Strontium-90 in deciduous teeth in Finland
A follow-up study

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Deciduous teeth of Finnish children born in 1958—1967 were analysed for strontium-90 by means of Čerenkov radiation. The strontium-90 content was about 9 pCi/gCa in children born in 1963—1964; the values decreased strongly in the subsequent cohorts of children. The strontium-90 content of the deciduous teeth varied in perfect unison with that of cow's milk ($r = +0.99$). The results confirm that deciduous teeth provide a practical and accurate indicator of the total body burden of bone-seeking environmental pollutants.

Key-words: Strontium-90; tooth, deciduous; milk

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Deciduous teeth have provided useful material for the determination of a number of bone-seeking elements that have entered the body from the environment; these include pollutants such as strontium-90 (*Rosenthal*, 1970; *Aarkrog*, 1971; *Rytömaa*, 1972 a) and lead (*Needleman et al.*, 1972; *Rytömaa & Tuompo*, 1974). It has previously been shown that the strontium-90 content of the deciduous teeth is an accurate indicator of the radioactive fallout contaminating the environment in Finland (*Rytömaa*, 1971, 1972 b). The material studied so far has consisted of teeth collected from children born in 1952—1963. The curve describing the radioactivity of deciduous teeth ended up with a sharp rise in 1962 and 1963, owing to the resumption of intensive atmospheric nuclear testing in 1961—1962. As only a few atmospheric nuclear tests have been carried out since 1962 (mainly Chinese and French tests), the curve for the strontium-90 content of deciduous teeth might be expected to show a decline in the children born in 1964 and later.

The aim of the present paper was to measure the strontium-90 content of deciduous teeth in Finnish children born up to 1967 and to relate the results to the strontium-90 content of milk.

MATERIAL AND METHODS

The material analysed consisted of 2091 deciduous teeth, collected in the dental clinics of the primary schools in Helsinki and Turku. The teeth were grouped according to the year of birth (1958—1967) of the tooth donor; different types of teeth were not analysed separately because it has been observed that the variation in ^{90}Sr content between tooth types is insignificant as compared to that between the years of birth of the donors (*Rytömaa* 1971, 1972 b).

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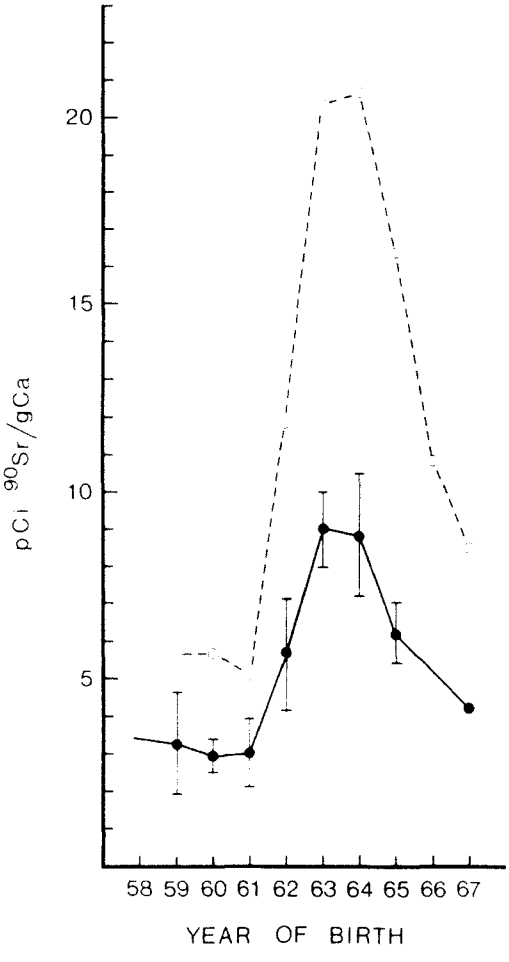

Fig. 1. Strontium-90 content of deciduous teeth in Finland (mean ± S.D.) plottet against the year of birth (o———o), and ^{90}Sr content of cow's milk in the corresponding years (o- - - o).

The radioactivities of the ashed samples were determined in a liquid scintillation counter by measuring the Cerenkov radiation produced by ^{90}Y; the techniques used have been described in detail earlier (*Rytömaa & Paakkola*, 1971; *Rytömaa*, 1972 a).

