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Socio-economic and Gender aspects of Arsenicosis - A Case Study in Rural West Bengal (India).

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Abstract: *With an aim to study the impacts of social as well as demographic factors of arsenicosis, a total number of 200 respondents have been interviewed on the basis of a structured questionnaire in arsenic affected rural areas under Murshidabad district of West Bengal. Using Logistic regression model it has been observed that respondents' income, age, gender and education play a significant role in augmenting or lowering this risk. The most significant finding of this study is that the worst affected of the arsenic- related disease is the poor male working groups mainly belong to agricultural activities. There exists significant poverty and gender related differences in access to health care for arsenicosis. Gender discrimination was also reflected through expenditure on medical treatment. The findings of this study may help the policymakers and planners at the national level to determine the target population for prevention and treatment in public health programmes.*

Key words: *Arsenicosis, Socio-demographic factors, Gender aspect, Logistic regression model, Murshidabad district.*

I. Introduction

Access to the safe water supply is one of the most important determinants of health and socioeconomic development [1]. To overcome the problem of microbiologically unsafe and untreated surface water, more emphasis is given on groundwater use in West Bengal. In seventies the use of surface water got replaced by heavy dependence on groundwater. During eighties, the use of groundwater reached a large proportion. This has been considered as a step that contributed to decreasing the infant mortality rate [2]. In 1983, however, it was discovered that these tubewells which is the major source of drinking and cooking water in West Bengal, are contaminated by naturally occurring arsenic [3]. Estimates are that at present the total population at risk in the state is approximately 28.7 million, 36% out of the total population of 80.21 million [4]. About 16.26 million population (35.48% of the total population of the State) covering 17533 number of habitations are located in the potential risk zone of groundwater arsenic related threat and diseases [5]. The problem of arsenic pollution is declared as national problem in 2002. The five districts- Malda, Murshidabad, Nadia, North 24-Parganas and South-24 Parganas situated at Eastern bank of river Bhagarathi are severely affected and at the Western bank three districts (Burdwan, Howrah, Hoogly) are comparatively less affected. Some parts of Kolkata (Capital of West Bengal) are also affected by groundwater arsenic pollution problem [6]. Arsenic contaminated drinking water is highly toxic and hazardous to human health. From research studies in Bangladesh [7, 8, 9], it was observed that there exists a correlation between socio-economic-demographic factors and the arsenic related health hazards (i.e. arsenicosis). Over Past three decades scientific studies [10,11,12,13] have been undertaken in West Bengal to understand the sources and extent of the problem of arsenic contamination in groundwater. Possible impacts on human health have been studied through epidemiological investigation [14,15,16,17]. While much is known about the extent and its probable causes [5,18,19], less is known about the health and socioeconomic and demographic implications.

I.1 Objectives of the Study

The present study tries to assess (a) the socioeconomic and demographic factors affecting arsenicosis among the people of the households in the arsenic affected areas; (b) to establish whether there is any significant poverty or gender related differences in access to health care as well as medical expenditures for arsenicosis.
The findings of this study may help the policymakers and planners at the national level to determine the target population for prevention and treatment in public health programmes.

I.2 Sources of Data

In this study, a total of 200 respondents were interviewed with a pretested scientific questionnaire in 2011. The respondents were randomly interviewed with some selected questions from several affected rural areas of Raninagar-II block and Jalangi block in Murshidabad district, West Bengal (India). To identify arsenic affected areas as well as arsenic concentration level in the tubewell water samples the study completely rely on the data

source published by Public Health Engineering Department of West Bengal Government[PHED(WB)[1]] and School of Environmental Studies of Jadavpur University[SOES(JU)[2]]. In this study, arsenicosis was assessed by the standard protocol of observing signs of clinical manifestations and discussing the symptoms. The households in the study area were already exposed to a number of awareness programmes on arsenic contamination. There are many who knew about the arsenic related issues owing to their visits to arsenic clinics. Various socio – economic factors (like income, occupation, education) and demographic factors (like gender, age) were considered at the time of data collection.

