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Epidemiological study of clinical signs and symptoms of mercury poisoning in fish consumers residing in five villages along Thane Creek and Ulhas River Estuary near Mumbai, India

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Abstract

The fish of Thane Creek and Ulhas River Estuary are contaminated with mercury. The traditional fishing folks residing along these water sources consume large amounts of these fish for their sustenance, therefore, being vulnerable to mercury poisoning. A survey on the clinical signs and symptoms of mercury poisoning was carried out in Wehele, Alimgarh and Diwe-Kewni along Ulhas River Estuary and Vittawa and Airoli along Thane creek. Fortunately, no alarming signals of mercury poisoning could be detected in these populations. Genetic make-up and/or use of onion and garlic in the fish preparations could be the probable detoxifying factors in these populations. However, these populations being vulnerable to mercury poisoning, continuous monitoring is recommended in these areas.

***Key words*:** Fish consumption, Mercury contamination, Neurological disorder, *Tilapia* spp

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Introduction

Exposure to mercury leads to numerous abnormalities. However the severity of abnormalities depends on the degree and dose of the exposure. Short term exposure to high doses of contaminants leads to harmful effects like the one occurred in Minamata incident of Japan. On the other hand, long

term exposure even to low doses can also lead to numerous abnormalities. In these cases, symptoms occur even at mild doses but these usually go unnoticed as they are practically indistinct. Only chronic exposure leads to some noticeable neurological, psychological and even congenital disorders. Some of the common symptoms associated with mercury poisoning are headache, fatigue, numbness of extremities, depression, cramps and convulsions, hearing impairments, tunneled vision, memory loss, lunatic fringe, delay in motor and language developments, emotional instability, increase in perspiration, sleep disorders, slurred speech, hair loss, high BP, poor muscular co-ordination, allergic reactions, tremors, memory disturbances, Ataxia and Dysmetria (Down to earth supplement, 2003; UNEP, 2007).

Several studies, in the past, have revealed that Thane creek and Ulhas River Estuary are highly polluted (MMR-ES Project, 2003). The Hg concentration in the fish was analyzed to be high in both Thane creek and Ulhas River Estuary, in comparison to the safety limits proposed by WHO (Menon and Mahajan, 2011). A study on the fish consumption pattern revealed that the traditional fishing communities residing in different villages along Ulhas River Estuary and Thane creek are highly dependent on the estuarine/creek fish for their dietary mainstay and consume large quantities of fish (Menon and Mahajan, 2013). A detailed study on the exposure of these populations to Hg revealed that though their dietary intake of Hg was high, their average Hair Hg concentrations were moderate (Menon and Mahajan, 2012).

An overall picture depicts that although these populations are chronically exposed to mercury due to their high dietary intake through fish consumption, accumulation of this potent neurotoxin in their hair is not very elevated. However, these populations were vulnerable to Hg poisoning and this phenomenon could not be overlooked. Hence, in the present study, an attempt has been made to study the prevalence of any clinical signs and/or symptoms of Hg poisoning and thereby warn the people about the future threats and frame recommendations on how to curb mercury poisoning.

Materials and methods

Study areas

The 54 km stretch downstream of Ulhas River (72°54'E and 19°17'N), which is estuarine and known as Ulhas River estuary (URE), is under the burden of a large number of industrial wastes and domestic sewage (Fig. 1). Intensive monitoring under the Department of Ocean Development (DOD) has identified Ulhas River Estuary as 'Hot spot of pollution' (MMR-ES Project, 2003).

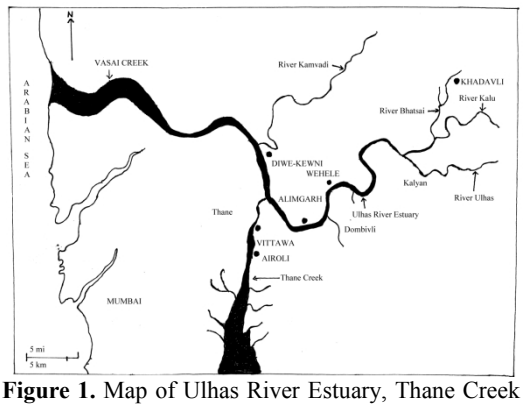

Figure 1. Map of Ulhas River Estuary, Thane Creek and study areas.

