Methodology of This Study

In keeping with the conceptualization of Social Epidemiology and ICIDH, a methodology was designed to study the social determinants and social consequences of arsenic toxicity in a rural area of West Bengal.

Objective

The research on arsenic poisoning had been planned starting with following objective: "To study impairment, disability and handicap due to arsenic poisoning in West Bengal at community level in order to identify the factors influencing its extent, distribution and impact as well as the response to the problem."

Research Questions

The following research questions were devised in order to operationalise the study's objective:

1. What is the extent, distribution and severity of manifestations of arsenic poisoning?
2. Which are the factors influencing the intensity of the toxic effects (i.e. impairment) of arsenic on exposed people e.g. levels of arsenic in the water source, duration of exposure, access to optional sources, nutritional status, consumption pattern of food, water?
3. What are the difficulties experienced by the affected people and their household members in their day-to-day life and what factors influence the degree of impact (i.e. disability and handicap)?
4. What has been the community response to the problem?
   a) Perception of the problem of arsenic poisoning of the affected and unaffected people.
   b) Understanding about the solution of the problem and action taken by the affected and unaffected people in order to tackle the problem.
   c) The attitude of others in the community towards the diseased - unaffected household members, neighbors, relatives, employers, traditional healers, private practitioners, formal and informal leaders.
5. What has been the official institutional response to the problem? What are the preventive, curative and rehabilitative measures undertaken?
6. What are the policy implications of the findings of the study for preventing and treating arsenic poisoning and limiting its impact in West Bengal?
Data Required

The data necessary to answer the research questions:

1. General profile of the district (area, population, number of blocks, villages, occupation, literacy, agriculture, irrigation, economy, culture and society).
2. Affected part of the study districts, number of affected blocks, villages, households and population.
3. Demography of study block, occupation, number of villages etc.
4. In the study villages

   **Socio Economic Profile:**
   i. Demographic Profile
   ii. Socio Economic Status
   iii. Occupation and household activities
   iv. Political structure
   v. Caste, religion, gender
   vi. Literacy, education facility and communication channels
   vii. Migration
   viii. Health service
   ix. Transport facilities

   **Nutritional Status**
   i. Food habits and eating patterns
   ii. Nutritional status measurement by anthropometric measurement and clinical signs.

   **Exposure to Arsenic**
   i. Measurement of arsenic in all water sources
   ii. Water consumption patterns

   **Impact of Arsenic Poisoning**
   i) Manifestation of arsenic poisoning of all patients
   ii) Difficulties in day-to-day life like in occupational and household activities and also on families arising from manifestation of arsenic toxicity.
   iii) Impact on social, cultural and political participation.

   **Official Response in the villages**
   i) Administrative measures
   ii) Preventive, curative and rehabilitative services
Study Design

Sources of Data

The required data collected from a variety of sources was.

Secondary data

i. Report of individual and household survey conducted by the district panchayat through local panchayat (land holding, occupational pattern, secondary income) from Panchayat Office.

ii. Arsenic levels in ground water and surface water from the survey conducted by the Public Health Engineering Department at district level and SOES, Jadavpur University, Calcutta, through individual effort.


iv. Literature Survey (from journals, newspaper, CDROM, and Internet) in different libraries (JNU, AIIMS, NML, INSDOC, WHO, UNICEF in New Delhi, Bose Institute, AIHPP, STM in Calcutta).

Primary data

Generating data on clinical manifestations, disability, handicap, arsenic level, social, political, cultural, economic life in study villages, impact of arsenic on village life through an in-depth community based study. The methods used are given below.

i. Survey of study population at household level using clinical assessment and schedule based interviews to identify individuals manifesting arsenic toxicity.

ii. In depth study of these individuals with interview and complete clinical assessment.

iii. Observation of day-to-day activities and impact of arsenic poisoning.

iv. Measurement of arsenic of ground water & surface water by field-test kit.

v. Focus Group Discussion separately with arsenic patients, men, women, politicians and health workers.

vi. Informal discussions

Study Population

Selection of District

Out of seven districts (in 1996, number of affected districts were seven, later, the eighth district of Howrah was also detected), Murshidabad was chosen as the study district for the following reasons:

- Along with South 24 Parganas district (adjoining Calcutta), Murshidabad was the first arsenic detected district [Chakraborty D, 1996(a)].

- In 1994 and 1996 studies conducted by SOES, Jadavpur University, Calcutta showed that Murshidabad is the worst affected district in terms of number of arsenic affected blocks, total area of arsenic affected block, total number of arsenic affected villages,
approximate number of people drinking arsenic contaminated water and approximate number of people showing arsenic related skin manifestation. (See table 2.1)

- Calcutta is the only place where proper treatment facility is available and Murshidabad is the farthest district (except Malda district) from it.

(See map of West Bengal with location of Murshidabad district in the next page)

**Selection of Block**

In Murshidabad district, one block (Domkol) was chosen from 14 arsenic affected blocks for the following reasons.