II. Materials and Methods

II.1 Study area

A detailed survey study report by SOES and PHED on the groundwater arsenic pollution problem is presented in Table 1 and the location of the Murshidabad district is shown in map 1. The demography of the state of West Bengal in India is as follows: the state consists of 18 districts (considering Purba and Paschim Medinipore as one district) with each district being further divided into several blocks or police station (P.S). Each block is again composed of several clusters of villages with each cluster known as Gram Panchayet (GP) and each GP having several villages.

Murshidabad district is one of the arsenic affected districts in West Bengal with highest number of people at risk (CGWB). The total area of the district is 5324 sq. km. and the total population is 5.9 million [4]. In Murshidabad district except Nabagram and Bharatpur-II, 24 blocks (out of 26) are arsenic affected. Arsenic concentration in drinking water ranges between 3-3000µg/L (SOES, JU Study). The average level of arsenic concentration in groundwater Murshidabad district is 240µg/L. Many people suffering from arsenicosis have died. It has been estimated that out of 2.5 million almost half 1.2 million people in Murshidabad district consume arsenic contaminated water with arsenic concentrations above 10 µg/L and 50 µg/L levels respectively [20].

Table 1: Arsenic Concentration in Nineteen Blocks of Murshidabad Districts

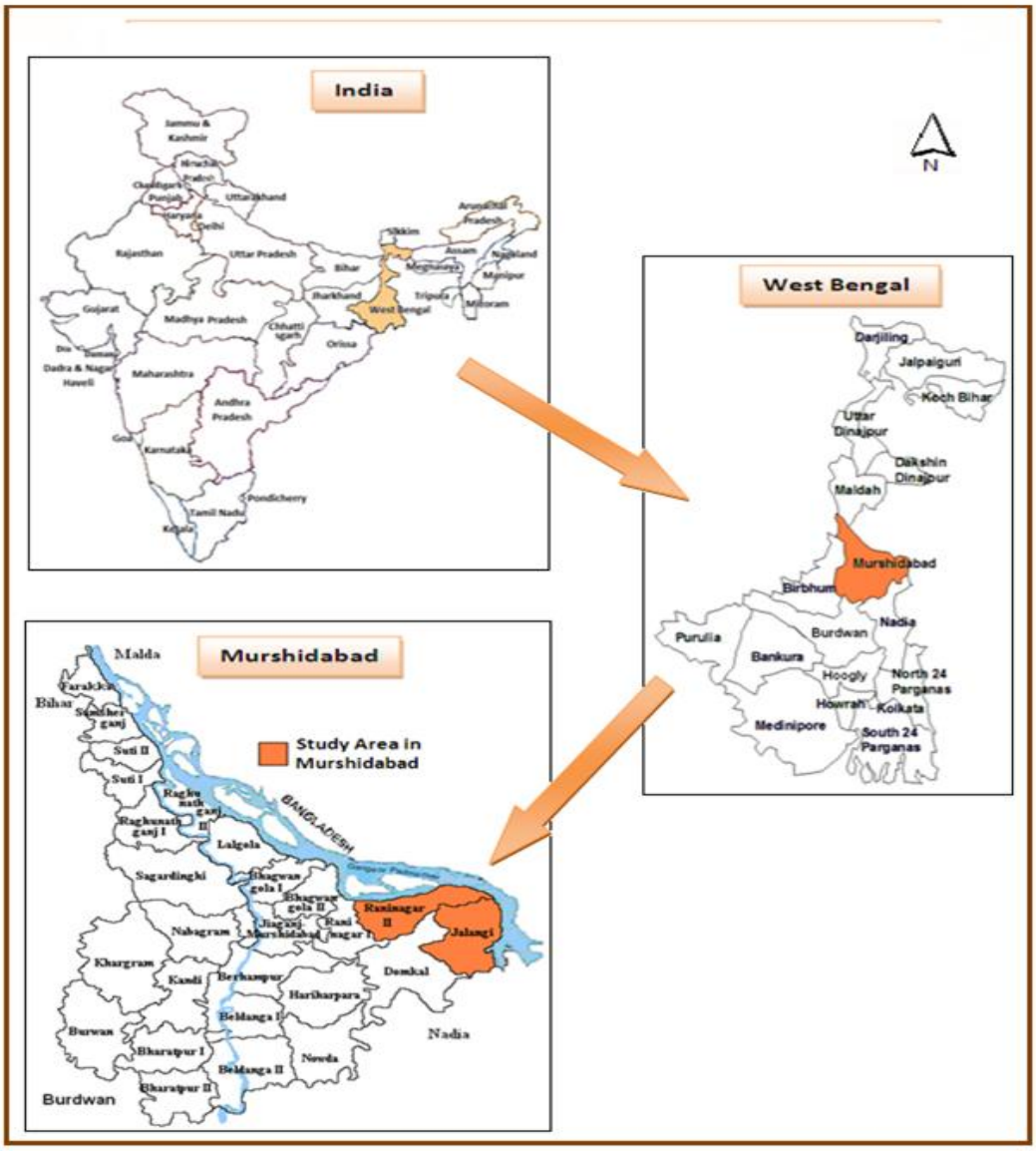
Sl. No.	Blocks of Murshidabad District	Average Arsenic Concentration (µg/L)								
		Whole Frequency Distribution			From WHO Level (10 µg/L)			From National Standard (50 µg/L)		
		JPOA	SOES	Combined	JPOA	SOES	Combined	JPOA	SOES	Combined
1	Nowda	67.15	48.34	58	74.86	74.53	75	158.56	163.98	161
