Mercury Content of Hair of Japanese after Emigration to Burma or East Pakistan

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In Japanese who had sojourned in foreign countries for more than one and a half years, the mercury content of the hair has been reported to increase gradually after returning to Japan (1). After one to two years the mercury content of the hair attained levels similar to that observed among resident Japanese. This phenomenon can be explained as the transition from one state of dynamic equilibrium between intake and excretion of mercury at a low level to another equilibrium at a high level. Problematic variations in mercury content due to sampling errors should have been cancelled during this interval of one to two years.

These results are understandable in the light of the following facts: First, the principal source of methylmercury in the usual Japanese diet is marine fish. Second, the biological half-life of methylmercury, measured on human volunteers, is about 70 days (3, 4). Third, insofar as the whole-body retention of mercury is concerned, methylmercury has the longest half-life among the various mercurials measured in rats and cocks (5, 6, 7). Finally, if it is assumed that the retention curve for mercury can be calculated from the hypothesis that the amount of excretion is simply proportional to the amount in the body, the time to attain a dynamic equilibrium is ten times the half-life (8).

However, the transition from a high to a low level equilibrium requires varying times that are determined not only by the half-life but the difference between the levels. In this report, the authors report the results obtained by measuring the mercury content in hair of the Japanese with varying periods of sojourn in Burma or East Pakistan and of the Burmese and the Pakistani who were working with the Japanese.

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Subjects and Methods

The Japanese in Burma or in East Pakistan were engineers and laborers engaged in the construction of factories. In Burma they lived and worked at Sale, which is located in a dry region near the east bank of the river Irrawaddy. In East Pakistan they resided and worked in the city of Chittagong (Fig. 1).

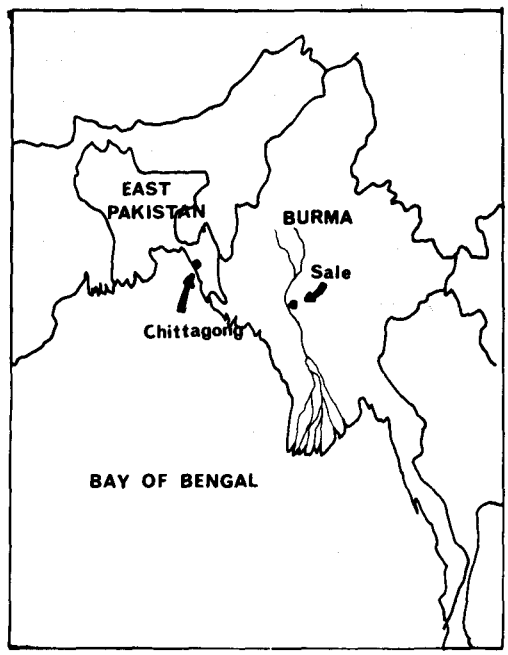

FIGURE 1. Location of Sale and Chittagong

There was a clear difference between food intake of Japanese in Burma and in East Pakistan. In Burma, they bought all foodstuffs in Sale, Rangoon or surrounding towns and villages except a few kinds of Japanese food such as soya bean sauce, miso (soya bean paste) and others. Chinese cooks were employed who prepared daily dishes of a mixed style with Japanese and Chinese cookings. Canned food from Japan, beef, whale meat, vegetables and a variety of marine fish provided the main food for lunch of Japanese in Chittagong,

East Pakistan. They were served by cooks of Christian Bengalese who made Japanized dishes by using imported rice from Formosa and other foodstuffs including locally available meat, fish and vegetables for breakfast and dinner. Fish was eaten more frequently in Chittagong than in Sale. In the latter, the chance was only given by sending a truck to Rangoon once a month for buying marine products.

Number, sex, years of age and period of sojourn of the subjects examined are shown in Table 1. The male Burmese whose hair was sampled were household servants of the Japanese. A boy 4-years-old was a son of Burmese widow who was a manager of the canteen for Burmese workers. Other female Burmese were working at the construction site as porters. The Burmese had not changed their food habits. Even the house workers were eating original Burmese dishes including curried rice with meat or fish, and vegetables. Fish was mainly river fish.

