Chapter – 4

Effects of Arsenic on Human Health

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4.1 Arsenic Contamination and Human Health Issues:

Water is an important element that controls different functions of human body, hence, it must be free from all the contaminants. The results from chapter 3 revealed the presence of different elements in the groundwater of *Murshidabad* district. These elements can create health issues ranging from mild to severe, amongst which *arsenic* is considered to be the most problematic. Hence, the present chapter focuses upon the effect of *arsenic* contaminated drinking water on human health. The health condition of the people was analyzed by the household survey.

4.2 General Characteristics of Arsenicosis:

Drinking of *arsenic* contaminated water depicted various symptoms which affects different parts of the body. The occurrence of ailments is associated with differential level of exposure to the *arsenic* concentration in groundwater (**Shannon** and **Strayer** 1989). The symptoms vary from non-specific minor ailments like limb pain, hyperpathia and vomiting/nausea, to severe types like painful *blisters, gangrene* and *carcinoma* of body parts.

Melanosis is the darkening of skin on the palm which slowly extends on the different parts of the body (**Saha** et. al 1999). It is further divided in two categories- *Diffused* and *Spotted Melanosis*. *Diffused melanosis* is the darkening of skin mainly on the palm, trunk and it gradually spreads over entire body while *spotted melanosis* is associated with spot on the hands and legs (**Guha** et. al 2006).

Black and white spots on different parts of the body (chest, back, hands and legs) is known as *Leucomelanosis*. This particular symptom is observed in the body of the patients in the advance stage of *arsenicosis* (**Saha** 1995). *Spotted* and *diffused keratosis* is another type of symptom that is related to the dry and spotted nodules and thickening of skin that generally appears after 5-10 years of the first sign of *Arsenicosis* (**Squibbs** et. al 1983). The thickening of skin on palms and soles further converts into cracks which is known as *hyperkeratosis* (**Mazumder** et. al 1988). Co-morbidity of *melanosis* and *keratosis* is also observed among the patients.

Carcinoma and severe *gangrene* is detected when the *arsenic* contamination in drinking water is high and is consumed for a longer period of time (**Ravenscroft** 2009).

From the survey it was observed that the effect of *arsenic* contamination was negligible in people below 20 years as the incubation period of *arsenic* poisoning is about 15-20 years.

The first sign of *arsenicosis* is largely observed in the people above 20 years (**Saha** et. al 1999). Hence, persons below 20 years were excluded from the analysis.

Fig. 4.1: Location of Sample Villages

The health pattern is based on the analysis of household survey conducted in 13 randomly selected villages using structured schedule. All of the surveyed villages except *Mokrampur* of *Beldanga-1* block, come under gram panchayat. *Mokrampur* is a municipal area and has deep underground water supply system, hence, it was taken into consideration. Till recent past, people used to consume water from the shallow hand pumps. In all the surveyed villages, groundwater is the major source of drinking water and shallow hand-pumps are largely used for extracting of groundwater.

Table 4.1. Basic Information of the Surveyed Villages

Sample Code	Block Name	Village Name	Total Population	Total Population Surveyed	Affected Population*
1	Raninagar-2	Katlamari	25798	488	295
2	Domkal	Garaimari	27943	463	189
3	Jalangi	Khayramari	15996	539	171
4	Berhampur	Balia Danga	913	506	153
5	Beldanga-1	Mokrampur	1534	484	79
6	Hariharpara	Dharampur Ramna	1058	427	60
7	Bhagawangola-2	Boalia	1270	389	42
8	Nawda	Patikabari	8840	462	13
9	Raghunatgunj-2	Mithipur	10885	459	9
10	Bhagawangola-1	Mahatpur	908	506	2
11	Burwan	Rahigram	731	382	0
12	Lalgola	Krishnapur	15165	437	0
13	Sagardighi	Binodbati	985	452	0

Source: DCHB 2001, Murshidabad, * Calculated from the Primary Data Collected from Field

4.3 Prevalence Rate and Arsenic Concentration in Groundwater:

The prevalence rate of *arsenicosis* ranged from nil to 60%. It was highest in the *Katlamari* village of *Raninagar-2* block (60.45%) where male and female rate was 36.88% and 23.57% respectively. In this village, the average *arsenic* concentration of groundwater was 0.12mg/l which was many-fold higher than the permissible limit of BIS (Table 1.2). The correlation value between arsenic concentration and prevalence rate was 0.633 (Fig. 4.2). In *Garaimari* village (*Domkal* block), *Khayramari (Jalangi* block) and *Balia Danga* village *(Berhampur* block*)*, the prevalence rates were 40.82%, 31.73% and 30.24% respectively.The male percentage was 55.56%, 61.40% and 72.55% respectively while amongst the females it was 44.44%, 38.60% and 27.45% respectively (Table. 4.2) (Fig. 4.3 and Fig. 4.4). The *arsenic* concentration in the three blocks was higher than the permissible limit except in *Balia Danga* (*Berhampur* block) (0.02mg/l).

Table 4.2. Prevalence Rate and Arsenic Concentration in Groundwater

Block Name	Village Name	Prevalence Rate (%)	Arsenic Concentration (mg/l)
Raninagar-2	Katlamari	60.45	0.12
Domkal	Garaimari	40.82	0.25
Jalangi	Khayramari	31.73	0.10
Berhampur	Balia Danga	30.24	0.02
Beldanga-1	Mokrampur	16.32	0.16
Hariharpara	Dharampur Ramna	14.05	0.05
Bhagawangola-2	Boalia	10.28	0.04
Nawda	Patikabari	2.81	0.03
Raghunatgunj-2	Mithipur	1.96	0.02
Bhagawangola-1	Mahatpur	0.40	0.06
Burwan	Rahigram	0.00	0.03
Lalgola	Krishnapur	0.00	0.03
Sagardighi	Binodbati	0.00	0.02

Source: Calculated from the Primary Data Collected from Field

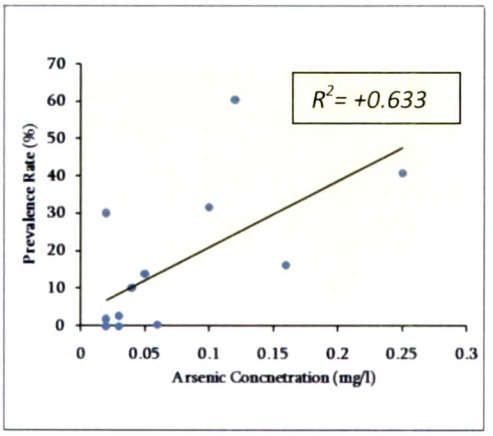


Fig. 4.2: Correlation between Prevalence Prevalence rate and Arsenic concentration concentration.

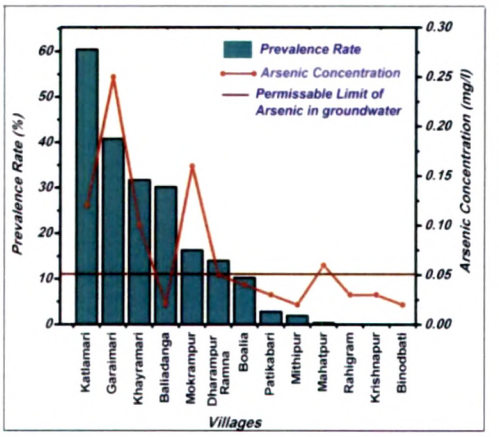


Fig. 4.3: Relationship between rate and Arsenic

The prevalence rate (Fig.4.3) in the *Mokrampur* (*Beldanaga-1* block), *Dharampur Ramna* village (*Hariharpara* block) and *Mahatpur* village of *Bhagawangola-1* block was 16.32%, 14.05% and 10.28% respectively and the concentration of arsenic was 0.16 mg/l, 0.05 mg/l and 0.04 mg/l respectively (Fig.4.2). It was low in *Patikabari* village (*Nawda* block), *Mithipur* village *(Raghunathganj-2* block*)* and *Boalia* village of *Bhagawangola-2* block (2.81%, 1.96% and 0.04% respectively). No person was affected in *Rahigram* village *(Burwan* block*), Krishnapur village (Lalgola)* and *Binodbati* village of *Sagardighi* block.