2	Hariharpara	83.48	83.25	83	117.62	129.92	124	203.00	218.74	211
3	Beldanga-I	89.92	85.21	88	124.23	137.80	131	196.25	219.55	208
4	Berhampur	58.08	29.78	44	58.08	60.88	59	115.25	120.75	118
5	Beldanga-II	35.98	23.81	30	71.26	60.13	66	132.33	116.65	124.5
6	Farakka	33.87	32.94	33	43.92	42.23	43	97.79	80.67	89
7	Suti –I	30.14	81.90	56	67.53	117.11	92	130.24	150.73	141
8	Suti –II	60.10	83.28	72	73.49	101.26	87	146.39	189.16	168
9	Samserganj	39.96	46.23	43	46.88	57.87	52	99.58	120.72	110
10	Raghumathganj-I	18.55	22.45	21	45.46	110.71	78	118.00	155.42	137
11	Raghumathganj-II	70.98	65.80	68	80.84	86.64	84	124.90	124.11	125
12	Bhagwangola -I	55.55	61.23	58	83.36	98.35	91	133.17	166.58	150
13	Bhagwangola -II	83.90	102.52	93	104.02	141.94	123	173.71	216.88	195
14	M –J Block	46.79	25.56	36	80.95	54.17	68	131.65	102.04	117
15	Lalgola	27.53	63.83	46	50.34	86.41	68	110.60	149.65	130
16	Jalangi	111.11	138.03	125	156.79	177.53	167	229.56	258.50	244
17	Raninagar -I	78.13	58.79	69	111.47	84.32	98	184.72	133.65	159
18	Raninagar –II	96.60	104.93	101	176.12	156.84	166.5	280.73	247.30	264
19	Domkal	79.04	80.14	80	116.43	113.64	115	185.69	195.86	191

Source- Authors' estimation (Calculated on the basis of PHED report, 2006 and SOES (JU) report, 2006)

[1] PHED (WB) is a nodal agency to provide safe water to the rural West Bengal. In collaboration with UNICEF a systematic record on arsenic concentration in tubewell water (Districtwise) in West Bengal was reported under Joint Plan of Action Study (JPOA).

[2] SOES(JU) Research team have dermatologist, geologist, neurologist, economist, social scientists, bio-chemist and environmentalist working on arsenic problem and its health effects in Ganga-Meghna-Brahmaputra(GMB) plain and Bangladesh more than two decades.