The Thane creek (72°55'E 19°00' N to 73°00'E 19°15'N) is 26 km long. It is connected to the Mumbai harbour on its

south and joins by minor connection with the Ulhas River on its north. On the east bank exists Thane-Belapur industrial belt, which is Asia's largest industrial zone, along with Navi Mumbai Urban Area. The west bank has highly urbanized and industrial regions of Mumbai and Thane. Since 1995, the creek is also being indiscriminately used as a dumping ground for huge quantities of solid wastes (Quadros *et al.*, 2001).

Five villages namely Wehele, Alimgarh and Diwe-Kewni along Ulhas River Estuary and Vittawa and Airoli along Thane creek were surveyed for the present study. Majority of people in these villages depended on the estuarine/ creek fish for their dietary mainstay. They seldom consumed other food items except rice and Bhakhari (traditional wheat bread) which were taken along with fish almost thrice a day. These villages were comprised of socio-economically weaker sections of the society whose main profession had been fishing in the earlier decades. However, now very few families are engaged in fishing. This, they comment, was due to the decline in fishery owing to polluted waters. A brief description of the study villages are given below.

Wehele: It is a small village situated on the northern bank of Ulhas River Estuary (19°14'N and 73°03'E). It is located on the opposite bank of the densely populated and industrial zone of Dombivli. The commonly consumed fish by this population are *Mugil spp., Mystus spp., Tilapia spp., Mudskippers, Lates spp. ,Scylla serrata, Prawns* and *Arius spp* (Menon and Mahajan, 2015a). The fish consumption rate of Wehele population was 3.23 g/kg body wt/week, and the Dietary intake was calculated as 1.71 µg/kg body wt/week (Menon, 2009).

Alimgarh: A small village on the northern bank of Ulhas River Estuary, Alimgarh lies 19°12'N and 73°02'E at a distance of 12 km from Thane city. It is located 7 km downstream of the village Wehele on the opposite banks of the town of Mumbra and is equally polluted. The commonly consumed fish are *Mugil spp., Mystus spp., Tilapia spp., Lates spp., Scylla serrata, Megalops spp., Therapon spp.,* prawns and *Boleophthalmus spp*. (Menon and Mahajan, 2015a). The fish consumption rate in Alimgarh was observed to be high with 5.47 g/kg body wt/wk and the dietary intake was also as high as 3.15 µg/kg body wt/week (Menon, 2009).

Diwe-Kewni: The twin villages of Diwe-Kewni are situated on the northern bank of Ulhas river estuary at 19°16'N and 73°E. The commonly available fish are *Mugil spp*. *Mystus sp, Tilapia spp., Arius spp., Scylla serata, Boleophthalmus spp.,Therapon spp.* and prawns (Menon and Mahajan, 2015a). The average fish consumption and dietary intake of Hg of this population was estimated to be 5.91 g/kg body wt/week and 2.84 µg/kg body wt/week (Menon, 2009).

***Vittawa*:** It is a village situated along 19°11'N and 72°59'E on the eastern bank of Thane creek at a distance of only 3 km from Thane city. Commonly consumed fish include *Mugil spp., Mystus spp., Tilapia spp., Megalops spp., Arius spp.,* Prawns *and Scylla serrata.* (Menon and Mahajan, 2015a). The average fish consumption was found to be 3.15 g/kg b wt/wk and the die-

tary intake of Hg was 1.75 µg /kg body wt/week. (Menon and Mahajan, 2015b).

***Airoli*:** Airoli is situated at 19°18'N and 72°59'E on the eastern bank of Thane creek at a distance of 8 kms from Thane city. The commonly available fish are *Mugil spp., Tilapia spp., Lates spp.*, prawns and *Scylla serrata.* (Menon and Mahajan, 2015a). The average fish consumption of the population of Airoli was calculated to be high as 5.03 g/kg body wt/week whereas the dietary intake of Hg was calculated as 1.79 µg/kg body wt/week.