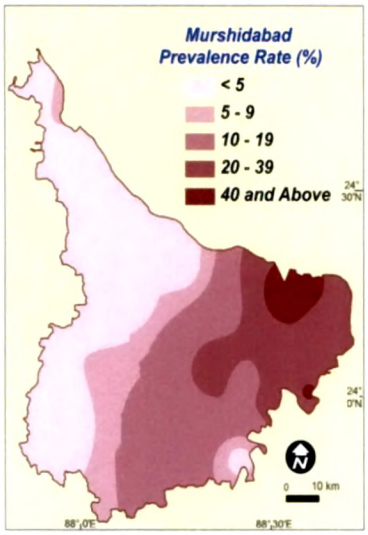


Fig. 4.4: Distribution of Prevalence Rate in Murshidabad District

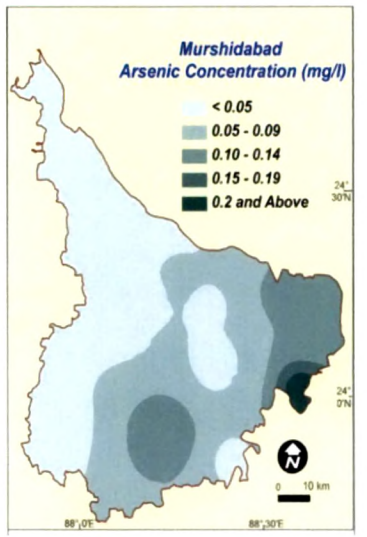


Fig. 4.5: Distribution of Arsenic Concentration in Murshidabad District

It is important to note that the concentration of arsenic in these blocks was below permissible limit. The high prevalence rate was noted in the eastern part (Fig. 4.4) and the concentration of arsenic in groundwater was also high in this part of the district.

4.4 Age and Gender Wise Distribution of Prevalence Rate:

4.4.1 Age Group wise Prevalence Rate:

The prevalence rate in *Katlamari* village of *Raninagar-2* block was 60.45%. An uniform increment was observed from 20-24 years (11.49%) to the age group of +65 years (100%). Similar pattern was observed in males and females (Table 4.3) (Fig.4.6). In all the age groups the prevalence rate was higher amongst male except between 25-34 years where the occurrence was higher in female (46.43% in 25-29 years and 86.27% in 30-34 years respectively).

In *Garaimari* village of *Domkal* block, prevalence rate was 40.82%. A consistent increase in rates from 20-24 years (10.11%) to 35-39 years (57.14%) was observed.

Table 4.3: Age group wise Prevalence Rate
(Katlamari village of Raninagar-2 block)

Age Group	Male	Female	Total
20-24	10.87	12.20	11.49
25-29	58.62	40.00	46.43
30-34	76.92	60.78	67.78
35-39	95.59	67.65	86.27
40-44	95.83	71.43	86.84
45-49	100	80.00	92.86
50-54	90.91	87.50	89.47
55-59	81.82	66.67	76.47
60-64	100	100.00	100
65 & above	0	100.00	100

Source: Computed from data collected through household survey

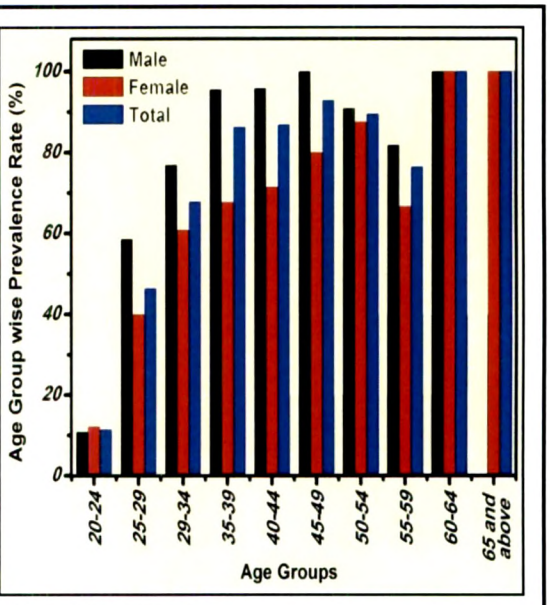


Fig. 4.6: Age group wise prevalence rate in Katlamari village of Raninagar-2 Block

Table 4.4: Age group wise Prevalence Rate
(Garaimari village of Domkal block)

Age Group	Male	Female	Total
20-24	14.89	4.76	10.11
25-29	29.73	32.6	31.33
30-34	52.78	50.00	51.52
35-39	66.67	50.00	57.14
40-44	46.88	66.67	52.27
45-49	69.23	42.11	57.78
50-54	33.33	62.50	45.00
55-59	33.33	33.33	33.33
60-64	0.00	50.00	25.00
65 & above	50.00	33.33	40.00

Source: Computed from data collected through household survey

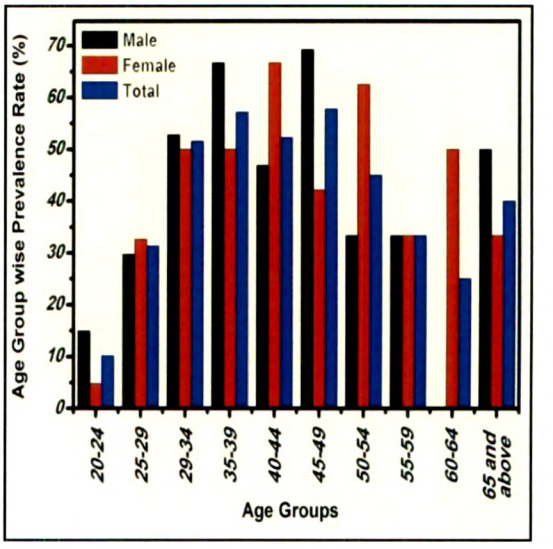


Fig. 4.7: Age group wise prevalence rate in Garaimari village of Domkal Block

Table 4.5: Age group wise Prevalence Rate
(Khayramari village of Jalangi block)

Age Group	Male	Female
20-24	60.00	40.00
25-29	41.18	58.82
30-34	60.61	39.39
35-39	71.43	28.57
40-44	39.29	60.71
45-49	76.92	23.08
50-54	81.82	18.18
55-59	62.50	37.50
60-64	66.67	33.33
65 & above	0.00	0.00

Source: Computed from data collected through household survey

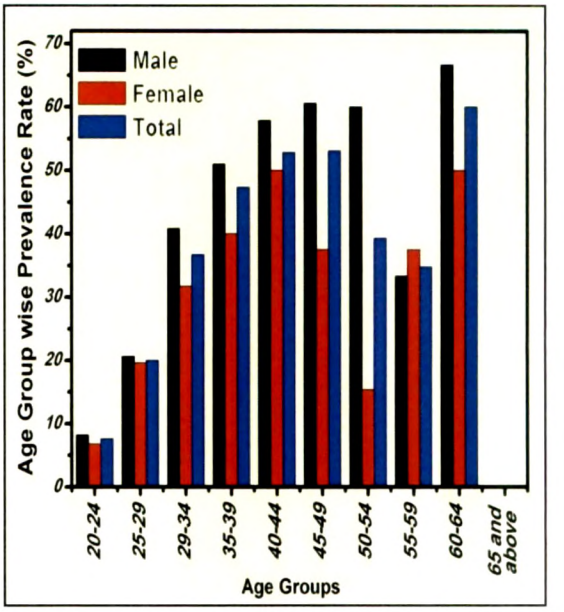


Fig. 4.8: Age group wise prevalence rate in Khayramari village of Jalangi Block

Later, no significant variation up to the age group of 45-49 years (57.78%) was observed. Subsequently, a decline was noticed with just a slight increase in + 65 years. Age group wise male-female share to total surveyed population showed that in 25-29 years (32.61%), 40-44 years (66.67%), 50-54 years (62.50%) and 60-64 years (50%) the males were more affected (Table 4.4) (Fig.4.7).

Khayramari village of *Jalangi* block ranks third in terms of prevalence rate (31.73%). A consistent increase was observed up to the age group of 45-49 years (53.06 %). Thereafter, a decrease was observed in the age group of 50-54 years (39.29%) and 55-59 years (34.78%) (Table 4.5) (Fig.4.8). A steep rise existed in the age group of 60-64 years (60%) but above 65 years, no person was found suffering with *arsenicosis*.

