Pregnancy and Lactation as a Factor of Increased Accumulation of Bone-seeking Radionuclides in Maternal Body: Analysis of the Techa River data

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ABSTRACT

A unique situation on contamination of the Techa River (Southern Urals, Russia) in 1950s by long-lived ^{90}Sr allows investigation of the features of bone-seeking elements (such as Y, Pb, Ba) accumulation in humans. This study is based on information compiled at the Urals Research Center for Radiation Medicine (URCRM, Chelyabinsk, Russia) over a long-term period, that includes the results of more than 38,000 *in vivo* measurements of ^{90}Sr-body burden for 20,000 persons obtained with a whole body counter SICH-9.1; data on personal medical examinations and residence and family histories.

The effect of pregnancy and lactation on accumulation of radionuclides in maternal body is not sufficiently known since the main attention in different studies was paid to accumulation of radionuclides in fetus and infant. Significant changes occur in maternal mineral turnover during pregnancy and lactation due to fetus/infant requirements in minerals. For example, such changes during pregnancy result in increase of Ca and Sr absorption from gastrointestinal tract; Ca and Sr urinary excretion and bone remodeling rate.

Our study of about 100 women from the Techa riverside villages shows an increase in accumulation of ^{90}Sr in maternal skeleton during pregnancy and lactation by a factor of 1.5-2 in comparison with non-pregnant, non-lactating (NPNL) women. Such increase is resulted from increased consumption of water and foodstuffs during pregnancy and lactation, as well as, changes in the rates of bone mineral turnover in the mother. Water and foodstuffs consumption by women mostly increases at lactation (by 25%) than at pregnancy (by 5-10%). Another possible reason of additional radionuclide accumulation is a rapid restoration of maternal bone mineral loss during pregnancy and lactation coincided with ^{90}Sr intake.

Our study indicates an increase in accumulation of toxic elements in pregnant/lactating women compared to NPNL women that lead to increased radiation/toxic doses and risk for women

1. Techa River data is a unique source of information on metabolism of bone-seeking elements in humans

Radioactive contamination of a small river **Techa in the Southern Urals in Russia** occurred in 1949-1956 as a result of releases of radioactive materials from the first Russian site for production of plutonium, the Mayak Production Association .

About 10^{17} Bq of ^{90}Sr were released in the river; 98% of the total activity was discharged in 1950-1951.

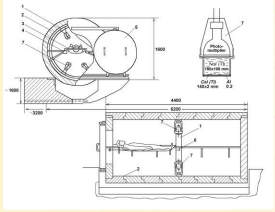
Ingestion of large amounts of ^{90}Sr by residents of the Techa riverside villages occurred mainly with river water .

Extensive radiometric and radiochemical investigations of the levels of radioactive contamination of humans and the environment have been performed in this area since mid-1951.

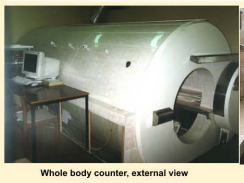
In vivo measurements were performed 25-45 years after the maximum ^{90}Sr intake with whole body counter SICH-9.1; the contents of ^{90}Sr were determined by measuring the bremsstrahlung of the ^{90}Y-beta rays with a phoswich detectors. Minimal detectable amount was equal to 2 kBq.

In total more than 30,000 WBC measurements were performed during 1974–1997. Many Techa Riverside residents were measured several times during this period. The results of WBC measurements were used for different purposes, primarily for estimation of individual doses due to ^{90}Sr.

Spectrometer for ^{90}Sr *in vivo* measurements (whole body counter)



A schematic sectional view of the SICH-9.1 whole body counter:
1 - ring for mounting the detectors;
2 - shielding, 200-mm cast iron and lining (lead, 5 mm; cadmium, 1 mm; and copper, 2 mm);
3 - movable bed;
4 - brackets for mounting the rails;
5 - door;
6 - motors;
7 - detectors (all measurements in mm).