- Along with Raninagar II, Domkol was the first arsenic detected block (before 1990) [Chakraborti D, 1996(a)].
- Along with Raninagar I + II, and Jalangi, Domkol was located in the corner of the district from where communication with district town and Calcutta had been very difficult.
- Seemed best for developing rapport and getting co-operation from community: According to Chief Medical Officer and Deputy Chief Medical Officer (Health Education) of Murshidabad district, Domkol block was more convenient as compared to Raninagar I & II and Jalangi. The reasons that were given by them – Block Sanitary Inspector and Block Health Education Officer of Domkol block were more actively involved in dealing with arsenic patients. They took the initiative to conduct studies in number of villages to identify arsenicosis patients and were well acquainted with the problem. In fact, it has been reported elsewhere that due to government inaction in tackling the problem many villagers of arsenic affected villages were not willing to co-operate with the government staff and especially with unknown outsiders.
- In the aforementioned blocks (except Domkol) the situation was not conducive from the security point of view to study. This was communicated by the district MO and Deputy CMO. Assurance from Block Sanitary Inspector, Block Health Education Officer, Block Medical Officer, Block Panchayat members and local panchayat leaders also encouraged selecting `Domkol' as study block.
- Secondary data was available for Domkol block: Further inquiry revealed that many panchayat offices (both arsenic affected and unaffected villages) of Domkol block had complete reports of household level socio economic study conducted by panchayat officer. It is noteworthy that due to protest from various opposition leaders in many other blocks the household survey had been stopped. The household survey report later proved to be a very important tool in stratifying socio-economic status of the entire households of the study villages.
- Domkol was the block where once a big arsenic camp had been organized. A number of national and international level experts arrived & stayed at the block head office, where they diagnosed and examined thousands of patients and measured arsenic level of water samples brought by the villagers.

(See map of Murshidabad district with location of Domkol block in the next page)
Map 1: Map of West Bengal Showing Location of Murshidabad District
Map 2: Map of Murshidabad District Showing Location of Domkol Block
Selection of Study Villages

That a single researcher would visit every village in the block was not logistically feasible. Therefore it was decided to undertake an in-depth study of five arsenic affected villages to make the research meaningful and valid. After discussion with Block Sanitary Inspector and Block Health Education Officer, five study villages around Garaimari PHC, which were affected by arsenic, had been chosen. Selection criteria of the study villages are given below:

i. All villages were severely affected by arsenic and were known to the villagers
ii. Villages were located near the PHC.
iii. Panchayat offices had complete record of household level socio economic status of these villages.
iv. Block Sanitary Inspector and Block Health Education Officer were familiar with all five villages as they participated in arsenic survey in these villages and villagers also knew them very well and were friendly.

Note: The names of the villages are not mentioned in order to avoid stigma and discrimination (detail description on this issue is in next chapter).

(See map of Domkol block with location of study villages in the next page)

Preparatory Phase

Much before selection of study district in the month of July to September 1996, I accompanied the epidemiological team of Department of Gastroenterology, Institute of Postgraduate Medical Education & Research, Calcutta who were conducting research on arsenicosis patients in South 24 Parganas district and attended once a week out door for arsenic patient at the same department to gain experience in diagnosing arsenic patients, grading severity of symptoms, differential diagnosis and to get first hand experience of community and household level problems.

Preliminary Exploration and Pilot Study

After selecting study villages, a preliminary survey had been conducted in order to get broad overview of arsenic problem at community level. A rapid appraisal had been done in one affected study village by selecting fifteen patients by purposive sampling (men, women, young, old, rich, poor, farmer and of other occupation) taken from a list of patients provided by Block Health Education Officer. Apart from rapid appraisal, all study villages had been visited; panchayat leaders, doctors and other health workers were informally interviewed. The objectives of preliminary survey were as given below:

- To know the symptomatology of arsenicosis, history of manifestation and treatment seeking behavior in the study area.
- To get familiar with the impact of arsenic poisoning on individual, households and to ascertain the societal response.
- To understand the perception of arsenic poisoning of the common people.
Map 3: Map of Domkol Block Showing Location of Study Villages
• To know the socio economic status, caste and religion, occupation, education, water supply and uses, sanitation facilities and practices, health service, food habits and culture of the study villages.
• To develop rapport with people in the area

After analyzing the preliminary survey report and pilot study, a schedule was made for main study and used for field-testing in one of the study villages. After getting feedback from field-testing, some sections of schedule were modified according to requirement. Rapport was established with local leaders, teachers, ANMs, quacks, shop keepers. Field-testing of schedule was done from 17th June 1997 to 24th June 1997.

Before starting primary data collection, complete household survey data from panchayat office was collected and arsenic level of ground water from Public Health Engineering dept., Murshidabad District were ascertained. All villagers from the study villages were to be screened to identify patients with arsenic symptoms. During screening, in-depth study of each case had been conducted after diagnosis as per the schedule. Each schedule was meant for a single case. Dermatological manifestations [Pigmentation, hypo-pigmented patch (de-pigmentation)] were the criteria to identify arsenic patients.

Data collection

The main phase of fieldwork started on 1st July 1997 and continued till 26th September 1997. Due to flood, some areas of study villages became inaccessible and hence field visits had to be postponed. It resumed on 24th Oct 1997, starting with arsenic measurement of unmeasured water source with the help of scientists of Bose Institute, Calcutta followed by data collection from the persons affected by arsenic toxicity and continued till 6th Feb 1998. After 21 days of interval, fieldwork resumed on 28th Feb 98 and was completed on 16th May 1998. Thus a total of 272 days were spent on field level data collection.

During the fieldwork period, entire study villages were surveyed and all 9427 villagers (except 417, who were left out during study period) were examined and all 410 persons with dermatological manifestations were examined thoroughly. Night stay at block town during whole study period also helped to get better idea of the village life and also provided more time to spend in study villages. Household and individual level data collection was started from one corner of one study village in early morning and continued till late afternoon. Missed households and / or household members were examined there after. Screening and data collection went on simultaneously according to the convenience of both researcher and the persons with dermatological manifestations. During examination of diagnosed cases, corresponding household survey report (i.e. land holding, livestock, housing, last month's income etc.) and report of arsenic level of ground water (if available) had been recorded.
Four focus group discussions in each village (separately with affected and unaffected men, women, and young people) and number of informal discussions with villagers, politicians, school children, health workers, local traditional healers, were conducted during my stay in the villages. Along with general enquiry regarding arsenic toxicity and its impact on the life of individual person and family and society, role of government (Panchayat, Block and District Health Service and other depts.) to combat the situation, community response before and after arsenic problem was exposed and preference of health service were also asked during focus group discussions. Apart from data collection, day-to-day activities of villagers (both unaffected and known patients), interactions, food habits, occupational activities and sufferings had been observed and documented.