Balia Danga village of *Berhampur* block had almost similar prevalence rate (30.24%). A continuous increase in prevalence rate was observed between 20-24 years, the prevalence rate was 0.82% to 30-35 years (22.13%).

Table 4.6: Age group wise Prevalence Rate
(Balia Danga village of Berhampur block)

Age Group	Male	Female	Total
20-24	1.32	0.00	0.82
25-29	10.53	13.04	11.48
30-34	28.95	10.87	22.13
35-39	28.95	8.70	21.31
40-44	13.16	13.04	13.11
45-49	30.26	21.74	27.05
50-54	11.84	17.39	13.93
55-59	18.42	6.52	13.93
60-64	1.32	0.00	0.82
65 & above	1.32	0.00	0.82

Source: Computed from data collected through household survey

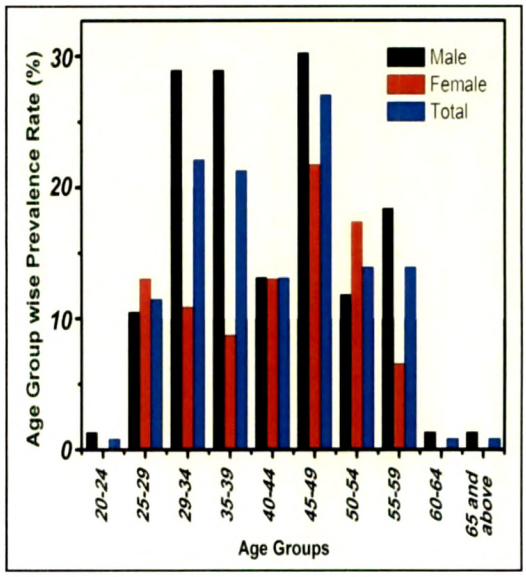


Fig. 4.9: Age group wise prevalence rate in Balia Danga village of Behrampur Block

From 35-39 years (21.31%) to 40-45 years (13.11%) a constant decrease was observed. Subsequently, uniform decrease up to the age group of + 65 years (0.82%) with a spike in the age group of 45-50 years age group was depicted (Table 4.6) (Fig.4.9). A continuous increase in male prevalence rate was observed up to 35-39 years (28.95%). Following this, a continuous decline existed in the prevalence rate with a higher percentage in the age group of 45-49 years. Females had higher prevalence rate in the age groups of 25-29 years (13.04%) and 50-54 years (17.39%).

The mean prevalence rate in *Mokrampur* of *Beldanga-1* block was 16.32%. A considerable rise of affected persons up to the age of 35-39 years was noticed (30.23%). Thereafter, a decrease except in the age group of 55-59 years (27.78%) was observed (Table 4.7) (Fig.4.10). There was a consistent increase of percentage in male population up to the age group of 35-39 years (38.89). Once again a steady decrease in the percentage existed and no person (male/female) + 60 years was found. The highest percentage of female affected persons was between 55-60 years (40%). In general, males were more affected than females. Prevalence rate in *Dharampur Ramna* village of *Hariharpara* block was 14.05%.

Table 4.7: Age group wise Prevalence Rate (Mokrampur of Beldanga 1 block)

Age Group	Male	Female	Total
20-24	0.00	0.00	0.00
25-29	10.00	3.28	5.94
30-34	28.57	9.09	18.60
35-39	38.89	15.63	30.23
40-44	37.50	15.79	27.91
45-49	29.63	21.05	26.09
50-54	12.50	14.29	13.33
55-59	23.08	40.00	27.78
60-64	0.00	0.00	0.00
65 & above	0.00	0.00	0.00

Source: Computed from data collected through household survey

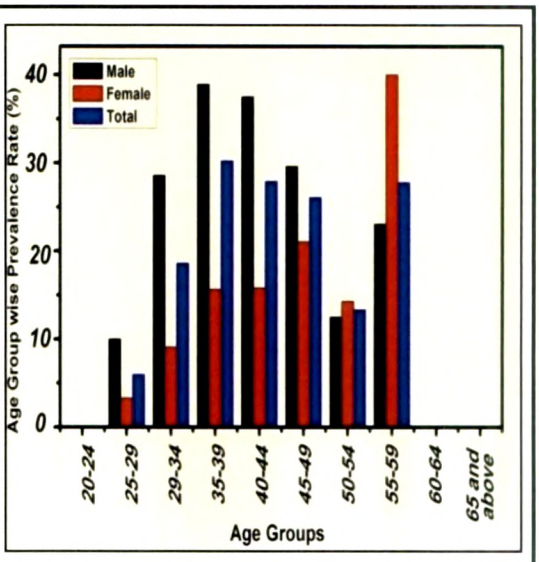


Fig. 4.10: Age group wise prevalence rate in Mokrampur of Beldanga-1 Block

Table 4.8: Age group wise Prevalence Rate (Dharampur Ramna village of Hariharpara block)

Age Group	Male	Female	Total
20-24	16.67	20.00	19.23
25-29	21.21	12.77	16.25
30-34	29.03	18.92	23.53
35-39	17.07	0.00	12.28
40-44	33.33	0.00	27.59
45-49	0.00	0.00	0
50-54	0.00	0.00	0
55-59	0.00	0.00	0
60-64	33.33	0.00	14.29
65 & above	5.45	5.41	5.43

Source: Computed from data collected through household survey

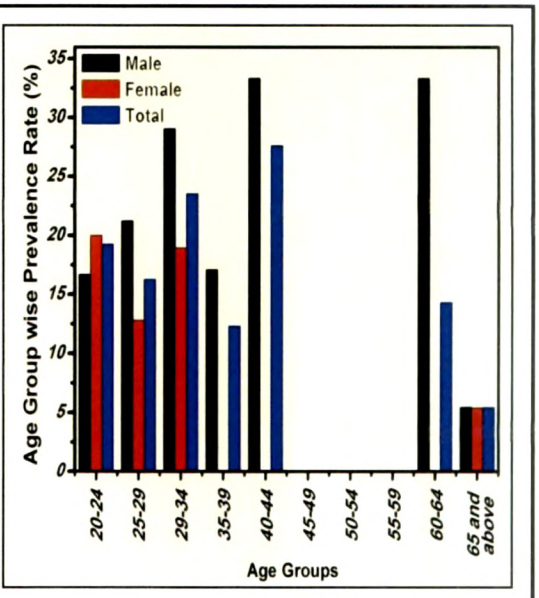


Fig. 4.11: Age group wise prevalence rate in Dharampur Ramna village of Hariharpara Block

A uniform increment was observed from 20-24 years (19.23%) to 40-44 years (27.59%). Thereafter, a sudden fall in the prevalence rate existed [60-65 years (14.29%) and above 65 years (5.43%)]. The similar pattern was noticed in males. The highest prevalence rate, were in 40-44 years and 60-64 years (33.00%). Between 45

and 60 years no case of *arsenicosis* was found. The prevalence rate in females, was 20% in 20-24 years, 12.77% in 25-29 years and 18.92% in 30-34 years (Table 4.8) (Fig.4.11). Above 35 years of females no cases of *arsenicosis* was observed. It was only + 65 years, where 5.41% females showed signs of *arsenicosis*.

In *Boalia* village of *Bhagawangola-2* block the prevalence rate was 10.28%. A continuous increase in prevalence rates was observed up to 45-49 years. After this, no case of affected person was brought into notice. Between 20-24 years the percentage of affected person was least (Table 4.9) (Fig.4.12) while between 30-34 years it was 18.18% and between 45-49 years, it was considerably high (12.50%). An increment up to 45-49 years was observed in males. Maximum percentage of affected male person was in 45-49 years (15.79%) and no affected person was found above 50 years.