Map 1: Location of Murshidabad District and the Study Area



II.2 Data collection

To collect data several steps were followed. The first step was to identify blocks and villages with habitations that have the highest level of arsenic concentration. We ranked the blocks on the basis of arsenic concentration level. Jalangi and Raninagar-II are the most affected blocks (Table 1). These two blocks are chosen for our study area. At the next stage while selecting the villages in the selected blocks we followed the same procedure as block selection, using village level arsenic concentration information and ranked them in descending order of arsenic concentration (Table A and Table B in Appendix). With our study objectives in mind total 200 respondents were interviewed (taking 100 from each block) in the study area using pretested questionnaire.

Household selection was done through random sampling. We visited all chosen habitations and identified the shallow tube wells for which concentration levels are reported. Then listed the households in the command area of each water source and randomly selected the number of households that they would interview. The number of households surveyed in each command area varied depending on the size of the command area.

A key aspect of the survey was to elicit arsenic disease related information through both direct questioning of the households and the knowledge that we have gathered from the preliminary discussions with expert dermatologists in Kolkata. In the study area we know, households were exposed to arsenic-awareness campaigns. Many also knew about their diseases because of visits to arsenic clinic. We identified some categories of arsenic related diseases: melanosis, keratosis, vascular disease, ulcer, lung problem, cancer etc.

III. Results and Discussions

III.1 Socio-economic and demographic Profile of the Respondent

The socioeconomic and demographic features of surveyed respondents are presented in Table 2. Respondents comprised 174 males and 26 females. Average age of the respondents was 44.58. About 11% of the population having age <30 years, 24.5% were within the age group (30-40), 33% were within the age group (40-50), 21% fell in the age group (50-60), 10.5% having age ≥60 years. The average size of the family member was 5. Among the respondents 47.5% had no formal education and 52.5% had education (13% completed primary education, 17.5% completed upper primary education, 12% completed secondary education, 10% had higher secondary and college education). The mean year of schooling among the literates was just 7.48. As the survey covered only rural households, a significant number of respondents (62.5%) were engaged in agricultural and related activities, 17.5% of the respondents in the sample area were engaged in the non-agricultural activities (includes service, business and self-employed) and 20% of the respondents were housewives, students and unemployed considered as other categories. The respondents have been classified by income categories also. The lowest income category with monthly income levels equal to or less than Rs.2000 represents the low income category followed by middle (income range Rs.2000 to Rs.6000) and higher income (income above Rs.6000) categories. A significant number of respondents (56.5%) fall under low-income category, 41% fall under middle income category and 2.5% fall under high income category.

Table 2: Socioeconomic and Demographic Profile of the Respondents

Characteristics of the Respondent	Total		Raninagar-II		Jalangi	
	n=200	%	n_1=100	%	n_2=100	%
Age(years)						
<30	22	11	14	14	8	8
30 -40	49	24.5	29	29	20	20
40-50	66	33	34	34	32	32
50-60	42	21	15	15	27	27
≥60	21	10.5	8	8	13	13
Mean	**44.58**		**41.08**		**46.08**	
Gender						
Female	26	13	12	12	14	14
Male	174	87	88	88	86	86
Average Family Member	**5**		**4.9**		**5.1**	
Educational status of the Respondent						
No education	95	47.5	48	48	47	47
Primary (1-4)	26	13	11	11	15	15
Upper primary (5-8)	35	17.5	18	18	17	17
Secondary(9-10)	24	12	10	10	14	14
Higher secondary(11-12)	10	5	5	5	5	5
College and Higher education (>12)	10	5	8	8	2	2
Mean	**7.48**		**7.98**		**6.95**	
Major occupation of the respondent						
Agricultural activities	125	62.5	66	66	59	59
Non-agricultural activities (includes Business, service, self-employment)	35	17.5	16	16	19	19
Others (Housewife, Students, unemployed)	40	20	18	18	22	22
Economic status of the Respondent (income group)						
Low income(0-2000)	113	56.5	62	62	51	51
Medium income(2000-6000)	82	41	35	35	47	47
High income(6000 & above)	5	2.5	3	3	2	2