During fieldwork, arsenic level of water from number of pumps used in irrigation, handpumps, wells and ponds were not available. Those sources were mapped, given the code according to the owner and, in the middle of the fieldwork period, those sources were measured using field kits provided by the Bose Institute, Calcutta. Thus arsenic level of almost all water sources used by the study populations located in the study villages and around was measured.

Tools – Interview Schedule

The schedule was partly single response type and mostly descriptive type. During field-testing of an earlier version of schedule, it had been revealed that the entire schedule of single response type was not suitable to community level studies for the following reasons: -

- Single response type schedules often require interruption and thus affected normal flow of conversation.
- Narration of suffering, particularly of disability and handicap on account of the arsenic problem required continuous speech. Frequent interruption led to loss of concentration and possibility of distraction from important issues.
- In certain aspects like narration of disability and handicap, a broad discussion with the affected was required. During field-testing ‘yes’ or ‘no’ response type questions had been asked. It was realized that dividing it in all possible single responses led to some points getting missed.

However, for information regarding general identification, part of land holding, water quality, migration, clinical examination, which is easily elicited by direct questioning, single response type is preferable since it saves time and makes analysis easier. Hence, the schedule was made up of mixed type (both single responsive and descriptive type) of questions according to suitability to subject.

The schedule was divided into number of sections:

I) General Identification
II) Land Holding and Income
III) Water Quality
IV) Food Consumption and Nutritional Status
V) Migration
VI) Clinical Examination (General)
VII) Clinical Examination (System wise – Impairment)
VIII) Disability
IX) Handicap
X) Treatment History and Government Response
XI) Concept of Arsenic Problem / Toxicity
XII) Impact of Arsenic Problem on Household and Community Response.
XIII) Comments

[See schedule in page no 249]

General Identification
Serial number, name of village, household number, name of household head, age, sex, religion, caste, educational status, marital status, occupation, extracurricular activities, total number of household members with age and sex.

Land Holding and Income
In land holding pattern – total area, irrigation facility, productivity, change of land holding due to arsenic poisoning have been included. Crop production included type of production, amount / year, change of crop production and / or pattern due to arsenic poisoning and reason/s behind it.

Income included primary income along with additional income like selling animal product, horticulture and horticulture product, fish and other miscellaneous, change of income due to arsenic poisoning.

Measurements of Socio Economic Status (SES) [see detail in later part of the chapter and in annexure I]

Water Quality
The important data, which have been collected are:
• Source/s of water used in drinking and cooking, arsenic content (of each), duration of consumption from each source (in last one year), approximate amount consumed from each source in last one year.
• Since when the water source has been changed and reasons (if any).
• If still continue drinking / using arsenic contaminated water reasons (if any).
Depths of old and new tube well.

Water used in irrigation, kitchen garden and cattle feeding (whether As contaminated or As free) and reasons.

Whether villages / ground water used for consumption of married women / widow / separated women (before marriage) are arsenic contaminated or not, detailed consumption pattern of water before marriage and after.

Measurement of arsenic exposure.

Food Consumption and Nutritional Status

The important data, which had been collected

- Varieties of food, frequency of eating, household consumption of rice, wheat, pulse, oil and sugar per month (average).
- Measurement of nutritional status i.e. height, weight, general profile.
- Any change of food intake due to arsenic poisoning and reason

Migration

Following data had been collected:

Migration days / weeks / months per year, destination, nature of job, sources of water and food in the migrated place, whether sources of water was arsenic contaminated or not.

Identifying Impairment Through Manifestations

Clinical Examination (General)

- Chief present complaints) (related to arsenic problem
- History of past illness (Presence of similar kind of symptoms in past, important other past illness which were cured or still continue, history of spontaneous abortion and birth defect of pregnancy, seasonal trend, duration of past symptoms, exacerbating factors, evolution of symptoms and factors reducing the suffering of symptoms)
- General examination (Cyanosis, jaundice, neck vein, clubbing, edema, pulse, respiration, blood pressure, lymph glands)

Clinical Examination (System Wise-Impairment):

- Dermatological Examination (Examination of palm, sole, chest, back, all over body, gradation of severity of symptoms (described latter), duration of symptoms, seasonal trend, exacerbating factors, impact of change of water consumption pattern, factors reducing the suffering from symptoms, and progression of symptoms and comments).
- Respiratory System Examination (General protocol of examination of respiratory system, gradation of severity of dyspnea (described latter), duration, exacerbation factor, seasonal trend, impact of change of symptoms due to change in consumption patterns of water,
factors reducing the suffering from symptom, progression of symptoms, any associated symptoms like haemoptysis, chest pain etc. history of heavy smoking, and comments)

- Neurological System Examination (General protocol of examination of peripheral nervous system, gradation of severity of manifestation (described latter), duration, exacerbation factor, seasonal trend, impact of change of symptoms due to change in consumption pattern of water, factors reducing the suffering from symptoms, progression of symptoms. Any associated spinal or central nervous symptoms and comments).