Table 4.9: Age group wise Prevalence Rate (Boalia village of Bhagawangola-2 block)

Age Group	Male	Female	Total
20-24	0.00	6.12	4.11
25-29	5.26	7.27	6.45
30-34	25.64	10.53	18.18
35-39	16.33	4.35	12.50
40-44	15.15	0.00	11.90
45-49	15.79	0.00	12.50
50-54	0.00	0.00	0.00
55-59	0.00	0.00	0.00
60-64	0.00	0.00	0.00
65 & above	0.00	0.00	0.00

Source: Computed from data collected through household survey

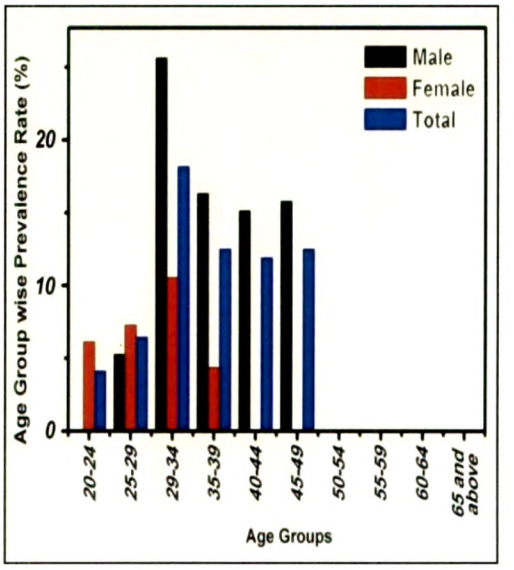


Fig. 4.12: Age group wise prevalence rate in Boalia village of Bhagawangola Block

Patikabari village of *Nawda* block with *arsenic* concentration of 0.03 mg/l had a low prevalence rate of 2.81%. The highest rate was observed in the age group of 60-64 years (20%) and above 35 years no case of affected persons were found. The prevalence rate in other age groups varied between 1.61% (25-29 years) to 8.33% (55-59 years).

Table 4.10: Age group wise Prevalence Rate (Patikabari village of Nawda block)

Age Group	Male	Female	Total
20-24	3.33	3.08	3.16
25-29	1.52	1.72	1.61
30-34	4.55	2.04	3.23
35-39	0	0	0
40-44	0	0	0
45-49	0	20	7.14
50-54	12.50	0	6.25
55-59	11.11	0	8.33
60-64	25	0	20
65 & above	0	0	0

Source: Computed from data collected through household survey

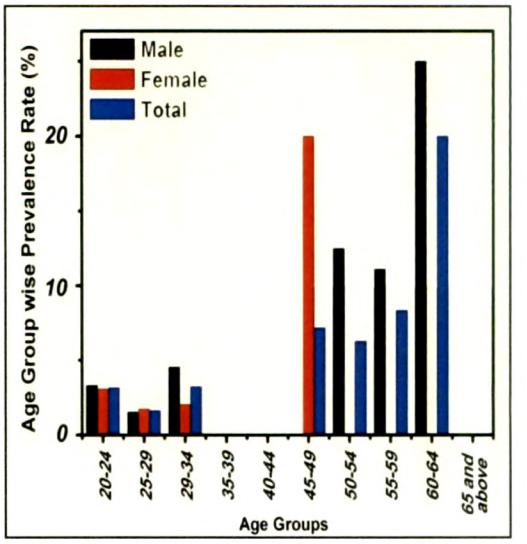


Fig. 4.13: Age group wise prevalence rate in Patikabari village of Nawda Block

Similar pattern was observed among males with highest prevalence rate in the 60-64 years (25%). No male was affected between 35 to 50 years and + 65 years (Table 4.10) (Fig.4.13). Affected females were only found in 20-24, 25-29, 30-34 and 45-49 of age groups with considerably lower prevalence rates of 3.08%, 1.72%, 2.04 and 20% respectively. No case of affected females was found above 50 years.

Mithipur village of *Raghunathganj-2* block had the total prevalence rate of 1.96% with average *arsenic* concentration of 0.02 mg/l. 1/3rd of the persons were affected in the age group of 55-59 years. In rest, it varied between 1.59% (35-39 years) to 11.11% (60-64 years).

No person was found affected in 20-29 years and 50-54 years (Table 4.11) (Fig.4.14). Male prevalence rate varied between 3.03% (35-39 years) to 5.13% (+ 65 years) without any specific pattern. In terms of females, it varied from 6.25% (40-44 years) to 50% (55-59 years).

In *Mahatpur* village of *Bhagawangola-1* block, the prevalence rate was as low as 0.04% with *arsenic* concentration of 0.05 mg/l. In this block only in the age group of 60-64 years few affected males were noticed.

Table 4.11: Age group wise Prevalence Rate (Mithipur village of Raghunathganj-2 block)

Age Group	Male	Female	Total
20-24	0	0	0
25-29	0	0	0
30-34	4.76	0	2.70
35-39	3.03	0	1.59
40-44	3.33	6.25	4.35
45-49	0	0	0
50-54	0	0	0
55-59	0	50	33.33
60-64	0	14.29	11.11
65 & above	5.13	0	3.57

Source: Computed from data collected through household survey

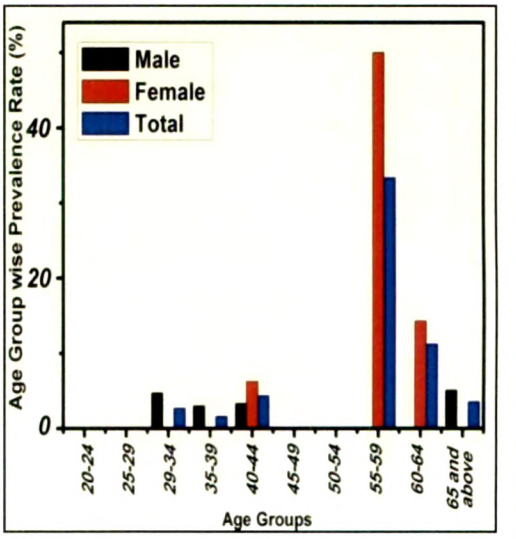


Fig. 4.14: Age group wise prevalence rate in Mithipur village of Raghunathganj-2 Block

In *Rahigram* village of *Burwan* block, *Krishnapur* village of *Lalgola* block and *Binodbati* village of *Sagardighi* block, no case of *arsenic* affected person was found. The *arsenic* content in these blocks were just 0.03 mg/l, 0.03 mg/l and 0.02 mg/l respectively.

4.4.2 Gender wise Percentage of Affected Person:

(Table 4.12) depicted gender wise and age wise percentage of affected persons in *Katlamari* village of *Raninagar-2* (Fig.4.15). In the age groups of 20-24 years and 60-64 years both the genders had similar share (50%). In the age groups of 20-24 years and 60-64 years both the genders had similar share (50%).

The percentage of males were higher in the age groups of 35-39 years (73.68%) to 55-59 years (69.23%). The percentage of females was higher than the males in the age groups of 25-29 years (56.41%) and + 65 years (100%).

No particular pattern was observed in *Garaimari* village of *Domkal* block. Maximum male percentage (77.78) was between 20-24 years (Table 4.13) (Fig.4.16). In all the ages the males were more in number with 25-30 years of age group being only exception where male percentage was 42.31 and female share was 57.69%. 100% females of 60-64 years were affected.

