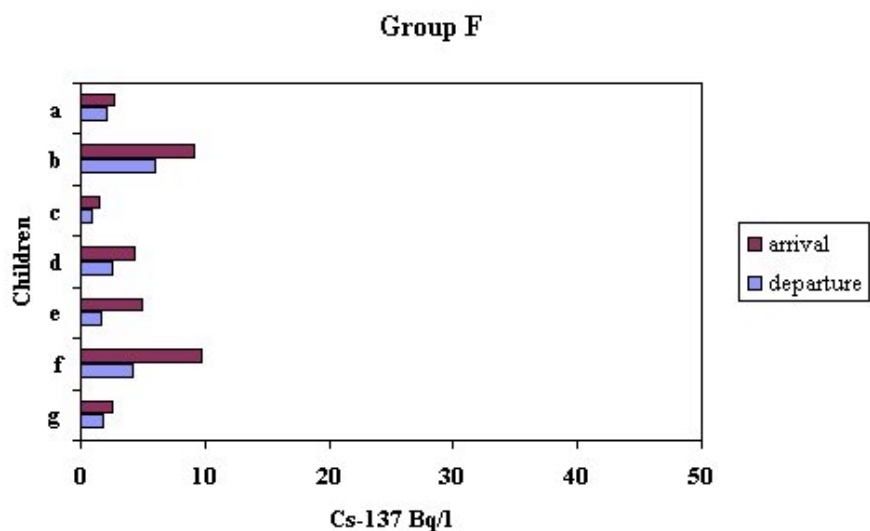


Figure 7. Values of the means of Cs-137 Bq/l in urine samples of children from the Belorussia (1998).

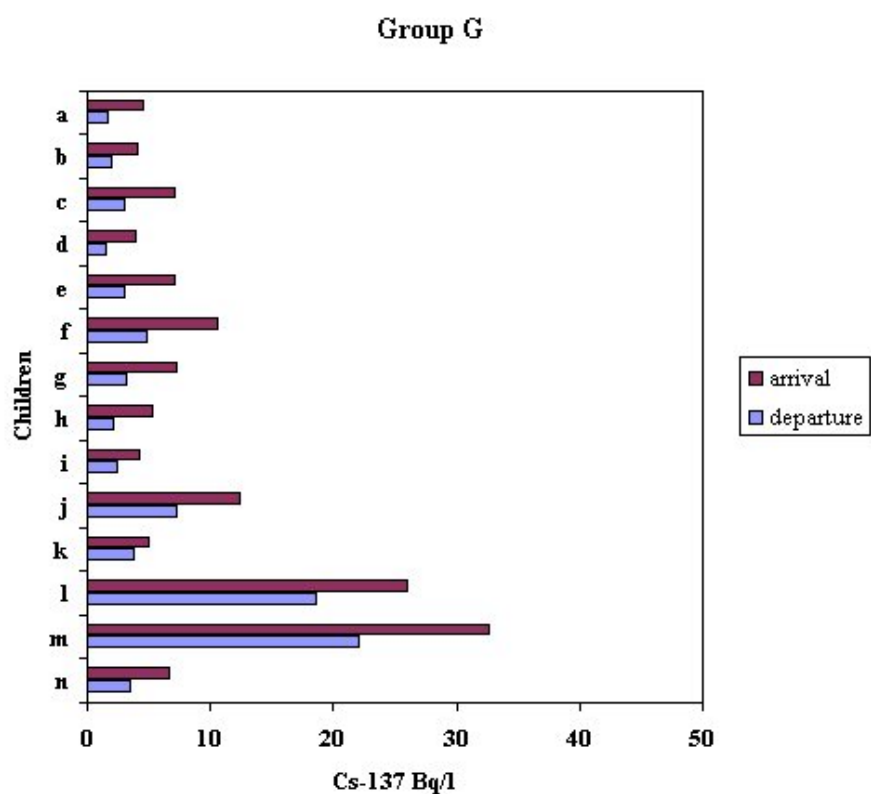


Figure 8. Values of the means of Cs-137 Bq/l in urine samples of children from the Belorussia (1999).

from the results it emerges that the concentration of Cs-137 is higher in the urine of the children from Belorussia than in that of the children from Ukraine.

the data of the Cs-137 concentration disposal percentages in urine after 30 days from the arrival in Italy, analysed in the various groups of children.

he analysis of the results evidentiates an average percentage decrease of Cs-137 concentration, on arrival and after a 30 day-stay, between 30% and 50% in 6 groups out of 7. In group B there is an average decrease of 60% (Fig.9).