- Hepatic System Examination (General protocol of examination of liver (i.e., size, surface, consistency, tenderness etc.), gradation of severity of manifestation (described latter), history of malaria, jaundice, enteric fever, alcoholism, passing of white stool, dark urine, Comments).

- Peripheral Vascular Examination (General protocol of peripheral vascular disease examination, history of smoking, duration, progression, seasonal trend, impact of changing water consumption pattern, exacerbation or reducing factors, comments).

- Examination of Eye (Conjunctiva) (Examination of conjunctiva, duration, seasonal change, associated manifestation, exacerbation factors, impact of change of symptoms due to change of consumption pattern of water, factors reducing the suffering from symptoms, Comments).

- Examination of other visceral impairment (if any).

Limitation: Hair & nail samples were not collected to measure the arsenic content due to inaccessibility to testing lab in Calcutta. Moreover study conducted by Chakraborty shows that there were significant number of population exposed to high level of arsenic (evidenced by arsenic concentration of hair and nail) having no symptoms. [Chakraborty D 1998 (a)]

**Categories of Disability**

The categories of disability had been selected on the basis of feedback from preliminary survey and pilot study (testing schedule). The following disabilities were chosen as they were found to be consequences of impairments resulting from arsenic poisoning. In study of each disability following data were collected, causative factor (impairment), linkage with relevant impairment, duration, extent, aggravating, relieving and contributory factors, associated problems, progress, gradation (severity) and other. Grade of disability has been mentioned later.

1. **Personal Care Disabilities**

They refer to an individual's ability to look after himself / herself in regard to basic physiological activities, such as excretion and feeding, and to caring for himself / herself such as with hygiene and dressing.

In the context of study population personal care disabilities have four different classifications:
a) Excretion disability in the context of chronic arsenicos is of study population was associated with transfer and confining difficulty of individual i.e. change of posture and walking.
b) Feeding disability was associated with several processes of feeding (like sitting, mixing food, eating hot / cold food, holding hot / cold utensil, getting up from sitting posture, washing hands etc).
c) Bathing disability was associated with pouring water over body or taking dip in pond, lifting and carrying bucket full of water and walking.
d) Hands and feet care disabilities

2. Loco-motor Disability
It refers to an individual’s ability to execute distinctive activities associated with moving, both himself / and objects from place to place.

Loco-motor disability has been classified into:

a) Walking disability.
b) Climbing disability
c) Running disability
d) Cycling disability
e) Confining and transfer disability
f) Lifting and carrying disability

3. Gripping Disability
It refers to adroitness and skill in holding objects with palm and fingers by gripping.

4. Environmental Disability
An environmental disability refers to intolerance to hot, cold, sunlight.

5. Apart from aforementioned disabilities, some provisions had been kept open to include different varieties of disabilities if required. Several instances were found (in the present study population) where one variety of disability was linked with some other variety of disability/ies. So there was space to incorporate relevant additional information.

Categories of Handicap
The categories of handicap had been selected on the basis of feed back from preliminary survey and pilot study (testing schedule). The following handicaps had been chosen as they were found to be consequences of disabilities and impairments resulting from arsenic poisoning. In study of each handicaps following data were collected, causative disability and impairment, linkage with relevant disability and impairment, duration, extent, aggravating factors, relieving factors, associated problems, coping mechanism, progress, gradation (severity) and other.
Handicap has been classified into several dimensions according to survival roles. In the context of chronic arsenic poisoning in the study villages, three types of handicaps have been considered relevant i.e., (i) Physical Independence Handicap (PIH) (ii) Occupation Handicap (OH) (iii) Social Integration Handicap (SIH).

i. Physical Independence Handicap:
It has been defined as the conditions, which do not allow the individual to sustain a customary effective independent existence. It included self-care and other activities of daily living.

ii. Occupation Handicap:
It has been defined as the individual's ability to occupy his / her time in the manner customary to his / her early part of life [before arsenicosis symptoms appear in his / her body and among other household member/s (if occurs)]. It was redefined on account of prevailing social preconditions in the study villages.

iii. Social Integration Handicap:
It has been defined as individual's ability to participate in and maintain customary social relationships.

Grade of handicaps are described latter. The questions related to handicaps were of descriptive type where patients' statements were recorded, close observations had been written.

Some handicaps mentioned in ICIDH were excluded from the study because of being irrelevant. Like Orientation Handicap, which has been defined as individual's ability to orient himself / herself in relation to his / her surroundings. In the context of chronic arsenic poisoning in the study villages, Orientation Handicap was not relevant. Mobility Handicap which is defined by ICIDH as, the individual's ability to move about effectively in his / her surroundings – has not been included. In the context of arsenic poisoning it was not relevant as it includes the individual's abilities augmented, where appropriate, by prosthesis or other physical aids, including a wheel chair. In the context of arsenic poisoning and its manifestation in the study population any kind of physical aids or prosthesis was not relevant. During survey it was found that nobody used any kind of physical aid. Wheel chair was not useful in the village due to its topography. People could not afford. Also culturally wheel chair was not familiar in the villages. People with other kind of walking disability in the villages, for example due to polio or amputation, walked with clutch or walking stick. But ordinary walking stick was not useful in the kind of walking problems the people encountered. Economic self-sufficiency handicap, which was one of the dimensions of handicap, has not been included as it was also found irrelevant in the context of chronic arsenic poisoning in the study villages. In ICIDH, grade of economic self-sufficiency handicap of individual was similar.
to the definition of various scale of SES of household in the study villages (mentioned latter in the measurement of SES). Moreover the grade of handicap in ICIDH was very much individualistic. It means, individual's economic status was solely determined by the individual person's earning. Furthermore, the definition of economic self-sufficiency handicap was more related to income, which was tangible (cash). Therefore, anybody's contribution in household's secondary occupation cannot fit into the ICIDH's definition. As far as income was concerned, in the study area, household was the unit, not individuals because, at household level income was calculated in collective manner. Therefore, there was little scope to include economic self-sufficiency handicap in the present research. Rather Occupational Handicap was more holistic and appropriate approach as it has encompassed people involved in primary economic activity, secondary economic activity and non-economic activity, including schooling, leisure time etc. Occupational handicap was more meaningfully linked with socioeconomic variables during analysis of data.

