INVESTIGATION OF INTERNAL DOSE RECEIVED BY THE HUNGARIAN POPULATION DUE TO CESIUM RADIONUCLIDES AS A CONSEQUENCE OF THE CHERNOBYL ACCIDENT

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INTRODUCTION

Hungary was one of the countries affected by radioactive environmental con-
tamination due to the reactor accident at Chernobyl. The total ground deposition
of radionuclides showed a non-uniform distribution over the country. According
to a nationwide survey the activity surface concentration varied within about an
order of magnitude from place to place. The most characteristic local averages
for ^{137}Cs ranged from 1 to 5 $kBq.m^{-2}$. An extended internal contamination monitor-
ing programme was introduced by whole body counting very soon after the accident.
The subjects to be measured systematically were selected from Budapest's residents
representing both sexes and different age groups. The total number of subjects
monitored regularly (control group) was 44. The representativity of the control
group for adults was checked by comparing the results with those obtained for
large number of subjects measured occasionally. The programme was later extended
also to other parts of Hungary by single reference measurements. Six weeks aver-
age monitoring interval was chosen for following the whole body activities due
to ^{134}Cs and ^{137}Cs radionuclides, which are responsible for the long term inter-
nal dose received by the population. The results obtained for adults are present-
ed here.

MEASUREMENTS

The measurements were carried out in the low background whole body counter
of the institute using single detector scanning arrangement. Multi-element bottle
phantoms were applied for activity calibration simulating the different shape
and body sizes of the subjects to be monitored. The gamma spectrometric measure-
ments were evaluated by least-square fitting decomposition procedure providing
the whole body activities of ^{134}Cs, ^{137}Cs and ^{40}K radionuclides. The reliability
of the measuring, calibration and evaluation methods applied has been checked
by international intercomparison measurements and the results were found to be
very satisfactory.

RESULTS

The statistical investigation of the whole body activities showed log-normal
frequency distribution. For this reason the value of the median was used in the
interpretation of the measurements. The ratio of the mean to median was found to
be about 1.10. The individual ^{137}Cs body contents in Budapest for adult males
and females against the time after the accident are presented in Fig.1. Con-
siderably large differences can be observed between the individual activity data.
The solid lines in the figure represent the medians for both adult sex groups.
The feature of the line course of ^{134}Cs activities is very similar to that shown
for ^{137}Cs but influenced also by the shorter physical half life. The ratio of
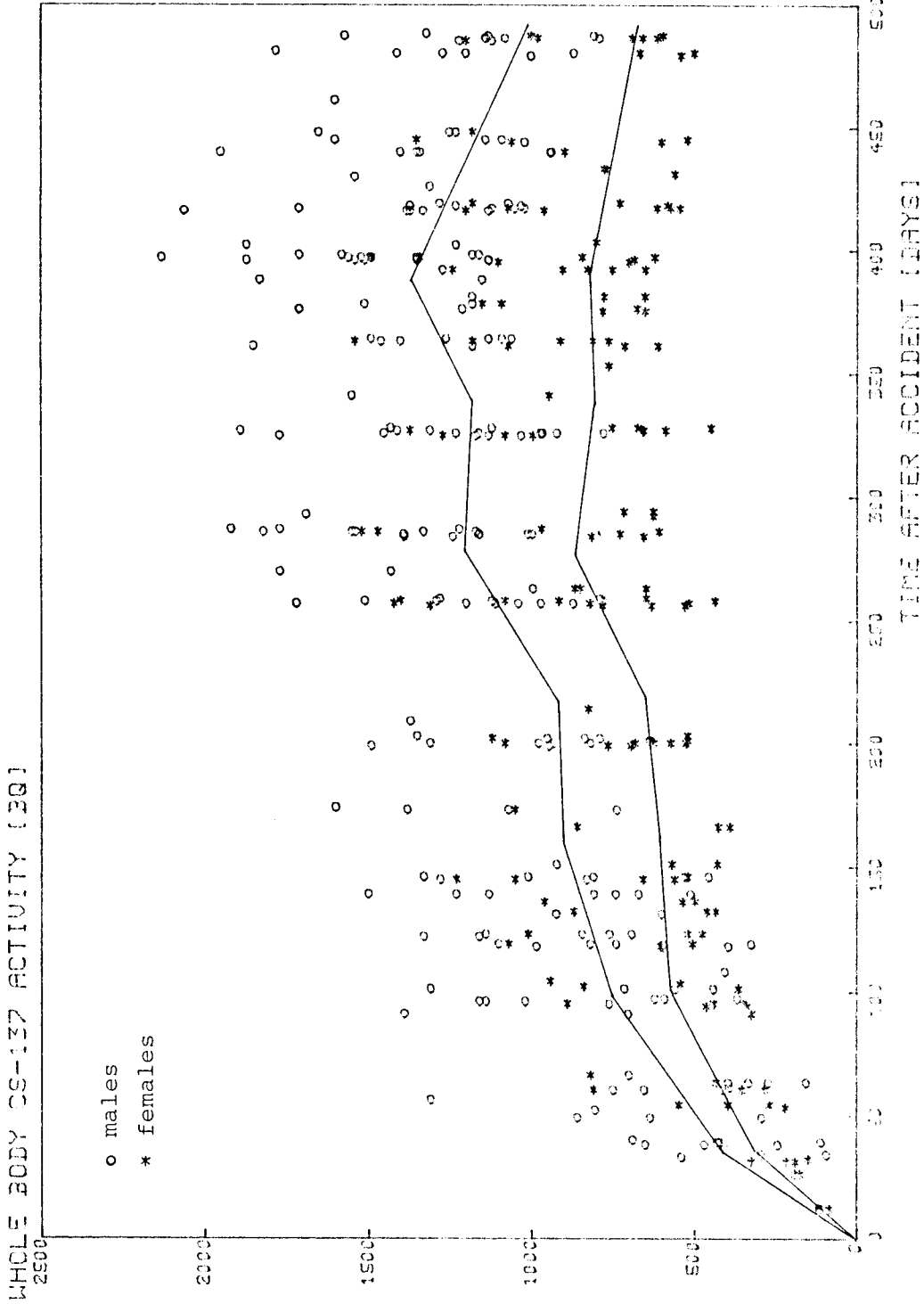whole body ^{137}Cs to ^{134}Cs activities was found to be 1.83 in May 1986.