III.2 Study of the Risk Factors

Almost 57% of the population that has been studied had arsenic lesions on their skin. The risk factors are greatly determined by age and gender differences, as the study has shown. Almost 70% of the productive age group (within 30- 50 years of age) is affected by Arsenicosis. Comparatively women are less affected by the same. The reason may be they are primarily engaged in domestic work and fetch water for household purposes either from their own tube well at home or the hand pumps in the vicinity, in case they do not have any private tube wells. From a great number of households that have been surveyed, women fetched water for domestic use from the nearby hand pumps which were deemed safe by the authority. On the other hand most men in the study village are landless labourers who work on the basis of daily wage and have to visit all over the villages for their work. They have to drink water from multiple sources. They consume water mostly from irrigation pumps and this is one of the most important sources of arsenic poisoning for them. For the very same reason, the number of persons who are affected by Arsenicosis is far greater in the case of their engagement in agricultural activities (62.4%) than that in non agricultural activities (54.29%) or that in others (40%). More educated people (who have studied at least till Higher Secondary level) are seen to be less affected (less than 50% of them are affected) by the disease than the less educated ones (who have not studied beyond the Secondary level). It has been seen that in the lower and middle income groups, the number of people suffering from arsenic related health hazards is far greater than in the higher income group. That the higher income groups are relatively safer may be due to their food intake which is definitely more nutritious than that of the two lower groups.

Table 3: Socio-economic and demographic variables Vs arsenicosis

Characteristics of the Respondent	No. of Respondents	Affected by Arsenicosis	%
Age(years)			
<30	22	14	63.63
30 -40	49	36	73.47
40-50	66	47	71.21
50-60	42	14	33.33
≥60	21	2	9.52
Gender			
Female	26	12	46.15
Male	174	101	58.01
Educational status of the Respondent			
No education	95	56	58.95
Primary (1-4)	26	17	65.38
upper primary(5-8)	35	20	57.14
Secondary(9-10)	24	12	50
Higher secondary(11-12)	10	4	40
Collage and Higher education(>12)	10	4	40
Major occupation of the respondent			
Agricultural activities	125	78	62.4
Non-agricultural activities (includes Business, service, self-employment)	35	19	54.29
Others (Housewife, Students, unemployed)	40	16	40
Economic status of the Respondent (income group)			
Low income(0-2000)	113	70	61.95
Medium income(2000-6000)	82	42	51.22
High income(6000 & above)	5	1	20

III.3 Gender Disparity in taking Medical Treatment

73% of the arsenic patients received medical treatment. Male and female respondents were compared in terms whether the affected member of the households received treatment for arsenicosis. A clear gender disparity was observed in treatment-seeking behaviour for arsenicosis (Table 4). Males sought medical treat more than women (76% for males and 42% for females). The reasons for such gender disparity of seeking medical help from registered practitioners ranges from social to economic. Transport cost becomes an economic burden over and above the expenditure for treatment. Moreover in a strong patriarchal society women are not allowed to venture out of home alone too often and this has restricted them within the confines of the local

doctors in their villages. For example, only men visited Kolkata for treatment (where proper medical facilities are available and it is approximately 250 km away from the surveyed villages).

Table 4: Gender Disparity in Taking Medical Treatment

Income Group	Number of Patients taking medical treatment		
	Male	Female	Total
Low Income (Group-I)	44	3	47
Middle Income (Group-II)	32	2	34
High Income (Group-III)	1	0	1
Total	77(out of 101)	5(out of 12)	82(out of 113)