RESULTS

The strontium-90 contents of the deciduous teeth collected in Helsinki and Turku were essentially identical and the results were therefore combined; they are presented in Fig. 1.

The mean strontium-90 content of the deciduous teeth reached maximum values in the children born in 1963 and 1964 — about 9 pCi/gCa — and decreased markedly in the subsequent cohorts. The tooth material collected from children born in 1966 was too small for a reliable analysis by the present assay technique; however, eight teeth were available from the cohort born in 1967 and this was sufficient for a single sample.

Fig. 1 also shows the mean strontium-90 contents of milk collected in southern Finland in 1959—1967 (*Paakkola et al.*, 1961; *Paakkola*, 1966; *Paakkola & Castren*, 1968). A close relationship is apparent between the two sets of data; the correlation coefficient computed for the mean values was as high as +0.99.

DISCUSSION

The results of the present study show that the strontium-90 content of deciduous teeth closely follows the changes in the fall-out rate of ^{90}Sr. The peak values were obtained for children born in 1963 and 1964; in the subsequent cohorts the values decreased sharply, approching the 1958 level in the cohort born in 1967. The form of the curve is essentially identical to that obtained for the ^{90}Sr content of cow's milk in Finland (Fig. 1); it is also interesting to note that the values conform precisely to the prediction model for ^{90}Sr as described by *Aarkrog* (1971).

In the present material the maximum average strontium-90 content of deciduous teeth was 9.0 pCi/gCa for the cohort born in 1963; this is essentially the same as that observed earlier for Finnish children (9.3 pCi ^{90}Sr/gCa) (*Rytömaa*,

1972 a). It may also be noted that a depression was observed in the strontium-90 curve for children born in 1960—1961; similar findings have been made before (*Rosenthal*, 1970; *Aarkrog*, 1971; *Rytömaa*, 1971, 1972 b; *Nagai & Ishii*, 1972).

When plotted against the ^{90}Sr concentration of cow's milk, the data for deciduous teeth adequately fit a linear equation with a slope of 0.38 ± 0.02 (Fig. 2). This value may be a more correct estimate of the »observed ratio» (OR = ^{90}Sr in tooth/^{90}Sr in diet) than that obtained by direct computation, because the least squares regression line does not pass through origo. The »odd» result that deciduous teeth seem to accumulate some ^{90}Sr even in the absence of dietary strontium-90 is probably due to a small systematic methodological overestimation of the ^{90}Sr content of the tooth or to a small systematic methodological underestimation of the ^{90}Sr content of the milk, or to both these factors.

The OR value 0.38 is much lower than the corresponding ratio (0.57—0.77) in the USA (*Rosenthal*, 1970) and may be indicative of a greater frequency of breast-feeding in Finland than in the USA. It has been shown that breast milk contains only about one-third of the ^{90}Sr present in cow's milk in Finland (*Paakkola*, 1965) and that the strontium-90 content of the deciduous teeth of breast-fed children in Japan is about half that of bottle-fed children (*Nagai & Ishii*, 1972).

The results of the present study lend further support to the suggestion (*Kalckar*, 1958) that deciduous teeth afford a most useful means of monitoring the entry of several (bone-seeking) environmental pollutants into the human body (*Needleman et al.*, 1971; *Rytömaa & Tuompo*, 1974). A major disadvantage of using teeth as indicators is, of course, the fact that tooth material is not available for analysis immediately; however, with the aid of teeth it may be possible to decide which other indicators can be used to obtain reliable estimates of the total body burden of a particular pollutant.

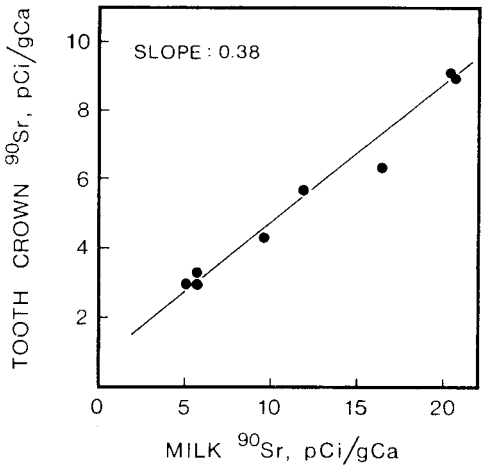

Fig. 2. Strontium-90 content of deciduous teeth versus strontium-90 content of cow's milk.

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