Questionnaire

The survey was conducted in the study areas with a custom-made questionnaire. Only estuarine fish consumers were considered for the study. This questionnaire comprised four parts. The first part included the socio-demographic characters and anthropometric details of the subjects. The second part included the fish consumption pattern of the villagers. The third part comprised the medical history, health conditions and any other signs and symptoms of Hg poisoning observed in the subjects. A fourth part of the questionnaire included questions based on the profession of the subject.

Results and discussion

Table 1 shows the epidemiological details of the fish consuming populations. Table 2 shows the average fish consumption, average dietary intake of Hg and average Hair Hg levels in the populations of the study areas as per earlier studies. Table 3 and 4 present the percentage of the clinical signs and symptoms observed in the study areas.

Tables 3 and 4 reveal that the percentage of clinical signs and symptoms related to mercury toxicity are low in the population. The reasons for such a low percentage of clinical signs and symptoms in spite of a high dietary intake can be attributed to the following factors.

In the survey, it was observed that fish was consumed mainly by boiling i.e. making curry. During cooking of fish by boiling (making fish-curry), the use of garlic, and other spices was a regular practice. Onion and garlic are known to contain selenium which interferes in the Hg metabolism suppressing Hg accumulation (WHO Food additives series: 44). Selenium oxide is an effective antagonist to the toxic effects of mercuric chloride in fish (Kim *et al.,* 1977). Selenium has been shown to counteract the toxicity of methyl-Hg in many systems (Whanger, 1992), including neuron cultures. Both Selenium and vitamin E reduced the toxic response of the nervous system to Hg exposure (Park *et al.*, 1996). This may probably be one of the factors for having low prevalence of clinical signs and symptoms of Hg accumulation in spite of a high dietary Hg intake in the study areas. It should be noted that the use of onion, garlic and other spices are rare in the preparation of the other countries.

Rate of excretion of Hg is different in different ethnic groups (Canuel *et al*., 2006). It has been proved by Canuel that the rate of Hg excretion depends upon enzyme Glutamine-S-transferase, the secretion of which may vary with ethnic races. A speculative analysis reveals that the clinical signs and symptoms appear comparatively more in the populations of Wehele, Alimgarh and Diwe-Kewni in comparison to Vittawa and Airoli, thereby showing their increased vulnerability to Hg toxicity to some extent. The possible reason for this difference may be genetic variability and

Table 1. Socio-demographic characters, literacy rate and professions of the populations of the study areas.

Population	Wehele		Alimgarh		Diwe-Kewni		Vittawa		Airoli	
	N	%	N	%	N	%	N	%	N	%
MEN	80	33.06	67	31.46	55	28.21	56	32.94	56	32.18
WOMEN	109	45.04	84	39.44	85	43.59	72	42.35	77	44.25
BOYS	28	11.57	21	9.86	24	12.31	22	12.94	19	10.92
GIRLS	25	10.33	41	19.25	31	15.90	20	11.76	22	12.64
Total	242	100	213	100	195	100	170	100	174	100

Professions	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Farming	19	7.85	14	6.57	6	3.08	0	0.00	0	0.00
Housewife	91	37.60	68	31.92	79	40.51	52	30.59	61	35.06
Business	24	9.92	14	6.57	18	9.23	23	13.53	19	10.92
Sand-dredging	20	8.26	23	10.80	4	2.05	0	0.00	0	0.00
Self-employed	5	2.07	0	0.00	0	0.00	0	0.00	0	0.00
Unemployed	15	6.20	9	4.23	5	2.56	13	7.65	13	7.47
Service	6	2.48	5	2.35	13	6.67	17	10.00	27	15.52
Fishing	9	3.72	20	9.39	11	5.64	9	5.29	4	2.30
Infants	12	4.96	5	2.35	14	7.18	9	5.29	7	4.02
Student	41	16.94	55	25.82	45	23.08	42	24.71	39	22.41
Retired	0	0.00	0	0.00	0	0.00	5	2.94	4	2.30
Total	242	100.00	213	100.00	195	100	170	100.00	174	100.00

Table 2. Averages of fish consumption, dietary intake and hair Hg levels in study areas.