Whole body counter, external view

Whole body counter, inside view

2. Characteristics of the women under study

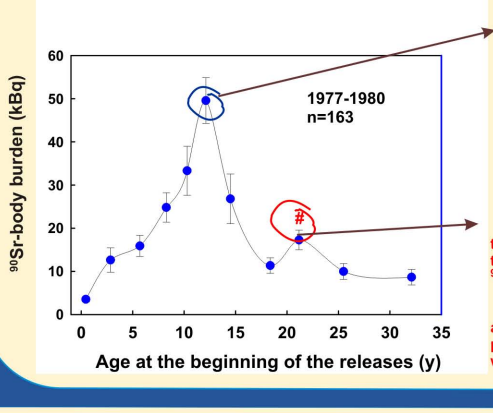
The study was performed for the settlement of Muslyumovo located in the mid Techa region (78 km from the release site). Muslyumovo was the most contaminated of the non-evacuated villages, and is often taken as the reference settlement for dosimetric investigations as it had a population of about 3,000 persons and has been studied in detail.

Women who lived in Muslyumovo during the whole period of releases and were later measured with whole body counter (WBC) have been selected for the analysis.

Persons from the studied group were examined at the URCRM Clinical Department for several times, in relation to their radiation exposure and possible resulting changes in their health status. In particular, the URCRM databases contain information on date of labors, number of children and other relevant data.

The WBC data for women of reproductive age have been analyzed. Those women who were pregnant and lactating in the period of maximal ^{90}Sr intake have been of the main interest in our study.

3. Age dependent ^{90}Sr-body burden for Muslyumovo women: results of direct measurements performed in 1977-1980 (30 year after the onset of intake)



Adolescents in the period of maximal ^{90}Sr intake; maximal skeletal growth and mineral accumulation resulted in significant ^{90}Sr retention

80% of women from this group gave birth in the period of maximal ^{90}Sr intake.

In other groups of adult women the percentage of parous women was 25-50%

4. Comparison of ^{90}Sr accumulation in women who were of different reproductive status in the period of maximal ^{90}Sr intake (1950-1951)

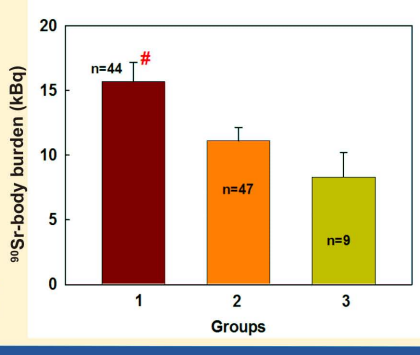
For the analysis, normalized values of ^{90}Sr-body burden have been used. For this purpose, WBC measurements performed in 1974-1997 have been normalized to a fixed date (1980) using individual or grouped-average ^{90}Sr elimination rates. Women aged 20-30 years at the beginning of ^{90}Sr intake were considered (n=100).

The following groups were selected:

1. Women who gave birth in the period of maximal ^{90}Sr intake (1950-1951)

2. Women who gave birth after the period of maximal ^{90}Sr intake

3. Women who gave birth before the period of ^{90}Sr intake or were childless



Women who gave birth in the period of maximal ^{90}Sr intake have higher ^{90}Sr-body burden by a factor of 1.5-2 compared to women who gave birth after or before this period or did not have children.

The reasons for increased ^{90}Sr-body burden are:

1. Increase in ^{90}Sr dietary intake in the period of pregnancy and lactation
2. Increase in Ca/Sr bone turnover rate in pregnancy and lactation
3. Rapid restoration of maternal bone-mineral loss during pregnancy and lactation coincided with ^{90}Sr intake

Conclusions

The increase in ^{90}Sr accumulation in the maternal skeleton during pregnancy and lactation results in higher absorbed dose in the red bone marrow.

The increase in the absorbed doses due to child-bearing should be taken into account in assessment of health effects in women.

Our results indicate increased risk for pregnant/breastfeeding women due to elevated accumulation of toxic bone-seeking elements, such as Pb, Ba, U.

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