**Treatment History and Government Response**

Treatment history included, where did he/ she seek treatment (chronologically) with reason, source of expenditure, how occupation created obstacles / or helped in seeking proper treatment. Opinion on curative service by local doctors, traditional healers etc Opinion on treatment in Calcutta (IPGMER) and follow up. Any administrative measure known to him / her.

**Concept of Arsenic Problem / Toxicity**

What are sources of arsenic, its impact on human being and remedy. Source of information of arsenic poisoning. Is it major health problem now why?

**Impact of Arsenic Poisoning on Household and Community Response**

It comprises the following: impact of arsenic poisoning on household activities, economy, lifestyle, education, social and cultural participation, marriage, relationship with neighbors and relatives and their inter relationship. Response of household to cope the situation. Assistance sought from household members and others, kind of assistance and reasons was also studied. Community response and household response before and after arsenic problem was exposed and sharing of water. Report of any death due to suspected arsenic poisoning; place where died and treatment history of the diseased.

**Comments**

It was based on general impression by the researcher.

Bangla is being the only spoken and understandable language in the community. The respondents gave their answers in Bangla and it was convenient to write the responses in the same language. More over immediate translation to English might have caused missing of important points.
Modification of ICIDH

The ICIDH has been used first time in the context of social epidemiological study of arsenic poisoning. But several changes have been made in order to make ICIDH appropriate in the context of the study population. In ICIDH, impairments are not categorized in grades. But in the research, relevant impairments are graded into three categories (mild, moderate and severe). Scale categories of both disability and handicap have been changed according to their relevance and to make it simple and free from ambiguity.

In data analysis there have been linkages of impairment – disability, disability – disability, disability – handicap and impairment – handicap, which were deviations from the ICIDH guidelines. But deviations of norms are based on observations of the study population.

Measurement of Variables

The following variables are measured and categorized to their respective natures like Nominal variable, dichotomous variables (binary variable), ordinal variables (ranked variables) and continuous (dimensional) variables. By and large all of them had been transformed into ordinal variables and continuous variables. For example, each patient's socio economic status (ordinal), average arsenic intake per day / liter of water (continuous), severity of impairments (ordinal), and food consumption (continuous), nutritional status (ordinal), disabilities (ordinal) & handicap (ordinal). This categorization was done prior to data analysis.

Estimation of Socio Economic Status (SES)

Measurement of socio economic status of households of five study villages of Murshidabad districts was done based on investigation at panchayat level, which included land holding and secondary sources of income, family size and also at general community level through group discussion and household survey. The households were categorized into five - Socio Economic Status (SES) (below subsistence, subsistence, just above subsistence, relatively comfortable position and rich had been kept in the SES categories I to V respectively) based on local context.

It was found that the villagers perceived the minimum requirement for survival of any household to include two meals (course rice or roti, puffed rice, small amount of vegetable, little cooking oil, salt), repaying small debts, minimum expenditure on health (by visiting local quack, PHC), petty household expenditure (minor repair, buying utensils etc.), minimum cloth, buying fodder (in extreme cases when normally grown plants used as fodder became non available), petty savings during harvesting period, minimum money for agriculture [seed, pesticide, fertilizer, irrigation (rent of water pump if alternative is not available)].

Further more, the discussion with villagers and panchayat leaders revealed that for subsistence level livelihood for one household (husband, wife and two adolescent children) at
least 3 acres of land is required (without secondary source of income). So 3 acres of land in the given context has been taken as benchmark. Average income from livestock had been acquired through village level survey. Reports on land holding, household members, primary and secondary occupation had been obtained from panchayat office. Observation and further inquiry during household survey and frequent informal discussion with villagers (all sections) and households (combined) supplemented this secondary data. This helped to stratify the entire household of five study villages into five socio economic categories in a meaningful manner. It was observed that majority of the people should have been put into one section i.e. the poor. But distinct variation had been noticed among this wide population as far as quality of life was concerned. Therefore the poor had been further divided into below subsistence level (SES I), Subsistence (SES II) and just above subsistence level (SES III).

Households, those who can afford their minimum requirements were included in SES II (subsistence level). Those who cannot afford any one or more of them belong to SES I (below subsistence level). People who can afford better quality and more quantity of food, more health expenditure, repaying bigger debt, were able to keep petty savings during non harvesting period, basic minimum education, better quality fodder and more expenditure in cultivation belong to SES III (above subsistence level). It is worth noting that although SES III is better than SES II, they are also not in a comfortable position because of their unstable status. Low agricultural production, natural calamity (drought and flood), unfavourable rural agricultural marketing, unyielding livestock, absence of secondary occupation, major disease, all can easily bring them down to SES II. The households who can easily afford more than SES III - entertainment (radio, T.V, video, movie, cultural program in district town), education up to secondary (at least) or more, can maintain their proper food habit, health status and education even when there is low agricultural production, a natural calamity etc – belong to SES IV (comfortable position). There are few households who are better than SES IV in terms of resources and that is reflected in their food habit, living style (cloth, private transport, entertainment, education), leading role in all cultural and political activities, can afford best health service facilities in the district (even outside the district) and thus considered rich and most respected household in the villages. They belong to SES V (rich). (For a detailed discussion on methodology for assessing SES see annexure I)

