An Investigation of a Group of Norwegian School Children with regard to Body Burden of $^{137}$Cs due to Radioactive Fallout

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The $^{137}$Cs body burden in three groups of children from the same school is presented (Group I: boys aged 19 years, Group II: boys aged 15 years, Group III: girls aged 15 years). A comparison between the three groups showed that the $^{137}$Cs body burden in Group I was twice as high as those in the other two groups between which there was only a negligible difference. Since the diet was principally the same for all the participants, it is suggested that the $^{137}$Cs metabolism changes between the ages of 15 and 19 years. It was impossible in any of the three groups to find a correlation between the daily milk intake and the $^{137}$Cs body burden.

The present authors have previously published a paper 1 concerning the $^{137}$Cs body burden in a group of Norwegian school boys. These boys, who have been examined twice since then (October 1964 and March 1965), have now left school and are no longer available for further examinations. It is of interest to note that since the examinations started in March 1963, their average $^{137}$Cs body burden increased until March 1965, when the examination for the first time showed a small average decrease.

Fig. 1 shows the individual and average $^{137}$Cs body burden at the first examination in March 1963 and at the last one in March 1965. The case numbers are assigned on the basis of their $^{137}$Cs body burden at the first examination. No. 1 is the boy with the lowest body burden, No. 22 the boy with the highest. One of the boys has left school since the first report was published, and his data have been omitted in this presentation.

Table 1 shows the year of birth.

<table>
<thead>
<tr>
<th>Year of birth</th>
<th>Case No.</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945</td>
<td>5, 7, 10, 12</td>
<td>4</td>
</tr>
<tr>
<td>1946</td>
<td>1—4, 6, 8, 9, 11, 13—21</td>
<td>17</td>
</tr>
<tr>
<td>1947</td>
<td>22</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1. The years of birth of the school boys in the first group examined (Group I).

In March 1965 the average age was, therefore, 19 years.

We thought it interesting to compare the $^{137}$Cs body burden of these boys (hereafter called Group I) with a group of younger boys (hereafter called Group II), and a group of girls (hereafter called Group III), and also try to evaluate the contribution of radiumesium in milk to their radiumesium body burden.

Therefore, in May 1965 we examined a group of 16 boys and a group of 36 girls, all from the same school as the boys in Group I. Table 2 gives the years of birth of these children. In May 1965 the average age of both of these groups was 15 years.

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Fig. 2 and Fig. 3 give the individual as well as the average $^{137}\text{Cs}$ body burden of these children. In Group II the average body burden is $23.5 \pm 0.5 \text{nCi}$, as opposed to $23.8 \pm 0.5 \text{nCi}$ in Group III, the difference being insignificant. As before, the numbers in Table 2 and Figs. 2 and 3 refer to the $^{137}\text{Cs}$ body burden. The boy in Group II with the lowest body burden is given No. 23, and the boy with the highest body burden in this group No. 37. Likewise, the girl in Group III with the lowest body burden is given No. 38, and the one with the highest body burden No. 74. Besides the $^{137}\text{Cs}$ body burden, the body content of potassium has been measured, and the body surface in square meters calculated ad modum du Bois.

Radioesium body burden can be expressed in the following units:

1) as the absolute body burden of $^{137}\text{Cs}$ in nanocuries (nCi) or picocuries (pCi),
2) as the ratio $^{137}\text{Cs}/\text{K}$ where $^{137}\text{Cs}$ is given in picocuries and potassium in grams,
3) as nCi or pCi of $^{137}\text{Cs}$ per kilogram of body weight,
4) as nCi or pCi of $^{137}\text{Cs}$ per square meter body surface.

Table 3 shows the average height, weight and body surface together with the body content of potassium and potassium per kilogram body weight.

<table>
<thead>
<tr>
<th>Height cm</th>
<th>Weight kg</th>
<th>Surface m$^2$</th>
<th>Potassium g</th>
<th>g K per kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I 182.0</td>
<td>71.0</td>
<td>1.90</td>
<td>140</td>
<td>1.96</td>
</tr>
<tr>
<td>Group II 170.5</td>
<td>54.4</td>
<td>1.63</td>
<td>110</td>
<td>2.03</td>
</tr>
<tr>
<td>Group III 166.0</td>
<td>52.1</td>
<td>1.57</td>
<td>95</td>
<td>1.82</td>
</tr>
</tbody>
</table>

Table 3. The average height, weight and body surface of all three groups.

It is interesting to note that the boys have a higher body content of potassium than the girls. Expressed in terms of potassium per kilogram of body weight, however, the difference is almost negligible.

Table 4 presents the body burden of $^{137}\text{Cs}$ in the four ways mentioned above.

<table>
<thead>
<tr>
<th></th>
<th>$^{137}\text{Cs}$ [nCi]</th>
<th>$^{137}\text{Cs}$ [pCi/g]</th>
<th>$^{137}\text{Cs}$ [pCi/kg]</th>
<th>$^{137}\text{Cs}$ [pCi/m$^2$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>47.2</td>
<td>337</td>
<td>665</td>
<td>24.8</td>
</tr>
<tr>
<td>Group II</td>
<td>23.5</td>
<td>212</td>
<td>432</td>
<td>14.4</td>
</tr>
<tr>
<td>Group III</td>
<td>29.8</td>
<td>252</td>
<td>457</td>
<td>15.1</td>
</tr>
</tbody>
</table>

Table 4. $^{137}\text{Cs}$ body burden in all three groups, spring 1965.
As can be seen from Table 4, the average $^{137}$Cs body burden in Group I is twice as high as that in Group II and Group III which do not differ significantly from each other.

Milk samples, which can be regarded as representative for that consumed by the children in all three groups, have been obtained from a central Oslo dairy and examined nearly every week for several years.

Fig. 4 shows the $^{137}$Cs concentrations from May 1964 to May 1965. In winter and spring, the $^{137}$Cs concentration is considerably lower than in summer and fall which is obviously one important reason why the body burden in Group I decreased from October 1964 to March 1965.

The average milk intake per week in the three groups is:

- Group I: 6.7 litres,
- Group II: 5.8 litres,
- Group III: 4.5 litres.

In our first paper it was shown that the milk consumption in Group I could not account for the individual differences in the $^{137}$Cs body burden even though there was a trend towards a higher $^{137}$Cs body burden among those with a large milk consumption. This was also found to be the case in the present investigation. It is impossible to find a significant correlation between the $^{137}$Cs body burden and the consumption of milk in any of the three groups. Neither can the milk consumption account for the fact that the $^{137}$Cs body burden is twice as large in Group I as in Group II and Group III.

Under otherwise similar conditions the body burden would obviously be in direct proportion to the intake of $^{137}$Cs through the diet. On the assumption that the retention follows a single exponential function with a biological half life of 70 days (I.C.R.P.‘s data), the above mentioned mean milk consumption alone over a period of one year would cause the following rise in the body burden in the three groups:

- Group I: 11.7 nCi,
- Group II: 10.1 nCi,
- Group III: 7.4 nCi.

Thus, the difference in the $^{137}$Cs body burden can only to a small extent be attributed to the intake of $^{137}$Cs through fresh milk. Other types of dairy products as well as agricultural products in general, and reindeer meat and mutton in particular, seem to be more important in this respect.

It should be pointed out that by interviewing the participants in the examination we confirmed that they all live under similar conditions and that only minor differences exist in their dietary habits.

It seems reasonable to suggest that an altered metabolism of $^{137}$Cs caused by the difference in age and sex must be an important reason for the higher $^{137}$Cs body burden in Group I.