Table 4.12: Age group wise Prevalence Rate (Katlamari village of Raninagar-2 block)

Age Group	Male	Female
20-24	50.00	50.00
25-29	43.59	56.41
30-34	49.18	50.82
35-39	73.86	26.14
40-44	69.70	30.30
45-49	69.23	30.77
50-54	58.82	41.18
55-59	69.23	30.77
60-64	50.00	50.00
65 & above	0.00	100.00

Source: Computed from data collected through household survey

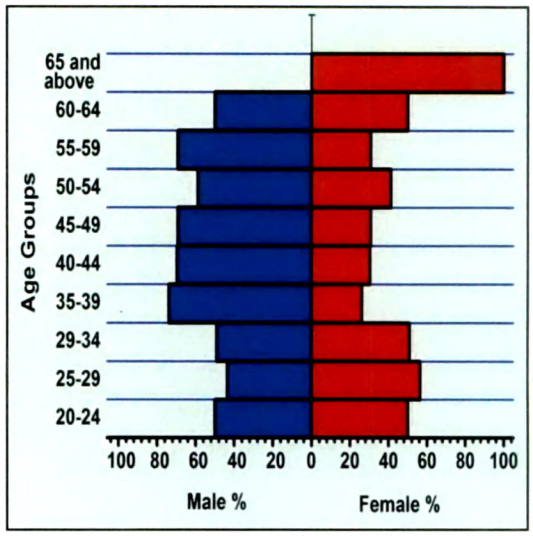


Fig. 4.15: Gender wise prevalence rate in Katlamari village of Raninagar-2 Block

Table 4.13: Age group wise Prevalence Rate (Garaimari village of Domkal block)

Age Group	Male	Female
20-24	77.78	22.22
25-29	42.31	57.69
30-34	55.88	44.12
35-39	50.00	50.00
40-44	65.22	34.78
45-49	69.23	30.77
50-54	44.44	50.56
55-59	66.67	33.33
60-64	0.00	100.00
65 & above	50.00	50.00

Source: Computed from data collected through household survey

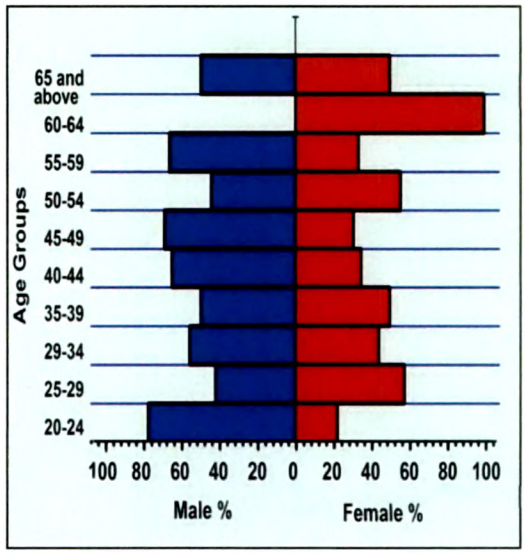


Fig. 4.16: Gender wise prevalence rate in Garaimari village of Domkal Block

In *Khayaramari* village of *Jalangi* block males were more affected than the females. Except for 25-29 and 40-44 years, the percentage of affected males was > 60%. In the age group of 50-54 years, the percentage of affected male was 81.82% while in 40-44 years, it was 39.29% (Table 4.14) (Fig.4.17).

Table 4.14: Age group wise Prevalence Rate (Khayramari village of Jalangi block)

Age Group	Male	Female
20-24	60.00	40.00
25-29	41.18	58.82
30-34	60.61	39.39
35-39	71.43	28.57
40-44	39.29	60.71
45-49	76.92	23.08
50-54	81.82	18.18
55-59	62.50	37.50
60-64	66.67	33.33
65 & above	0.00	0.00

Source: Computed from data collected through household survey

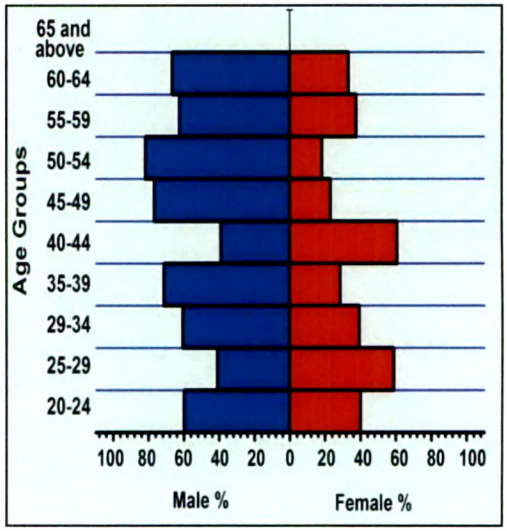


Fig. 4.17: Gender wise prevalence rate in Khayramari village of Jalangi Block

Highest prevalence rate in females was in the age group of 40-44 years (60.71%) while between 50-54 years it was least (18.18%). Rest of the age groups the prevalence rate amongst females was 23.08% (45-49 years) and 58.82% (25-29 years).

Table 4.15: Age group wise Prevalence Rate (Balia Danga village of Berhampur block)

Age Group	Male	Female
20-24	100.00	0.00
25-29	57.14	42.86
30-34	81.48	18.52
35-39	84.62	15.38
40-44	62.50	37.50
45-49	69.70	30.30
50-54	52.94	47.06
55-59	82.35	17.65
60-64	100.00	0.00
65 & above	100.00	0.00

Source: Computed from data collected through household survey

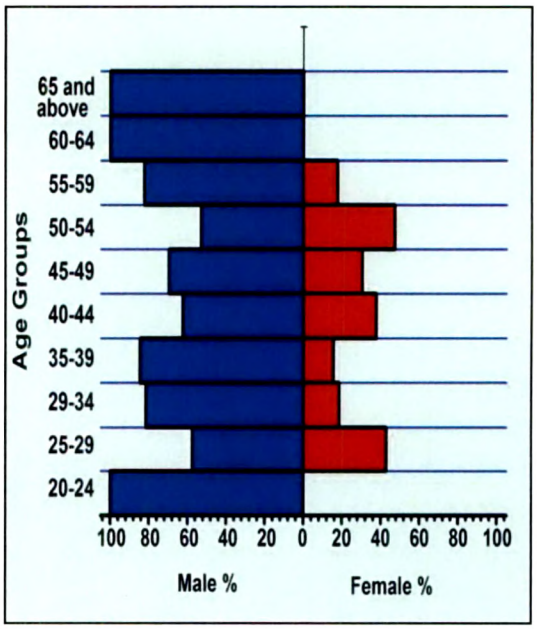


Fig. 4.18: Gender wise prevalence rate in Balia Danga village of Behrampur Block

In *Balia Danga* village of *Beharmapur* block, the highest percentage (47.06) of female population was in the age group of 50-54 years (47.06%). In rest of the age groups, the percentage of affected female population was considerably low.

In all ages, the male share was more than 60%; while, females contributed more in 25-29 years (42.86%) and 40-44 years (37.50%) age groups (Table 4.15) (Fig.4.18).

Table 4.16: Age group wise Prevalence Rate (Mokrampur of Beldanga-1 block)

Age Group	Male	Female
20-24	0.00	0.00
25-29	66.67	33.33
30-34	75.00	25.00
35-39	80.77	19.23
40-44	75.00	25.00
45-49	66.67	33.33
50-54	50.00	50.00
55-59	60.00	40.00
60-64	0.00	0.00
65 & above	0.00	0.00

Source: Computed from data collected through household survey

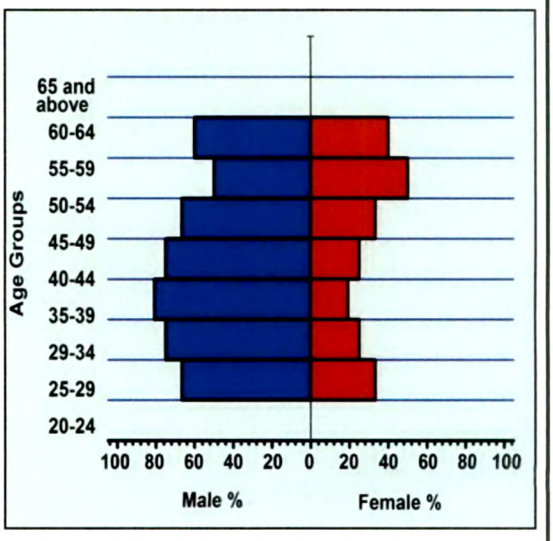


Fig. 4.19: Gender wise prevalence rate in Mokrampur of Beldanga-1 Block

Dharampur Ramna village of *Hariharpara* block had more affected males except for 20-24 years age group where female percentage was much higher (80%). In 35-39 years, 40-44 years and 60-64 years, 100% males were affected (Table 4.17) (Fig.4.20). Female affected persons were only observed between 20-34 years and in the age group of + 65 years.

In *Mokrampur* of *Beldanga-1,* 80.77% of men were affected in the age group of 35-39 years. In rest of the age groups the percentage was more than 50% with 20-24 years and + 60 years as exceptions (Table 4.16) (Fig.4.19). A continuous increment was observed in females up to the 55-59 years (40%). It was only in the age group of 35-39 years a slight decrease in female share was observed.