Pakistani workers were divided into three groups: (1) Moslem clerical workers, (2) Christian cooks, and (3) Hindu women sweepers. Socially and economically, Moslem Bengalese were the top group, and some of them positively imitated the Japanese way of life in every aspect. The second position was occupied by Christian Bengalese who cooked the dishes of their own menu by and for themselves. The fish

TABLE 1

Subjects Examined for Mercury Content in Their Hair

Subject	Sex	No.	Years of age mean (range)	Period of sojourn (months) mean (range)
Burma				
Japanese	male	30	33.0 (25-47)	6.0 (1-17)
Burmese	male	9	31.0 (4-53)	---
Burmese	female	12	25.3 (13-48)	---
East Pakistan				
Japanese	male	12	28.3 (21-39)	10.2 (6-15)
Pakistani	male	10	32.1 (18-57)	---
Pakistani	female	3	35.0 (*)	---

* All were 35-years-old.

was eaten daily. The Hindu were the lowest in caste and also in their income.

The sample of hair was obtained from the frontal part of the head. The cuttings were 2 to 3 cm in length and weighed about 100 mg. The hair was not washed before oxidation with a solution of conc. H_2SO_4 and conc. HNO_3 in a reflux condensor. The oxidized solutions were analyzed by mercury vapour photometry (9).

Results

The results are depicted in Figs. 2 and 3.

The mercury content of the hair of the Japanese in Sale, the male Burmese of the female Burmese was, on the average, 3.52, 2.90 or 2.39 μg/g, respectively. There were no significant differences among three averages, but the values from

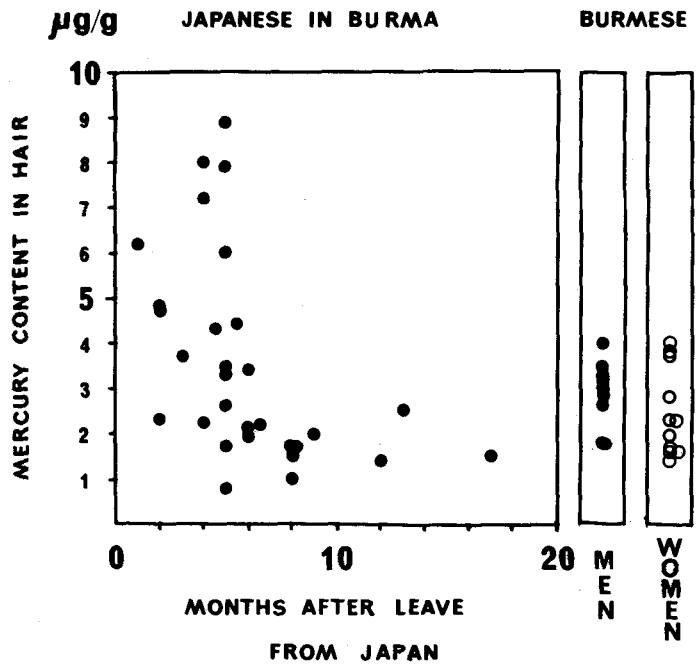

FIGURE 2. Mercury content of hair from the Japanese and Burmese in Sale

the Japanese after a stay of six months in Sale were clearly diminished compared to those from the Japanese whose sojourn was less than six months. The averages were 4.28 μg/g in the latter and 1.72 μg/g in the former (a statistically significant difference by F-test, $p < 0.05$).

Even after a stay of ten months or more no diminishing tendency was observed in the mercury content of the hair from the Japanese sojourning in Chittagong (Fig. 3). The variability of mercury content in hair from male Pakistani was similar to that observed among the Japanese. The three female Pakistani had very low levels. This observation is in striking contrast to the observations on Burmese (Fig. 2).