**Measurement of Arsenic Exposure**

Arsenic consumption has been measured from daily average exposure per one litre of water from approximate total yearly consumption. It is to be noted that measuring exact amount of consumption of water by every individual (410 patients) was beyond my scope. Moreover consumption varies according to seasons. Therefore an attempt was made in order to calculate arsenic level / litre of water consumed every day from approximate yearly calculation. In all previous studies, arsenic level of domestic sources (or any single source) were taken as arsenic exposure level, which could not give right picture as water consumption of every individual is very complex and unstable. Therefore, the present strategy was adopted to minimize the error as
much as possible. Taking duration of intake from particular source/s into account would have given further more accurate calculation of arsenic exposure. But according to the concerned scientists, measurement of duration of contamination of each source (i.e. from beginning of contamination) is extremely difficult, as starting of contamination from each source and level of contamination vary according to geological factors. Although the geological processes are very slow and insidious in nature, it is technically impossible to calculate the month or year regarding beginning of contamination from single spot check and also changing pattern of contamination, unless regular measurements are made (longitudinal study). So in order to make rational as well as meaningful measurement, following methods have been adopted.

The parameters that have been used in calculation included arsenic concentration / liter as reported by Public Health Engineering Dept. of Murshidabad district, district level data by SOES, Jadavpur University and by person who had individual report. Field test kit was also used to measure arsenic after collecting water from field. Arsenic was measured in all water sources used by the person along with average daily intake of water from each source in 365 days and duration of intake from each source/s (in days) in 365 days were then estimated in discussion with each respondent.

A formula was constructed to calculate the average daily intake.

Average daily intake of arsenic / litre of water = $\frac{A_1 \times l_1 \times d_1 + A_2 \times l_2 \times d_2 + \ldots \ldots A_n \times l_n \times d_n}{(l_1 \times d_1 + l_2 \times d_2 + \ldots \ldots + l_n \times d_n)}$

As = arsenic concentration of any particular source / litre

I = amount of water of respective source in litre per day

d = duration of intake of respective source in days / in last one year

Note:

• For migrating laborers where arsenic concentration was not available, average arsenic content at district level (SOES, JU) had been taken into account. For measuring quantity some reference containers had been used.

• Guo also opined that multiple variable approaches could identify a positive association of malignancy at the highest arsenic exposure categories. He contradicted the conventional methods where average arsenic level of any locality had been considered as level of exposure. He developed a model to measure arsenic exposure to eliminate errors and used national level data of arsenic level of ground water. Further more, he stated that by using multiple variables to describe an exposure in ecological studies may facilitate a better description of the exposure status and thereby lead to more accurate risk assessment, especially when dose response relationship is not linear. However, he assumed people drink water from one particular source throughout the year and entire
population as a homogeneous community. [Guo et al 1998] In fact this was not found true for this study population.

Measurement of Food Consumption

Purpose of measurement of food consumption was not to determine exact calorie intake and absolute intake of food. Rather it was to measure relative difference among the people from each household and correlate with socio economic status. Due to time constraint and other limitations calculation of daily food intake of every patients (total 410) was impossible. Therefore an indirect technique had been adopted. Every individual household’s monthly cereal and pulse consumption was obtained through household level study. Thus, proportionate intake of cereal [rice (both boil and puffed) and wheat] and pulse by an adult male from each respective household had been calculated. Other variety of food stuff like oil, sugar, vegetables and milk products could not be calculated due to non-availability of reliable data. Moreover cereal and pulse are the staple food among the study population.

As energy is a prime requisite for body function and growth, calorie has been taken into account. From Indian Council for Medical Research (ICMR)’s recommended dietary intake for Indians, age and sex wise calorie requirement has been taken for calculation. In each household (separately), according to age and sex of all household members a ratio of calorie intake was made.

Estimate of Nutritional Status of Individual Patients

The Body Mass Index (Quetelet’s Index) was used for nutritional assessment of the patients. [Asthana S 1998, Clark OD 1997, Dietz AT 1997, Luke A, Ory FG 1996 & Park]. FAO / WHO / UNU have suggested to accept BMI as measurement of nutritional status for adults. Skin Fold Thickness is another method to measure nutritional status, but due to non-availability of reliable cut-off point in Indian context, many nutrition researchers do not recommend it [Asthana S 1998]. Poor repeatability of Skin Fold Thickness is another major reasons of non-acceptance [Park]. BMI is calculated by weight (in kilogram) divided by square of height (in meter). According to National Nutrition Monitoring Bureau (NNMB), BMI should not be calculated for 14 years and below. (See detail in Annexure III page 236)

Note: Nutritional status was measured at the point when people already had experience of arsenic related illness for years. So, it could be argued that poor nutritional status has been result of arsenic related illness. But technically it was not possible to go for retrospective measurement of nutritional status due to non-availability of information. Moreover, there have been many other non-arsenic related factors, which were responsible for deterioration of socio-economic status, availability of food, for example natural calamity, family dispute, erratic public distribution of food etc. Therefore, nutritional status was taken as an important variable.
Measurement of Severity of Pigmentation and De-pigmentation

Severity of pigmentation and de-pigmentation has been measured during interview and clinical examination. It was classified into three – mild, moderate, and severe. [See photographs in the next page]