Table 4.17: Age group wise Prevalence Rate (Dharampur Ramna village of Hariharpara block)

Age Group	Male	Female
20-24	20.00	80.00
25-29	53.85	46.15
30-34	56.25	43.75
35-39	100.00	0.00
40-44	100.00	0.00
45-49	0.00	0.00
50-54	0.00	0.00
55-59	0.00	0.00
60-64	100.00	0.00
65 & above	60.00	40.00

Source: Computed from data collected through household survey

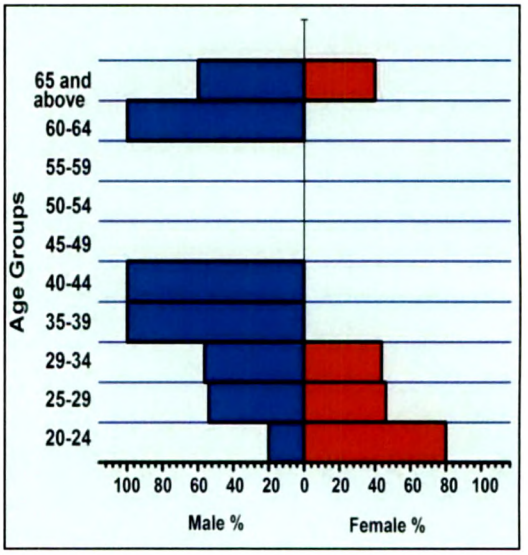


Fig. 4.20: Gender wise prevalence rate in Dharampur Ramna village of Hariharpara Block

Patikabari village of *Nawda* block the age groups of 50-55 years, 55-60 years, and 60-65 years, 100% males were affected while in the age group of 45-50 years,

Table 4.18: Age group wise Prevalence Rate (Patikabari village of Nawda block)

Age Group	Male	Female
20-24	33.33	66.67
25-29	50.00	50.00
30-34	66.67	33.33
35-39	0.00	0.00
40-44	0.00	0.00
45-49	0.00	100.00
50-54	100.00	0.00
55-59	100.00	0.00
60-64	100.00	0.00
65 & above	0.00	0.00

Source: Computed from data collected through household survey

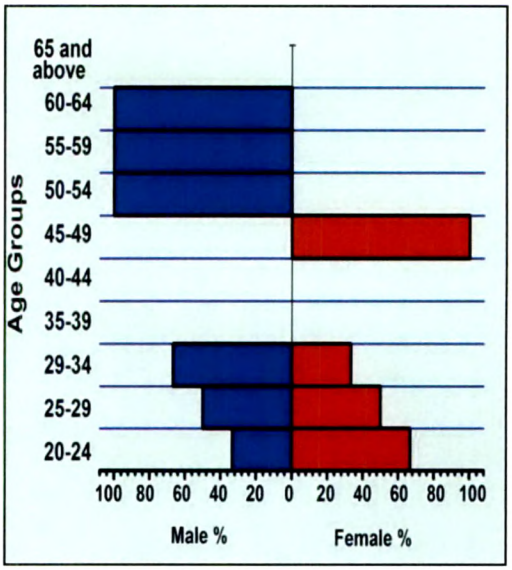


Fig. 4.21: Gender wise prevalence rate in Patikabari village of Hariharpara Block

female share was 100% (Table 4.18) (Fig.4.21). Other than these age groups, age groups of 20-25 years, 25-30 years and 30-35 years showed male percentage of

33.33%, 50% and 66.67% respectively, while in the same age groups the female share were 66.67%, 50% and 33.33% respectively.

In *Mithipur* village of *Raghunathganj-2* block, 100% males were noticed in the age groups of 30-34 years, 35-39 years and + 65 years, while in the age groups of 55-59 years and 60-64 years, 100% females were affected (Table 4.19) (Fig.4.22). In the age group of 40-44 years, both males and females had equal percentage. In the remaining age groups no case of *arsenicosis* was found in both the genders.

Table 4.19: Age group wise Prevalence Rate (Mithipur village of Raghunathganj-2 block)

Age Group	Male	Female
20-24	0.00	0.00
25-29	0.00	0.00
30-34	100.00	0.00
35-39	100.00	0.00
40-44	50.00	50.00
45-49	0.00	0.00
50-54	0.00	0.00
55-59	0.00	100.00
60-64	0.00	100.00
65 & above	100.00	0.00

Source: Computed from data collected through household survey

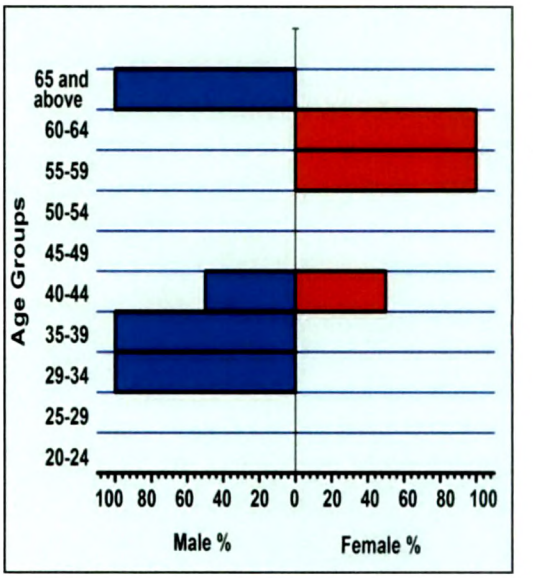


Fig. 4.22: Gender wise prevalence rate in Mithipur village of Raghunathganj-2 Block

4.5 Health Characteristics of the Surveyed Villages:

4.5.1 General Symptoms:

Issues like *limb pain, nausea/vomiting, cough complaint, hyperpathtia, distal parethesias, tremor* and *abnormal sweating* are broadly categorized as non-specific general symptoms. The co-morbidity of these symptoms was 263.47% in *Dharampur Ramna* village of *Hariharpara* block, 223.97%in *Garaimari* village of *Domkal* block (Table 4.20). Other than these two villages, *Raninagar-2* had co-morbidity of 176.64%, *Bhagawangola-2* had 210.80%, *Raghunathguanj-2* had 193.90% and *Lalagola* showed

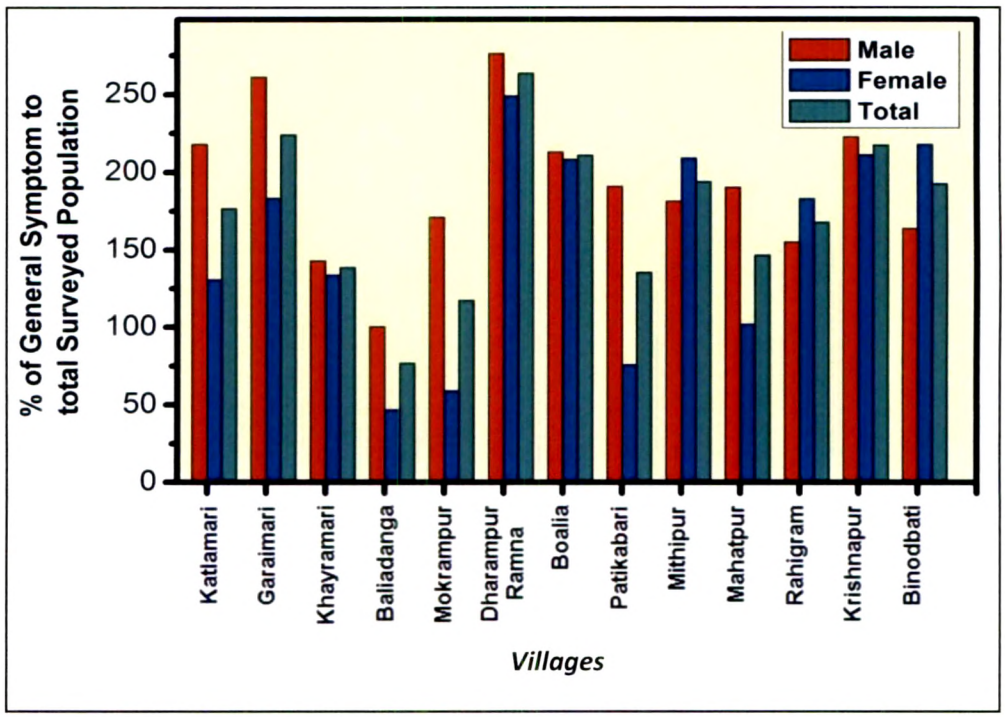


Fig. 4.23: Village wise Percentage of Total General Symptoms

217.39%. In the blocks of *Sagardighi* and *Burwan* the percentage of co-morbidity was 192.48% and 167.80% respectively. The males outnumbered females in terms of sufferings.