Figure 1: Arsenic Patients Taking Medical Treatment

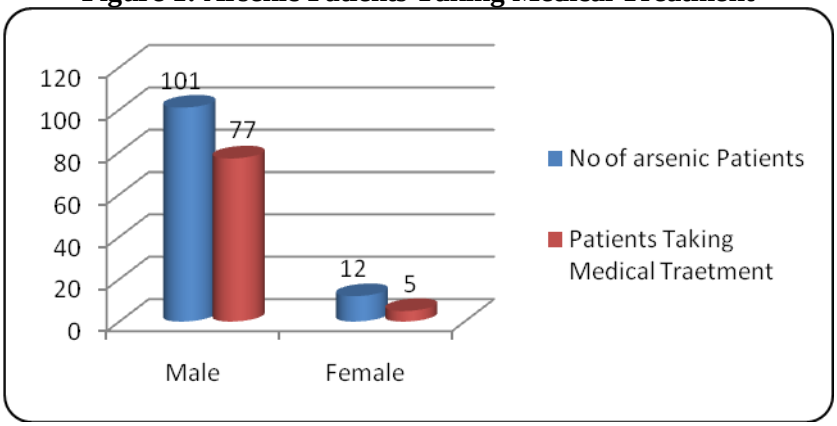
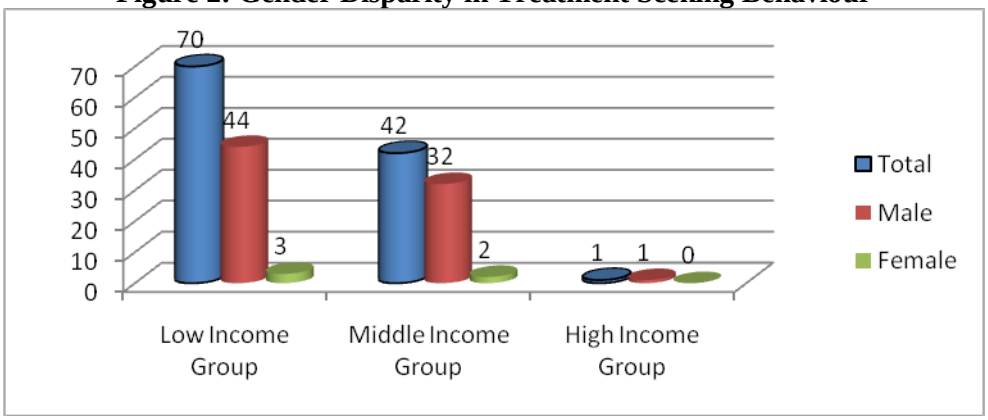


Figure 2: Gender Disparity in Treatment Seeking Behaviour



III.3.1 Source for Financing Medical Expenditures

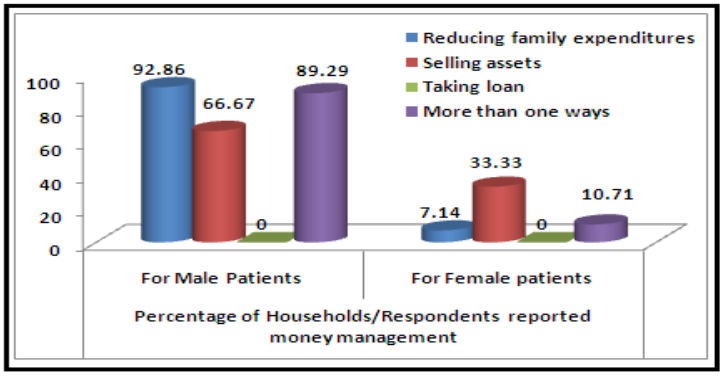
Gender discrimination was also reflected through expenditure on medical treatment. For treatment of males, borrowing money or selling household property were the sources of money though debt is less for treatment. For example, selling assets for medical care of males is 67%, for females is 33% and expenditure procured by reducing family expenditures is 93% for males and 7% for females and more than one ways (like taking loan, selling off properties, reducing family expenditures) is 89% for males, for females is 11%. Two reasons why more attention was paid towards males' medical treatment are traditional gender bias towards males and more severe manifestation of symptoms of arsenic poisoning among males.