<table>
<thead>
<tr>
<th>Severity</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Isolated diffused patch over chest, back, and/or neck. Isolated spotted patch over chest, back and/or neck or limbs.</td>
</tr>
<tr>
<td>Moderate</td>
<td>More diffused patch throughout chest, back, neck along with its extension to abdomen, calf thigh and arm. Spotted patch over entire chest, back, neck, and also more extensive patch on limbs.</td>
</tr>
<tr>
<td>Severe</td>
<td>Skin became dry and rough over patchy area. More extensive patch over chest, neck, back, entire arms and legs. Patches are easily visible from distant (typical rain drop pigmentation).</td>
</tr>
</tbody>
</table>

Measurement of Severity of Keratosis

Like Pigmentation and de-pigmentation, severity of keratosis has been measured during interview. These symptoms also classified into three – mild, moderate, and severe. [See photographs in the next page]

<table>
<thead>
<tr>
<th>Severity</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Isolated corn like papules on palm and sole (particularly at friction sites). Rest of the skins is smooth and normal.</td>
</tr>
<tr>
<td>Moderate</td>
<td>More papules covering more surface area of palm and sole. Older keratosis plaque becomes bigger with occasional pigmentation and or crack and painful.</td>
</tr>
<tr>
<td>Severe</td>
<td>Extensive keratotic plaques on entire palm and sole. Loss of normal skin texture of palm and sole. Crack, fissuring ulceration, bleeding and painful. Occasional plaque in other parts of body.</td>
</tr>
</tbody>
</table>

Measurement of Severity of Respiratory distress

Severity measurement of respiratory distress (dyspnea) developed by earlier researchers been adapted [Morgan 1995, Veena Muralidhar 1996]. After getting descriptive data, dyspnea had been measured into three - mild, moderate, and severe.

<table>
<thead>
<tr>
<th>Severity</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Shortness of breath more than a person of the same age and sex while walking quietly on the level or on climbing an incline or flight stairs.</td>
</tr>
<tr>
<td>Moderate</td>
<td>More shortness of breath and unable to keep up with persons of the same age and sex while walking on the level.</td>
</tr>
<tr>
<td>Severe</td>
<td>Shortness of breath while walking on the level and while performing every day tasks at work, walking from one room to another, even in fast talking.</td>
</tr>
</tbody>
</table>

Measurement of Severity of Neurological Manifestation

Severity measurement of neurological manifestations (neuropathy) has been adapted from scales used by previous researchers [Margil L Bleaker 1994, Samuels MA 1996]. After getting descriptive data, neuropathy had been measured into three - mild, moderate, and severe.
Photo 1 (above): Mild diffused pigmentation patch over chest, which is more prominent over upper left part of chest. Photo 2 (below): Moderate pigmentation over upper portion of chest with isolated spotted dark patch.
Photo 3 (above): **Severe** manifestation with extensive diffused and spotted pigmentation patch along with de-pigmentation patch. Skin is dry and rough. Photo 4 (below): **Severe** variety of depigmentation patch over leg skin.
Photo 5 (above): Mild keratosis on palms showing isolated corn like papules. Rest of the skin is smooth. Photo 6 (below): Moderate keratosis on palms showing more papules covering more surface area. Older keratosis plaque becomes bigger and showing with some pigmentation on it.
Photo 7 (above): **Severe** keratosis on palms showing extensive plaques on entire palm. Crack, fissure and ulceration are also seen. Photo 8 (below): **Mild** keratosis on sole of foot showing isolated corn like papules. Rest of the skin is smooth.
Photo 9 (above): Moderate keratosis on sole of foot showing more papules covering more surface area. Photo 10 (below): Severe keratosis on sole of foot showing extensive plaques on entire surface area. Crack, fissure and ulceration (bandaged) are also seen.

[All photographs were taken in IPGMER, Calcutta]
Severity Criteria

<table>
<thead>
<tr>
<th>Severity</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Numbness and tingling of digital parts of limbs (mainly lower limbs), slight hyperalgesia and paresthesia of distal lower limbs.</td>
</tr>
<tr>
<td>Moderate</td>
<td>More numbness and tingling of digital parts of limbs (both lower and upper limbs), hyperalgesia and paresthesia of both upper and lower limbs. Associated with slight muscle weakness, and tenderness. Lower limbs more affected.</td>
</tr>
<tr>
<td>Severe</td>
<td>Along with the symptoms of moderate variety, more muscle tenderness, cramps, muscle weakness (foot muscle – extensor variety, hand muscle) and stocking gloves sensory-motor neuropathy. Lower limb more affected than upper limb.</td>
</tr>
</tbody>
</table>

Measurement of Severity of Liver Enlargement (Hepatomegaly)

Severity measurement of hepatomegaly has been done through descriptive data collected through patients' clinical examination. It has been divided into three – mild, moderate, and severe.

<table>
<thead>
<tr>
<th>Severity</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Just palpable (sub costal surface).</td>
</tr>
<tr>
<td>Moderate</td>
<td>Easily palpable (one finger below costal surface), consistency soft, border not easily felt.</td>
</tr>
<tr>
<td>Severe</td>
<td>More than one finger palpable and consistency soft to firm.</td>
</tr>
</tbody>
</table>

Measurement of Disability

The entire disability related data collection was from the narratives of affected persons in response to specific questions as related to the clinically observed impairment. During data collection detail information on individual disability and observation were noted. Scale of each disability was based on these data.

Severity of disability is categorised into different scales, (0 – 4), which has been used in this study as given below.

Severity Scale Categories:

0  Not disabled:
   Includes – no disability present (i.e. the individual can perform the activity or sustain the behaviour unaided and as his / her own without difficulty).