In terms of gender wise distribution (Fig.4.24), the share of males and females in *Katlamari* village was 64.97% and 35.03% respectively. In *Garaimari* village it was 60.95% and 39.05% while in *Dharampur Ramna* village, it was 55.73% and 44.27% respectively.

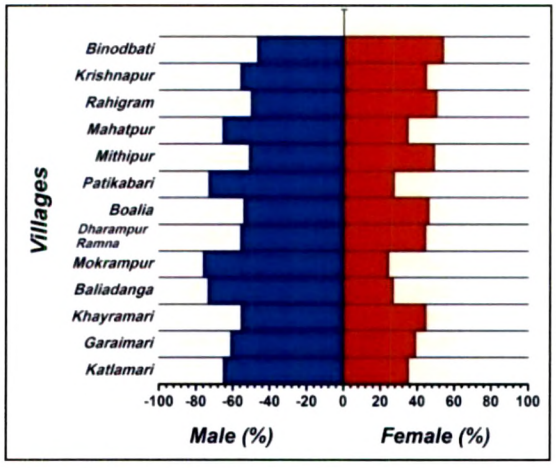


Fig. 4.24: Gender wise % of Persons Having Total General Symptoms

Table 4.20: Percentage of General Symptoms

Sr. No.	Block Name	Village Name	(%) of Total General Symptoms to Surveyed Population			(%) of Total General Symptoms to Affected Population	
			Male	Female	Total	Male	Female
1	Raninagar-2	Katlamari	217.90	130.74	176.64	64.97	35.03
2	Domkal	Garaimari	261.16	183.26	223.97	60.95	39.05
3	Jalangi	Khayramari	142.76	133.73	138.59	55.42	44.58
4	Bearampur	Balia Danga	100.35	46.85	76.88	73.26	26.74
5	Beldanga-1	Mokrampur	171.03	59.05	117.36	75.88	24.12
6	Hariharpara	Dharampur Ramna	276.21	249.00	263.47	55.73	44.27
7	Bhagawangola-2	Boalia	212.98	208.29	210.80	54.02	45.98
8	Nawda	Patikabari	190.79	75.78	135.28	72.96	27.04
9	Raghunathganj-2	Mithipur	181.27	209.13	193.90	51.12	48.88
10	Bhagawangola-1	Mahatpur	190.20	101.99	146.44	65.45	34.55
11	Burwan	Rahigram	155.07	182.86	167.80	50.08	49.92
12	Lalgola	Krishnapur	222.69	211.06	217.39	55.79	44.21
13	Sagardighi	Binodbati	163.71	217.84	192.48	46.67	53.33

Source: Calculated from the Primary Data Collected from Field

4.5.2 Thickening of Skin and Skin Lesions:

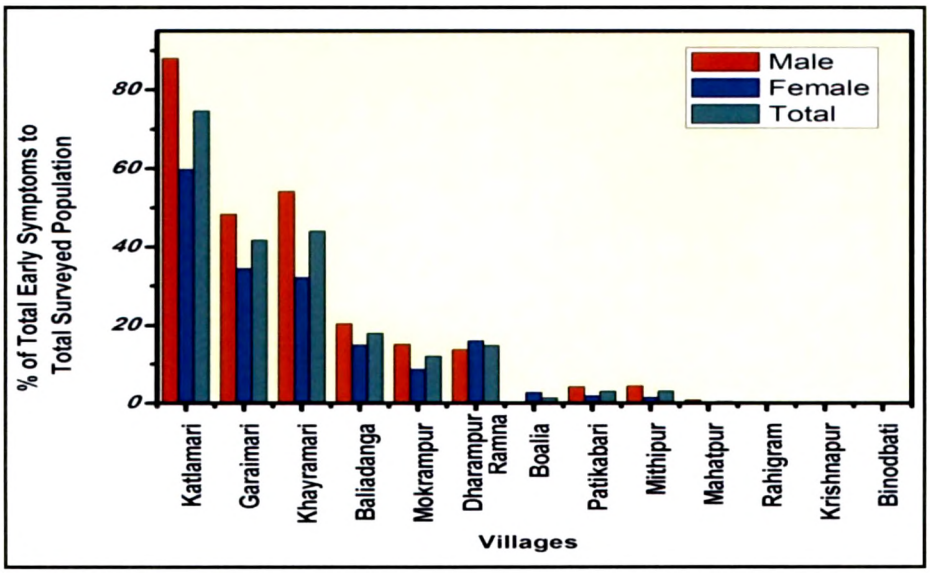


Fig. 4.25: Village wise Total Percentage of Thickening of skin and skin lesions

Co-morbidity of thickening of skin and skin lesions had highest percentage in the *Katlamari* village of *Raninagar-2* block (74.59%).

In the village of *Garaimari (Domkal)* and *Khayramari (Jalangi)* the percentage is 41.68% and 43.97% respectively. In the remaining villages, the co-morbidity to these two symptoms ranged between 17.98% *(Balia Danga* village of *Berhampur)* to 0.40% *(Mahatpur* village of *Bhagawangola-1* block).

In the villages of *Rahigram (Burwan), Krisnapur (Lalgola)* and *Binodbati (Sagardighi)* no cases of these two symptoms were found. In all the villages the percentage of affected male was higher than the females.

Table 4.21: Percentage of Thickening of Skin and Skin Lesions

Sr. No.	Block Name	Village Name	(%) of Total Early symptom to Surveyed Population			(%) of Total Early Symptom to Effected Population	
			Male	Female	Total	Male	Female
1	Raninagar-2	Katlamari	87.94	59.74	74.59	62.09	37.91
2	Domkal	Garaimari	48.35	34.39	41.68	60.62	39.38
3	Jalangi	Khayramari	54.14	32.13	43.97	66.24	33.76
4	Bearampur	Balia Danga	20.42	14.86	17.98	63.74	36.26
5	Beldanga-1	Mokrampur	15.08	8.62	11.98	65.52	34.48
6	Hariharpara	Dharampur Ramna	13.66	16.00	14.75	49.21	50.79
7	Bhagawangola-2	Boalia	0.00	2.76	1.29	0	100
8	Nawda	Patikabari	4.18	1.79	3.03	71.43	28.57
9	Raghunathganj-2	Mithipur	4.38	1.44	3.05	78.57	21.43
10	Bhagawangola-1	Mahatpur	0.78	0	0.40	100	0
11	Burwan	Rahigram	0	0	0	0	0
12	Lalgola	Krishnapur	0	0	0	0	0
13	Sagardighi	Binodbati	0	0	0	0	0

Source: Calculated from the Primary Data Collected from Field

In *Katlamari* village the male share was 87.94% while the females were 59.74%. In the village of *Mahatpur* males were least (0.78%) and no case of affected females was found (Table 4.21) (Fig.4.25).

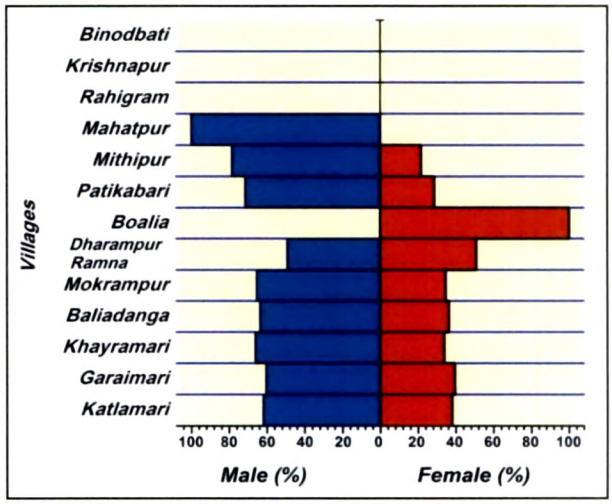


Fig. 4.26: Gender wise % of Persons Having Total Thickening of Skin and Skin Lesions

The number of males were more in all the villages than the females except for the village of *Dharampur Ramna* where they contributed a similar percentages (49.21 and 50.79 respectively). In all the villages affected males were more than 60% while affected females varied between 21.43% *(Raghunathganj-2)* and *Bhagawangola-2* (100%).

