EXPOSURE TO CADMIUM OF THE WEST-GERMAN POPULATION

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AVERAGE INTAKE AND ABSORPTION OF CADMIUM BY MAN IN THE FRG

Similar to the situation in other countries the diet and cigarette smoking represent the major sources of cadmium intake of the West-German population. Based on the median cadmium content of different food items and taking into account the average dietary habits of the West-German population the Federal Health Agency calculated the mean cadmium intake of males to be 0.2425 mg/week and that of females to be 0.1882 mg/week (1). The cadmium concentration in the tobacco of German commercial cigarettes has been studied by Szadkowski et al. (2), Müller (3) and Scherer & Barkemeyer (4). According to these studies the cadmium concentration in cigarette tobacco varies between 0.2 and 2.0 ppm or 0.5 - 1.5 μg Cd/cigarette. The average cadmium content in the mainstream smoke of German filter cigarettes is about 0.1 μg Cd/cigarette or less. In plain cigarettes the cadmium content of the mainstream smoke usually exceeds 0.1 μg/cigarette. 80 - 95 % of the mainstream smoke cadmium occur in particulate form. Gas-phase cadmium contributes between 5 and 20 % to the total amount of cadmium in the mainstream smoke.

Assuming a gastrointestinal absorption of 5 % and a pulmonary retention of 30 % the average cadmium intake and absorption of the West-German citizen can be characterized as shown in Table 1. It is evident that the diet represents the major source of cadmium intake and absorption in non-smokers, whereas in cigarette smokers the inhalation of cigarette smoke may contribute about 50 % of the total cadmium amount absorbed resulting in a nearly twofold increased cadmium absorption compared to non-smokers.

Taking into account a mean cadmium concentration of 1 μg/l in drinking water, the cadmium intake from water and water-based beverages is likely to average 1 - 2 μg/day. The concentrations of airborne cadmium vary between 1 and 3 ng/m³ in rural and urban areas (5). Breathing 15 m³ of air per day would thus result in an uptake of 0.02 - 0.05 μg/day. Assuming a deposition of 30 % in the lung tissue (the remainder being exhaled) and a complete absorption of the deposit results in a pulmonary absorption of less than 0.01 up to 0.02 μg/day. Absorption of cadmium in normal respiration is, therefore, small compared with the amount absorbed from food or from inhalation of cigarette smoke.

The FAO/WHO Joint Expert Committee on Food Additives recommended a provisional maximum tolerable weekly intake for cadmium from all sources of 400 - 500 μg (6). The data presented in Table 1 show that the average cadmium intake by the general population in the FRG is well below this limit. It should be noted, however, that the amount of cadmium ingested by individuals is likely to vary widely with individual habits. People consuming, for example, large quantities of certain species of shellfish (particularly crab brown meat and pastes), or eating some types of vegetables grown on soil contaminated by cadmium fall-out near lead and zinc smelters or repeatedly fertilised with sewage sludge containing cadmium, are likely to have intakes substantially in excess of the average and perhaps in excess of the FAO/WHO recommended level.
Table 1. Average cadmium intake and absorption in the general population of West-Germany

<table>
<thead>
<tr>
<th>Source</th>
<th>Cadmium intake (µg/Tag)</th>
<th>Cadmium absorption (µg/Tag)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet and drinking water a)</td>
<td>34.6 (M) 26.9 (F)</td>
<td>GIT Absorption rate 5 % 1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lung Deposition rate 30 % 0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lung Deposition rate 50 % complete absorption 1.0</td>
</tr>
<tr>
<td>Air b)</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>cigarette-smoke c)</td>
<td>2.0</td>
<td></td>
</tr>
</tbody>
</table>

a) Data according to ref. (1).
b) Taking into account air cadmium levels of 2.5 ng/m³ and a breathing volume of 15 m³ per day.
c) Assuming an inhalation dose of 0.1 µg per cigarette.

LEVELS OF CADMIUM IN HUMAN BIOLOGICAL MEDIA AS INDICATORS OF EXPOSURE

In the last years, several studies were conducted in the FRG to determine the levels of cadmium in blood, urine, and hair in the occupationally non-exposed general population. The more recent studies applying modern analytical techniques and careful quality control have been reviewed by Ewers et al. (7). Additional data concerning cadmium levels in blood, urine, and hair of children have been presented by Brockhaus et al. (8) and Wilhelm et al. (9). From these studies the normal ranges of the cadmium concentrations in the above named biological media can be derived. The upper limits of the normal ranges (95. percentile values) are summarized in Table 2. It should be noted that the mean values usually are substantially below these "upper normal limits".

The available data show that the cadmium concentrations in blood, urine, and hair are influenced by a number of factors:

- Cigarette smokers have significantly higher blood cadmium levels than non-smokers;
- Adult non-smokers have higher blood cadmium levels than children;
- Adults have higher urine cadmium levels than children;
- People living near lead and zinc smelters have, on average, higher levels of cadmium in blood, urine and hair than otherwise comparable population groups;
- Women and young girls tend to have higher urine cadmium levels than men and boys, respectively, of similar age.

Data on the cadmium concentrations found in placental tissue of mothers living in different areas of the FRG have been presented by Thieme et al. (10) and Krause et al. (11). The mean values vary between 40 and 60 ng/g.