SN	Study Villages	Average fish consumption of population in g/kg body wt/wk	Average Dietary intake of Population in µg/g/kg body wt/wk	Average Hair Hg levels in population in µg/g
1	Wehele	3.23	1.71	6.74
2	Alimgarh	5.47	3.15	8.87
3	Diwe-Kewni	5.91	2.84	9.02
4	Vittawa	3.15	1.75	4.84
5	Airoli	5.03	1.79	5.37

Source: Menon (2009), Menon and Mahajan (2012), Menon and Mahajan (2015b)

Table 3. Common Clinical signs and symptoms related to mercury toxicity observed in the populations of the study areas

SN	Clinical signs and symptoms	Wehele	Alimgarh	Diwe-Kewni	Vittawa	Airoli	Avg
1	Headache	9.8	10.1	9.2	2.7	5	7.36
2	Limb pain	6.5	0	4.6	2.03	1	2.83
3	Weakness	3.2	0	3.2	2.7	0	1.82
4	Arthritis	3.9	2	0	6.08	0	2.4
5	Chronic cold and cough	3.2	4.7	7.2	1.35	4	4.09
6	Weak eye sight	2.6	3.38	0	0.67	2	1.73
7	Neural problems	0.6	4	2.4	0	0	1.4
8	Breathlessness	1.3	6.08	0	4.05	1	2.49
9	Rashes on skin	1.9	4	4.6	1.35	1	2.57
10	Swelling of limbs	6.5	0.6	2.6	0	1	2.14
11	Low memory	1.9	0.6	2.6	0	0	1.02
12	Dizziness	0.6	0.6	1.6	0.67	0	0.69
13	Blurring of eyes	0	0	0	0	1.35	0.27

14	Psychological problems	0	0	0	0	0.67	0.13
15	Late speech	0.6	0.6	0	0.67	1	0.57
16	Numbness of finger	0.6	0.6	0.65	0.67	0	0.5
17	Shivering of limbs	0.6	0	0.65	0.67	0	0.38
18	Hearing problems	0	0	0.65	0.67	0	0.26
19	Mental retardation	0	0	0.65	0	0	0.13
20	Physical retardation	0	0	0.65	0	0	0.13
21	Paralysis	0.6	0	0.65	0	1	0.45
22	Epilepsy	0.6	1.3	0	0	0	0.38
23	Spondylosis	1.3	3.38	2.6	2.03	3	2.46
	Average	45	38.56	41.9	24.28	19.02	

Table 4. A few other probable clinical signs and symptoms observed in the population of the study areas

SN	Clinical signs and symptoms	Wehele	Alimgarh	Diwe-Kewni	Vittawa	Airoli	Avg
1	Backache	6.5	4	0.65	3.38	6	4.11
2	Menstrual disorder	16.6	0	20	6.08	3	9.14
3	Miscarriage	5	0	12.7	2.03	0	3.95
4	Dental caries	3.9	8.1	5.2	4.73	3	4.99
5	Diabetics	2.6	4	1.3	3.38	2	2.66
6	Allergy	1.9	0.6	4.6	0	0	1.42
7	Constipation	0	0	7.8	0	0	1.56
8	Low weight	0.6	0.6	3.9	1.35	1	1.49
9	Stomach pain	1.3	2	3.9	1.35	1	1.91
10	Chest pain	0	0	3.2	0	0	0.64
11	Vomiting	0	0	3.2	0	0	0.64
12	Watery eyes	1.3	0	3.9	0.67	0	1.17
13	Fibroids in uterus	0	0	0	6.08	0	1.22
14	Heart ailments	1.3	0.6	0.65	1.35	4	1.58
15	Low birth weight	0.6	0.6	0.65	0.67	1	0.7
16	Infant mortality	0	0	0.65	0	0	0.13
	Average	41.6	20.5	72.3	31.07	21	37.31

ethnicity of the populations as proposed by a few other workers (Yamaguchi *et al*., 1975; Canuel *et al*., 2006).

Conclusion

Though the present study sounds no alarming bells of any signs, symptoms or abnormalities in the population, it is no indication of the total safety of the fish consuming population. Continuous monitoring of the contaminant levels and recommendations based on the fish consumption patterns must be carried out. As most of the observed symptoms of chronic mercury exposure can have a variety of other possible causes, they are not particularly helpful in singling out mercury as the main culprit. Therefore, the symptoms observed need not be due to mercury poisoning alone. A detailed study in this aspect is necessary.

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