Table 5: Management of Money for Treatment Expenditures

Ways	Number of Households/Respondents reported money management		
	For Male Patients	For Female patients	Total
Only by Reducing family expenditures	39(92.86)	3(7.14)	42(54.53)
Only by Selling assets	2(66.67)	1(33.33)	3(4.11)
Only by Taking loan	0	0	0
More than one ways	25(89.29)	3(10.71)	28(58.36)

Note: Figures in the parentheses are percentages

Figure 2: Source of Finance to Treat Arsenic Patients in the Family



IV. An Econometric Analysis

We have carried regression analysis to discern causal relation and relative strength of determining variables to help in deriving policy implications. Here we treat 'occurrence of arsenicosis' as a dependent variable. Because of the dichotomous nature of the dependent variable, logistic regression analysis was carried out using the statistical software STATA (Version 10). Let Z be the occurrence of arsenicosis that is, a dichotomous dependent variable, which takes values 1 and 0. Z is classified in the following way:

$$Z_i = \begin{cases} 1. \text{arsenicosis is occured} \\ 0, \text{otherwise} \end{cases}$$

The model helps in estimating the probability of occurrence of an event and is given by

P_i = Probability (event) = $1/(1+e^{-z_i})$

Where Z_i is the linear combination of variables $X_1, X_2, X_3 \ldots\ldots, X_q$

$Z_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \ldots\ldots + \alpha_q X_q$

If P_i is the probability of occurring the event, then $(1- P_i)$ is the probability of not occurring the event.

Therefore, we can write

$P_i/(1- P_i) = 1+e^{z_i}/1+e^{-z_i} = e^{z_i}$

Now, $P_i/(1- P_i)$ is simply the odd-ratio in favour the event.

The above probability expression can be transformed to determine the log odds in favour of the event as

$L = \text{Log } [\text{Prob(event)}/\{1- \text{Prob (event)}\}] = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \ldots + \alpha_q X_q \ldots\ldots$ (1)

the log of odd ratio is not only linear in X, but also linear in parameters αi , the slope measures the change in L for a unit change in X, that is, it tells how the log-odds in favour of the event.

IV.1. Model Specification

It is postulated that the probability of an individual suffering from the arsenicosis depends on the following attributes

a. Income of the individual(INC)
b. Age of the individual (AGE)
c. Gender of the individual (GEN)
d. Education of the individual (EDU)

Thus equation (1) can be rewritten as

$Z = \beta_1 + \beta_2 (\text{INC}) + \beta_3 (\text{AGE}) + \beta_4 (\text{GEN}) + \beta_5 (\text{EDU})$ ……(2)

Education of the respondent is considered as dummy variable [literate=1, illiterate=0]. Estimated values of the parameters β_1 to β_5 can be used to describe the probability of a person suffering from the arsenicosis.

IV.2. Logit analysis for the prevalence of arsenicosis

The role of the selected risk factors in explaining the prevalence of arsenicosis was examined by logit regression analysis. Empirical analysis through the estimation of logit model helps us to get the nature and magnitude of the coefficients of the equation (2). Respondent's income, age, gender and education were considered as predictors.

Table 6 gives the estimated coefficient values of the variables and corresponding p-values. The variable income (INC) has expected sign and statistical significance. Thus the probability of 100% prevalence of arsenicosis among the low income people is established. Respondent's ages (AGE), gender (GEN) and education (EDU) all have a high significant impact on arsenicosis.

Table 6: Parameter Estimates

Variable	Coefficient	p-value
INC	-0.000306	0.031
AGE	-0.1018482	0.000
GEN	2.672388	0.000
EDU	-0.0942487	0.018

As the model assumes a non-linear functional relationships between the dependent and independent variables, the marginal effects of each of the independent variables are also reported (Table 7). These marginal effects can be interpreted as the increment in the probability of taking medical treatment due to an increase in any one of the independent variable by 1%. The statistical results of the Table 7 explain that all the variables have significant marginal contribution on the dependent variable.