1  Difficulty in performance:
   Includes – difficulty present (i.e. the individual can perform the activity or sustain the behaviour unaided and on his / her own but only with difficulty).

2  Assisted performance:
   Includes – the need of a helping hand (i.e. the individual can perform the activity sustain the behaviour, whether augmented by aids or not, only with existence from another person)
Dependent Performance:
Includes - complete dependence on the presence of another person (i.e. the individual can perform the activity or sustain the behaviour, but only when some one is with him / her while performing the job most of the time) Exclude: inability (category 4).

Complete inability:
Includes – activity or behaviour impossible to achieve or sustain even with full assistance.

Measurement of Physical Independence Handicap
Similar to disability, the entire handicap related data was collected by asking the affected persons to describe their normal daily activities, the barriers faced in performing them and the mechanisms adopted to deal with them. Gradation of each handicap was based on these data.

Grade of PIH (measurement of PIH).

0 Fully Independent:
Includes: independence in self-care and without dependence on aids, appliances, environmental modification or the assistance of other people.

1 Adapted Independence:
It is characterised by two conditions. First, that the immediate environment customary to the way of the individual and the group of which he / she is a member creates physical obstacles to independence and secondly, the potential to create or provide an alternative environment is available in that culture or develop alternative mechanism to accomplish the activities.

2 Situational dependence:
It is characterised by difficulty in meeting personal needs but without being largely dependent on others, such may arise because aids and appliances or environmental modifications or adaptations are not feasible or applicable or not available within the culture in which the individual lives or if available are declined, due to seasonal or diurnal or any other changes.

Measurement of Occupational Handicap
Grade of OH (measurement of OH)

0 Customarily occupied

1 Intermittently Occupied:
Intermittent inability to follow customary occupational (primary and secondary economic, household and education) activities. It is characterised by slowing the activity speed by various means in order to overcome the difficulty and accomplish the customary activities. It was mostly associated with seasonal changes, which included specific weather and agricultural season.

2 Curtailed Occupation:
Reduced ability to follow customary occupation that restricts participation in all the major and burdensome activities associated with their customary occupation.
3 Adjusted Occupation:
Inability to follow customary occupation, but individual is able to follow modified or alternative full time occupation (including modification to customary occupation), activities.

In ICIDH, three more scale categories i.e. Reduced Occupation, Restricted Occupation, confined occupation and no occupation have been mentioned. But these four were deliberately omitted in social epidemiological study of arsenicosis due to their irrelevance. Grading of Occupational Handicap based on available data were often overlapping and confusing when reduced and restricted occupation had been included along with curtailed and adjusted occupation. In order to make the gradation of Occupational Handicap free from ambiguity, whole scale category was simplified by removing these two categories. No occupation was applicable only with bed ridden patients or patients who need constant support in every survival roles, which was not applicable with arsenic patients in study villages.

**Measurement of Social Integration Handicap**

**Grade of SIH (measurement of SIH)**

0 Socially integrated full participation in all customary social relationships.

1 Inhibited Participation: Individuals in whom the presence of an impairment or disability gives rise to non specific disadvantage that may inhibit but not prevent participation in the full range of customary social activities. This includes difficulties in movement, embarrassment, shyness or lack of willingness to participate in all day to day regular interaction (which was customary to age, sex and culture of the individual before having the symptoms of arsenic poisoning.

2 Restricted Participation: Individuals who do not participate in the full range of customary social activities (like in different cultural activities).

**Data Analysis**

After collecting quantitative and qualitative data from the primary and secondary sources, the data was computerized for analysis. Quantifiable data were put in an Excel spread sheet. Non-quantifiable data were compiled systematically by themes. These were then cross tabulated and linked together to find answers to the research questions.

All the data were organized into four chapters i.e., (i) Context and Response to Arsenicosis in the Study Villages (ii) Impairment: Distribution and Determinants (iii) Disability: Distribution and Determinants (iv) Handicap: The Social Consequences of Chronic Arsenicosis.

Bi-variate analysis was undertaken to relate the demographic, socio-economic, nutritional and exposure levels to the degree of arsenicosis based on the dynamics of social, biological and ecological factors observed during the field study. The underlying idea was to quantify and analyze the link between two factors and also to establish and redefine the complex relations.
among various factors through establishing the logical process by which they interacted to determine the outcomes of arsenic contamination of water, based on an epidemiological understanding of the causality, pathological and social processes involved.

During analysis, data on the population of all five villages were put together, as the villages their social and demographic features were similar and the rate of exposure to arsenic as well as conversion were found to be similar. Confidentiality of the names of the villages and patients has been maintained by changing the name of individuals and using letters A-E for the villages to avoid any stigma. Local leaders stated that there had been several occasions where publication of names of villages and the patients in the newspaper caused denial of jobs and also affected marriage prospects. The local leaders specially requested not to mention the name of the villages in the thesis.

Limitations

• No reliable data was available at household level on the depth of old and new tube wells, so it was not used in data analysis.
• Arsenic contamination of water used in irrigation, kitchen garden and cattle feeding could not be measured in amount. No reliable method was available to measure arsenic from plant and animal source. But general description has been made in social profile of the study villages.
• There was no data available on nutritional status of all patients before symptoms appeared. So changes of nutritional status with appearance of arsenic symptoms could not be assessed.
• No reliable source of information existed on history of spontaneous abortion and birth defect of pregnancy in PHC or BPHC records. Moreover to get information through community level survey needs a very large study sample. Inspite of those questions were asked about obstetric history and stillbirth to the women in the study villages, but no assessment could be made about the prevalence in the arsenic affected and the unaffected women on the basis of the responses received.