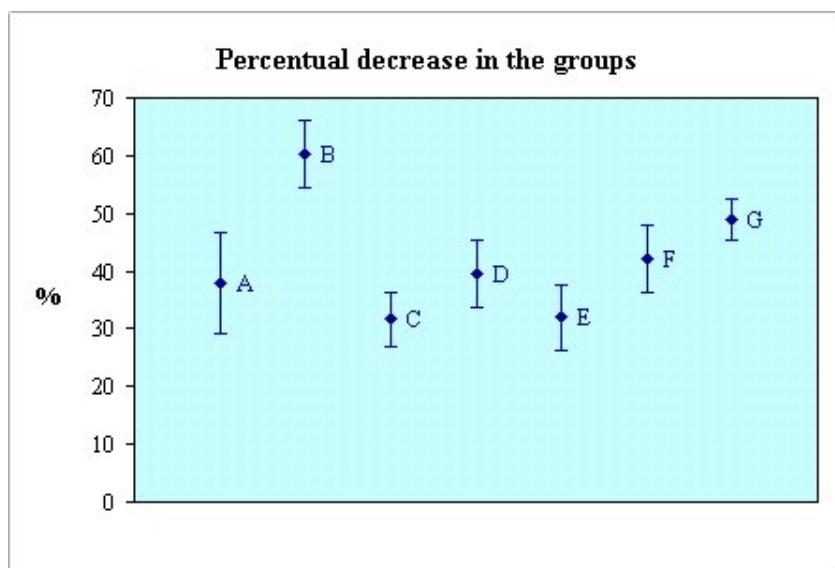


Figure 9. Average percentage decreases and standard error of Cs-137 in all the group of children examined.

rom the thyroid scan of 25 children during their stay in 1997 four children showed a regular ecostructure of the thyroid parenchyma, 19 children showed ecostructural alterations (focus and goitre ones). 23 children resulted euthyroidal, only 2 children showed a probable tumoral thyroid pathology due to radiocontamination from I-131 after the Chernobyl accident, in fact they had undergone thyroid surgery and had been given a substituting therapy of thyroid-based medicines (Eutirox).

he ultrasound thyroid control scanning repeated in 1998 confirmed the results of 1997 in all the subjects. Finally in 1999 the scanning of the same group of children revealed the absence of pathological manifestations. All the children were found to be euthyroidal. Improvement in hypothyroidism and endemic goitre was noticed, after a therapy based on iodate substances given during the stay in Italy and also in their own countries.

CONCLUSIONS

he data collected in this multidisciplinary project show a decrease of about 30% and 50% in Cs-137 levels in the urines from the time of arrival in Italy to the children's departure.

It emerges that the group with the initial highest Cs-137 is also the one that shows a highest average percentage decrease. It is not possible to observe a direct connection between the concentration quantity present on arrival and the average percentage decrease, because the groups with the initial lowest concentration value show a higher decrease (Groups A-D-F-G). This indicates that even a brief visit to an uncontaminated environment is beneficial to the children's health.

urthermore, the possible correlation between the concentration of Cs-137 in the children's urine and the environmental contamination of the same radionuclide in the children's place of origin was verified (10).

he results of the thyroid scan on the 25 children, examined from 1997 to 1999, show the absence of tumoral pathology, with the exception of 2 children who already had a tumour on their arrival in Italy. The presence of echostructural focus and goitre alterations in some children confirms the hypothyroidism and the endemic congenital goitre, typical of the areas from which the children come from.

ther tests are in progress in order to verify eventual correlations between the data analysed in this paper and other parameters.

he project team intends to check a wider sample of children who come to Italy several times each year, in collaboration with the International Federation of Red Cross and Crescent Societies that is still working on the Chernobyl Humanitarian Assistance and Rehabilitation Programme (CHARP) (11).

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