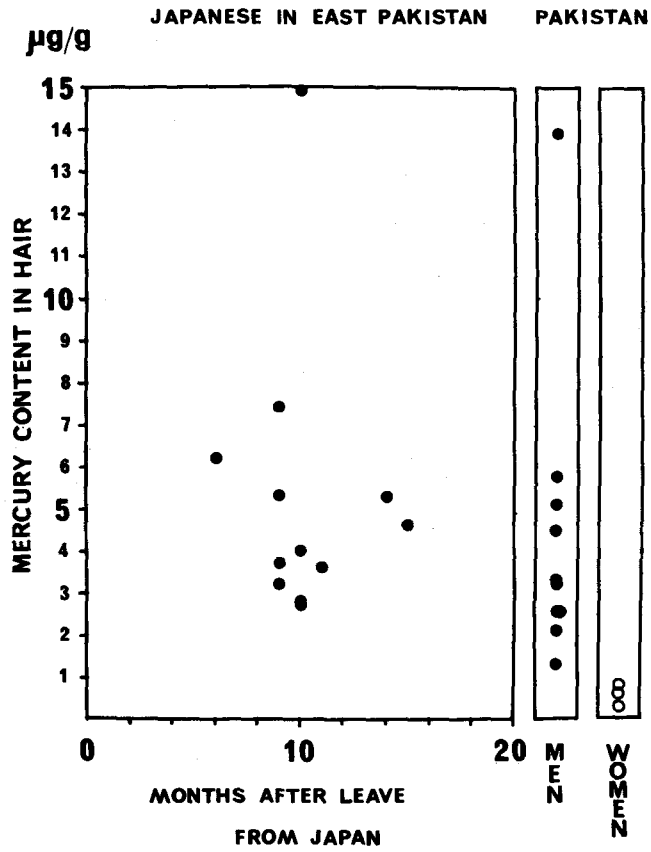

FIGURE 3. Mercury content of hair from the Japanese and Pakistani in Chittagong

Discussion

There appear to be appreciable differences in human exposure to environmental mercury in Sale and Chittagong. One thinks first of exhaust from factories using any form of mercurials and the use of mercury-containing fungicides. In both cities these sources of environmental mercury were not noticed. Consequently, we suspect that the consumption of marine fish accounts for the differences observed in mercury content of hair, though we did not determine the mercury content in food eaten by the subjects.

Socially, economically, and/or culturally determined food habits may play an important role in the transfer of mercury from the environment to man. The persistence among the Japanese of native food and fishing-eating habits are implicated. As one more example, the results of a study on Japanese immigrants to Bolivia and Brazil are worthy of mention (10). Very low values were obtained for the mercury content of the hair from Japanese inhabitants in Bolivia, where the colony subsisted under conditions in which fish was scarce and mercurials were not employed in agriculture---average and standard deviation were 1.3 and 0.74 μg/g, respectively. High values were observed among Japanese in northeastern Brazil, where methoxyethylmercury salts were used in agriculture and fish was eaten frequently---average and standard deviation were 5.7 and 6.2 μg/g, respectively.

There is one more point to be discussed: the length of time for a transition between two different equilibria. The data on the Japanese in Sale served in this analysis. Taking into account the fact that the rate of hair growth is about 1.5 cm/month (11, 12), it may be concluded that the sampled hair had started to grow 2-6 months prior to sampling. The large variation of mercury levels among Japanese in Sale who had stayed 4-6 months is thus explained.

It was supposed that the condition of equilibrium in Japan was reflected in hair sampled up to 4 months of sojourn. The data from that time were fitted to the equation:

$Y = A\, e^{-Bt} + C$ (Y, mercury content in hair; e, the base of a natural logarithm; t, time expressed by month; A, a constant; B, a constant meaning a turn-over rate of mercury; and C, a constant meaning a value at the equilibrium after transition).

With the aid of an electronic computer, the equation: $Y = 4.3\, e^{-0.65t} + 1.5$, was found by the method of least

squares (13). The turn-over rate of -0.65 in a month corresponds to the biological half-life of 1.1 months (33 days), which is clearly shorter than the half-life of methylmercury in man, 70 days. If the equation correctly reflects the actual decrease of mercury in the body, we shall consider the mixed uptake of methylmercury and other mercurials with shorter half-lives in Japan or in Sale.

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