# Dietary intake of manganese by New Zealand infants during the first six months of life

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1. The manganese concentrations of breast-milk, liquid and dried cow's milk, and foods widely used in mixed feeding of infants in New Zealand, were measured by atomic absorption spectrophotometry.

2. The dietary supply of Mn to infants during the first 6 months was calculated. This varied from 2·5 to 75 μg/d per kg body-weight depending upon the age of the infant, the type of milk and the quantity of solid foods consumed. Young infants in New Zealand received about as much Mn as has been reported for infants elsewhere.

Deficiency of manganese would not be expected to arise in human adults because the element is widely distributed in foodstuffs. Infants might, however, be at risk because animal foods like meat and milk contain less Mn than cereals and vegetables, and losses might occur during the processing of ready-to-serve infant foods. No significant deficiency has in fact been reported, although Widdowson (1969) found that the faecal loss of Mn by babies during the 1st week of life was about five times greater than their intake in breast-milk, and Schroeder, Balassa & Tipton (1966) reported a falling concentration of Mn in human tissue during the first 45 d of life. Since nothing was known about the intake of infants in New Zealand, we decided to employ the analytical techniques which we had developed (McLeod & Robinson, 1972) to determine the Mn content of breast-milk, and of liquid and dried cow's milk, as well as of foods widely used in mixed feeding in this country. The results suggest that young infants in New Zealand receive about as much Mn as has been reported for infants elsewhere (Cotzias, 1958, 1962; Underwood, 1962; Schroeder *et al.* 1966; Widdowson, 1969).

## EXPERIMENTAL

Mn was determined on nitric–perchloric digests of both liquid and dry milks by atomic absorption spectrophotometry after chelation with sodium diethyldithiocarbamate and extraction into methyl isobutyl ketone (McLeod & Robinson, 1972). Samples of food were dried, wet-digested and aspirated directly.

Samples of breast-milk were collected at the end of the 1st week of lactation from ten women in the Queen Mary Maternity Hospital, Dunedin, with precautions being taken to prevent contamination. No metal utensils were used and the glass hand-pumps had been sterilized in deionized water. Pasteurized cow's milk was taken from the city supply during spring, summer and late autumn. Foods for infants chosen for analysis were those frequently used in New Zealand; processed cereal (Farex; Glaxo Laboratories, N.Z. Ltd) and the ready-to-serve canned foods, cereal and apple, mixed vegetables, and beef liver with mixed vegetables.

## RESULTS

Concentrations of Mn in the milks used are listed in Table 1, together with the dietary supply of Mn for infants aged 1, 3 and 5 months, corresponding to average body-weights of 4, 5·7 and 7 kg respectively. These values were derived from the daily volumes of breast-milk and milk mixtures suggested by Begg (1970) for infants

Table 1. *Concentration of manganese in liquid milk and dried milk, and daily intake of Mn from milk by infants 1, 3 and 5 months old, corresponding to body-weights of 4, 5·7 and 7 kg, respectively*

(Mean values; values in parentheses are ranges)

| | | Daily Mn intake (μg) | | |
|---|---|---|---|---|
| | Mn in milk | 1 month | 3 months | 5 months |
| Liquid milk (μg/l) | | | | |
| Breast | 15 (12·0–20·2) | 11 | 14 | 18 |
| Cow's (pasteurized) | 40 (32–52) | 24 | 35 | 46 |
| Dried cow's milk (μg/g) | | | | |
| Full-cream | 2·1 | 147 | 214 | 294 |
| Skim | 1·1 | — | — | — |

Table 2. *Concentration of manganese in some infant's foods and the amounts of Mn supplied to infants by them*

| | Mn content | | Daily Mn (μg) intake at age: | |
|---|---|---|---|---|
| | μg/g DM | μg/ml | 3–4 months | 5–6 months |
| Cereal: Farex | 28 | 9·2 | 92 | 184 |
| Ready-to-serve foods; | | | | |
| Mixed vegetables | 8 | 2·0 | 10 | 60 |
| Beef liver and mixed vegetables | 11 | 1·8 | 9 | 54 |
| Cereal and apple | 8 | 3·6 | 36 | 72 |

DM, dry matter.

in New Zealand. The breast-fed infant would have the smallest intake of Mn, less than half of that supplied by diluted cow's milk, and a tenth of that supplied by reconstituted full-cream milk powder. Diluted cow's milk is most generally used as the milk mixture.

Solid foods are introduced when the infant is 3–4 months old and by 5–6 months the baby is established on a mixed regimen. Table 2 lists the Mn present in some of these foods. At 3–4 months, the infant consumes only small quantities of these foods

(Begg, 1970) and thus also of Mn, but by 5–6 months the increasing intake of these foods would supply more than most infants were getting from milk, with Farex contributing the greatest amount.

## DISCUSSION

Breast-milk and cow's milk appeared to have a slightly higher concentration of Mn in New Zealand than elsewhere (Underwood, 1962), but only a few samples have been investigated in this and other studies. Contamination with Mn occurs frequently from the environment and from stainless-steel and aluminium utensils (Bowen, 1966). Special precautions were taken to prevent contamination of the breast-milk but the cow's milk had been pasteurized. Samples of cow's milk collected on separate days of the same week gave the extreme values in the range of Mn concentration of cow's milk (Table 1); there was no indication of a seasonal variation. Possible contamination during pasteurization would seem small compared with that during the drying of milk, for the reconstituted dried milk contained far more Mn than liquid milk (Table 1). No information is available on the form of this extraneous Mn or whether it is absorbed. Radioactive studies with adult subjects gave absorptions of 3–4% of orally ingested $MnCl_2$ using $^{54}Mn$ (Greenberg, Copp & Cuthbertson, 1943). Widdowson (1969) drew attention to the large negative balances of Mn in 1-week-old infants resulting from a faecal loss of almost 11 $\mu$g/d per kg body-weight. The large loss was ascribed to failure to reabsorb Mn secreted by the bile. Dietary supply of Mn to New Zealand infants during the first 6 months of life may vary from 2·5 to 75 $\mu$g/d per kg body-weight depending upon the age of the infant, the type of milk given and the quantity of solid foods consumed (Tables 1, 2). Nothing is known of the form or availability of Mn present in these foods, nor of how much is absorbed and retained. However, the absence of clinical symptoms of Mn deficiency in New Zealand people suggests that adaptation to the various intakes has occurred at an early age. Further, Schroeder *et al.* (1966) showed that, although the Mn concentrations of human tissues fell during the first 45 d of life, they remained remarkably constant thereafter.

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