WHOLE BODY CS-137 ACTIVITY [BQ]

o males
* females

Figure 1. Whole body ^{137}Cs activity in Budapest's residents against the time

The dose rate due to the cesium radionuclides has been calculated for each individual by the formula

$$H(t) = \frac{q(t)}{M} \sum_i Y_i \cdot E_i \cdot \phi_i(M)$$

where $H(t)$ is the dose equivalent rate at time t,

$q(t)$ is the whole body activity for the given radionuclide at time t,

Y_i is the yield per transformation of the i-th type of radiation,

E_i is the average energy of the i-th radiation emitted,

$\phi_i(M)$ is the absorbed fraction of E_i energy for a given body mass M.

For cesium radionuclides both the source and target organs were assumed to be the whole body. The absorbed fraction of gamma radiation varies considerably with the total body mass. The mass dependence was taken into account individually.

CONCLUSIONS

The time variation of the medians of dose equivalent rates for males and females due to both ^{137}Cs and ^{134}Cs are shown in Fig.2. The whole body internal dose equivalents calculated for the first year after the accident are summarized in Table 1. where the values associated with the 5-95% interval of the frequency distribution are also indicated in parentheses. The local variation of the internal dose over the country was estimated by single reference measurements on 5-10 subjects from each place. The results are shown in Table 2. The differences which were found to be within a factor of 4, are in good correlation with those obtained for the local average ground deposition of these radionuclides over the country. The roughly predicted whole body 50 years dose due to the internally deposited cesium radionuclides will not exceed 100 μSv as an average in Budapest area. These follow up studies will be continued and extended also for children.

Table 1. Internal dose of Budapest's adult residents in the first year after the accident due to cesium radionuclides

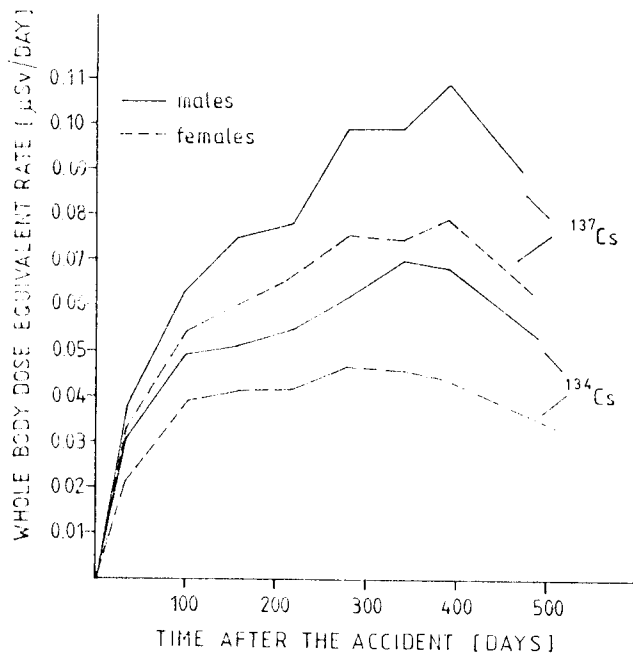|	WHOLE BODY DOSE EQUIVALENT [μSv]	
	males	females
^{137}Cs	27.0 (12-65)	21.6 (10-40)
^{134}Cs	16.4 (7-38)	14.1 (7-24)
SUM	43.4 (19-103)	35.7 (17-64)

Figure 2. Internal dose equivalent rate against the time for Budapest's adult residents due to cesium isotopes

Table 2.   Comparison of the total internal dose received by males living in different counties of Hungary due to cesium isotopes

COUNTY	WHOLE BODY DOSE EQUIVALENT [μSv]
Budapest	43
Szaboles-Szatmár	26
Zala	63
Heves	54
Csongrád	35
Gyür-Sopron	104
Tolna	32