Table 7: Marginal Effects

Variable	Marginal effect(dy/dx)	p-value
INC	-0.0000744	0.032
AGE	-0.024747	0.000
GEN	0.5444093	0.000
EDU	-0.0229005	0.017

V. Conclusion and Recommendation

Hence from the above discussion it follows that the occurrence of arsenicosis and the level of household's income is negative. The number of arsenic affected male patients is much higher than the female ones. People engaged in agricultural activities are definitely more exposed to this threat than the people involved in non agricultural activities. The poor population pays the highest cost due to groundwater arsenic pollution as they are already made vulnerable by their poor socio- economic standards of living. This also poses a great health threat to the most productive section of the society. As the study shows the men within the age group of 30-50 years are the worst affected by this problem, what follows from here that the dependency ratio in these villages will increase and productivity and life expectancy will be significantly lowered in the near future. The meeting of the Millennium Development Goals seems more difficult. What is recommended is that the health care system can be selective in distribution of health service by introducing appropriate institutional mechanisms so that it can cater more to the low income and the most vulnerable section of the society. Greater emphasis should be placed on the provision of arsenic free safe water to be made easily available to the people of the affected areas which would surely yield direct health benefits to the patients of Arsenicosis as well. More knowledge intensive and more frequent awareness programmes have to be organized in the affected areas. Along with the regular awareness programmes where all the villagers are supposed to assemble at a designated time, dissemination programmes through various research surveys which are individualized by research teams as well as peer to peer communication should be made more frequent. Involvement of the patients in information dissemination is necessary as they can be the live example of the health hazards of groundwater arsenic pollution as well as the dire need for arsenic free safe drinking water. To list the most sparsely served areas is important to make the awareness programmes widespread. Schools and colleges should be also included as the young students educated there can in turn educate their families and there lies a promise of a better future. Trainers' training programmes can be introduced through which school and college teachers as well as school children can become the great champions of this cause and help the information dissemination produce more effect.

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Appendix A

Table A: Arsenic Concentration in Jalangi Block

Block	Average Concentration (µg/L)								
	Whole Frequency Distribution			From WHO Level (10 µg/L)			From National Standard (50 µg/L)		
JALANGI	JPOA	SOES	COMBINED	JPOA	SOES	COMBINED	JPOA	SOES	COMBINED
Sagarpara	172	181.29	177	212.09	211.22	212	278.90	302.42	291
Kharamarai	163	175	169	212.69	201.01	207	286.17	279.21	283
Sadikhardiar	191	122.41	157	269.10	156.60	213	403.10	242.69	323
Faridpur	68.32	80.24	74	116.92	130.47	124	186.29	256.86	222
Ghoshpara	113.45	193.79	154	145.52	214.69	180	204.49	260.08	232
Debipur	96.18	147.77	122	124.55	163.38	144	204.06	223.69	214
Jalangi	144.52	70.83	108	198.70	101.43	150	218	164.94	191
Kantabari	93.16	64.76	79	135.84	97.19	117	197.66	188.65	193
Choapara	*65.65*	*47.16*	*56*	*95.04*	*75.84*	*85*	*135.80*	*121.69*	*129*
Sahebnagar	68.11	*26.75*	*47*	108.84	59	84	211.71	*106.13*	*159*
Block as a whole	111.11	138.03	125	156.79	177.53	167	229.56	258.50	244

Appendix B

Table B: Arsenic Concentration in Raninagar-II Block

Block	Average Concentration (µg/L)								
	Whole Frequency Distribution			From WHO Level (10 µg/L)			From National Standard (50 µg/L)		
RANINAGAR-II	JPOA	SOES	COMBINED	JPOA	SOES	COMBINED	JPOA	SOES	COMBINED
Malibari- II	209	286	248	274.11	297.76	286	312.91	324.54	319
Malibari-I	122	146	134	201.89	175.10	188	303.75	267.13	285
Katlamari-I	130	64	97	191.57	125.78	159	290.61	202.75	247
Raninagar-II	60	112	86	140.41	149.31	145	241.26	236.10	239
Rajapur	41	127	84	94.63	131.79	113	179.01	203.43	191
Katlamari-II	45	32	39	84.75	46.87	66	134.36	170.58	152
Raninagar-I	32	26	29	66.27	50.25	58	146.75	128.36	138
Kalinagar-II	19	21	20	53.20	39.27	46	132.64	121.36	127

Kalinagar-I	*16*	*18*	*17*	*52.17*	*46.59*	*49*	*225.50*	*110.57*	*168*
Block as a whole	96.60	104.93	101	176.12	156.84	166.5	280.73	247.30	264