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Consumption of homegrown products does not increase dietary intake of arsenic, cadmium, lead, and mercury by young children living in an industrialized area of Germany

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Abstract

The dietary intake of arsenic (As), cadmium (Cd), mercury (Hg), and lead (Pb) was studied among young German children with different food consumption behaviour (consumption of own grown foodstuffs and of products from the supermarket). The study area comprised an industrialized and a rural area of West Germany. Dietary intake of contaminants was measured by the duplicate method according to the WHO guideline. A total 588 duplicate portions were collected daily from 84 individuals between May and September 1998. Intake of food groups was calculated from dietary records. Determination of As, Cd, Hg, and Pb was performed following high-pressure digestion of lyophilized samples by atomic absorption spectrometry (AAS). Geometric mean weekly intake [$\mu g/(kg_{bw} \cdot week)$] was as follows: As 1.4, Cd 2.3, Hg 0.16, and Pb 5.3. Geometric mean intake corresponded to the percentage of the provisional tolerable weekly intake (PTWI) as follows: As 9.7%, Cd 32%, Hg 3.3%, Pb 21%. As and Hg intake were mainly influenced by fish consumption. The amount of cereals and bakery wares mainly determined the Cd and Pb intake. Children living in the industrialized area with a substantial food consumption of own grown vegetables or products from domestic animals products had no increased dietary intake of the metals.

Keywords: Arsenic; Cadmium; Lead; Mercury; Dietary intake of contaminants; Dietary intake of food groups; Duplicate study; Children

1. Introduction

Children may experience greater exposures to environmental pollutants through ingestion routes than adults (Williams et al., 2003). Estimating the intake of environmental pollutants due to ingestion mainly include the media breast milk, food with drinking water, soil and house dust. Estimates of the dietary intake of environmental pollutants among young children are periodically carried out by our group (Schrey et al., 1998; Wilhelm et al., 2002a;

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Wittsiepe et al., 2001). The duplicate method is a suitable tool to estimate the dietary intake of substances (Laryea et al., 1995; Thomas et al., 1997; Kroes et al., 2002).

In our previous duplicate study (sampling period 1994–1995), we found that the Cd and Pb dietary intake was higher in children from an industrialized area compared with those living in a remote region. (Wilhelm et al., 2002b, 2003b). We supposed that consumption of homegrown food could have contributed to the higher intake of Cd and Pb. Therefore, the main objective of this study was to clarify if young children living in a highly industrialized region with a substantial consumption of homegrown foodstuffs have a higher dietary intake of As, Cd, Hg, and Pb compared with other children. For this purpose, the duplicate method was chosen to estimate the dietary exposure. No data on the contamination of special food items are reported. Additionally, a detailed analysis of dietary records evaluated by the methods of the Dortmund Nutritional and Anthropometric Longitudinally Designed (DONALD) Study (Kersting et al., 1998) is included.

2. Materials and methods

2.1. Study area

The study was conducted in two areas of North-Rhine Westphalia (West Germany): the highly industrialized Ruhr District and the rural Steinfurt District. The Ruhr District is the region with one of the highest population density in Germany and was the main area for steal and coal factories. Although the air quality has improved clearly during the last decades, some local health authorities still recommend not to eat fruits and vegetables from own gardens. The Steinfurt District is located in the north of North-Rhine Westphalia and is primarily used by agriculture and small-scale industries.

2.2. Study population

Participants were 84 children at the age of 14 to 83 months. Three study groups with 28 children, 14 male, and 14 female each were recruited via leaflets, notices in kindergartens, and practices of paediatricians, press, and personal contacts. A first selection was made by telephone interviews with the parents concerning food consumption behaviour, general dietary habits, diseases, medication, and possible gastrointestinal disorders. Groups I and III were children with food consumption, including a substantial part of products from the families own vegetable gardens or the surrounding area and/or products from own domestic animals. Group I composed of children from the Ruhr District, group III from the Steinfurt District. Group II consisted of children living in the Ruhr District consuming exclusively food from the supermarket. Information on the general food consumption behaviour of the households was obtained by a questionnaire. The body weight and body height of the children were measured by the interviewer at the beginning of the sampling period. Weight and height of the children were within the normal range for age ($\geq$3 percentile and $\leq$97 percentile). A short medical check-up revealed no acute or chronic illnesses except for some infections of the upper respiratory tracts. For motivation of the participants and to minimize changes of usual dietary habits during the sampling period, the parents got an appropriate expense allowance. All children consumed a mixed diet. None of the children was on a special diet, and no participant was vegetarian.

2.3. Sampling of food duplicates

Duplicate portions of all food and beverages consumed were collected daily between May and September 1998 on 7 consecutive days for each child following the WHO guidelines (WHO, 1985). The sampling time May to September was chosen to include the main time period of homegrown consumption activity and for better comparison with our previous duplicate studies in this area. Each sample was kept in the refrigerator of the household and was transported the day after sampling to our laboratory. The food samples were weighed, homogenized, and pooled to weekly samples. The samples were then lyophilized and frozen at -20 °C until analysis.

2.4. Dietary records

Food consumption was partly weighed and partly reported as estimated quantities, e.g., household