Garaimari village of *Domkal* block (41.68%), *Katlamari* Village of *Raninagar-2* (74.59%) and *Khayramari* village of *Jalangi* (43.97%) had the highest percentage of thickening of skin. In *Garaimari* and *Khayramari* male dominance in this ailment was noticed (60.62% and 66.24% respectively). The remaining ten villages had considerably less inhabitants with the problem of thickening of skin. In the *Mahatpur* village of *Bhagawangola-1, Binodbati* village of *Sagardighi, Krishnapur* village of *Lalgola* and *Rahigram* village of *Burwan* none of the people were suffering from this particular symptom.

Skin lesions were largely observed in the *Katlamari* village of *Raninagar-2* (30.94%) and *Khayramari* village of *Jalangi* (17.25%) with higher percentage of males (27.04% and 16.60% respectively) (Fig.4.26). In *Dharmapur Ramna* village *(Hariharpara),Balia danga* village *(Berhampur)* and *Garaimari* village *(Domkal)* the percentage of population associated with the ailment, ranged between 6% to 9% with

higher percentage of male population. In the remaining blocks considerably lower percentage of people were affected.

4.5.3 Pigmentation:

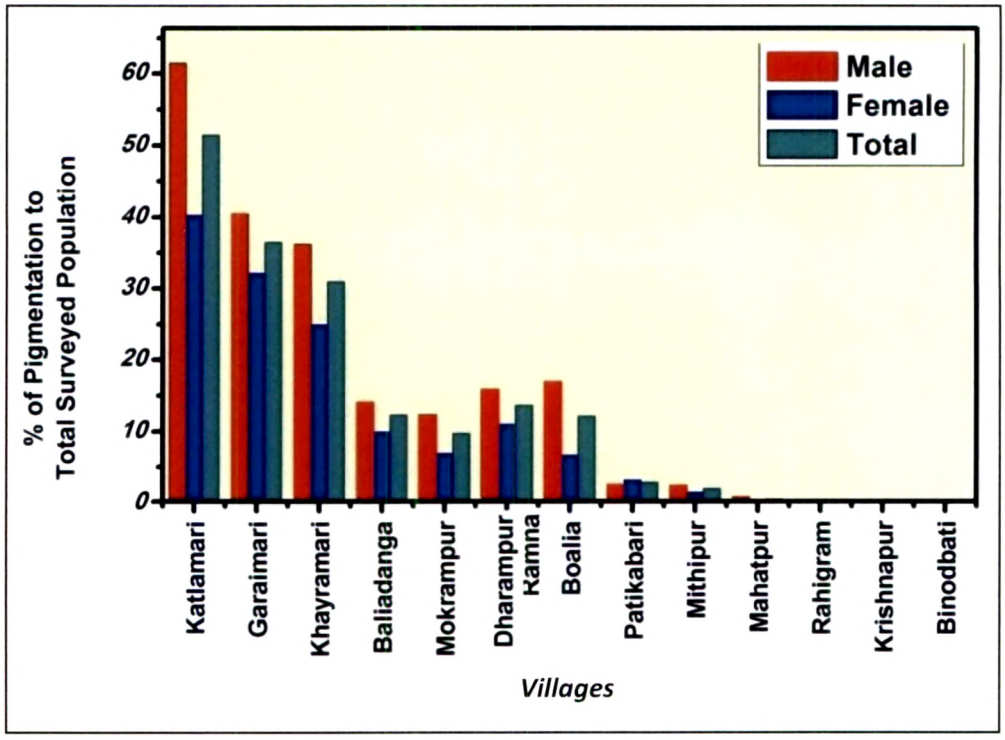


Fig. 4.27: Village wise % of Pigmentation

In *Katlamari* village of *Raninagar-2* block, 51.43% of the persons had pigmentation. The villages of *Garaimari* (*Domkal* block) and *Khayramari (Jalangi)* the percentage of affected persons were 36.50 and 30.98 respectively (Fig.4.27). In rest of the villages, the percentage varied between 0.04 in *Mahatpur* village of *Bhagawangola-1* block to 12.2 in *Baliandanga* village of *Berhampur* block. In all the villages, the males were more affected than the females. Highest percentage was noticed in *Katlamari* village (61.48) *(Raninagar-2)* and least in *Mahatpur* village of *Bhagawangola-1* block (0.78). Amongst the females it ranged between 40.26% (*Katlamari* village) to 1.22% in *Raghunathganj-2* block 100% males were affected in *Mahatpur* village and in *Garaimari* village 57.99% while highest percentages of affected females were found in

the village of *Patikabari* village of *Nawda* block (53.85%) and lowest in *Boalia* village of *Bhagawangola-2* block (25.53%) (Fig. 4.27) (Fig. 4.34).

Table 4.22: Percentage of Pigmentation in the Surveyed Villages

Sr. No	Block Name	Village Name	Arsenic concentration	(%) of Total Pigmentation to Surveyed Population			(%) of Total Pigmentation to Affected Population	
				Male	Female	Total	Male	Female
1	Raninagar-2	Katlamari	0.03	61.48	40.26	51.43	62.95	37.05
2	Domkal	Garaimari	0.37	40.50	32.13	36.50	57.99	42.01
3	Jalangi	Khayramari	0.12	36.21	24.90	30.98	62.87	37.13
4	Berhampur	Balia Danga	0.02	14.08	9.91	12.25	64.52	35.48
5	Beldanga-1	Mokrampur	0.16	12.30	6.90	9.71	65.96	34.04
6	Hariharpara	Dharampur Ramna	0.05	15.86	11.00	13.58	62.07	37.93
7	Bhagawangola-2	Boalia	0.04	16.83	6.63	12.08	74.47	25.53
8	Nawda	Patikabari	0.03	2.51	3.14	2.81	46.15	53.85
9	Raghunathganj-2	Mithipur	0.02	2.39	1.44	1.96	66.67	33.33
10	Bhagawangola-1	Mahatpur	0.08	0.78	0.00	0.40	100.00	0.00
11	Burwan	Rahigram	0.03	0.00	0.00	0.00	0.00	0.00
12	Lalgola	Krishnapur	0.03	0.00	0.00	0.00	0.00	0.00
13	Sagardighi	Binodbati	0.02	0.00	0.00	0.00	0.00	0.00

Source: Calculated from the Primary Data Collected from Field

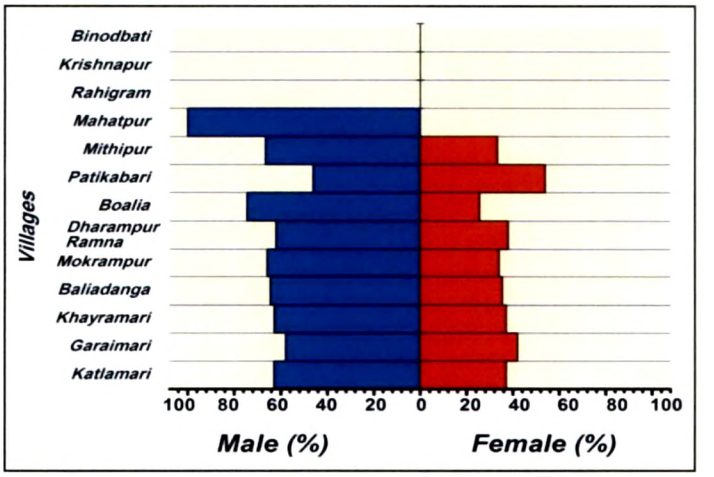


Fig. 4.28: Gender wise % of Persons Having Pigmentation

4.5.4 Keratosis and Carcinoma:

Katlamari village of *Raninagar-2, Garaimari* village of *Domkal* block and *Khayramari* village of *Jalangi* block had higher co-morbidity of *keratosis, carcinoma* and severe

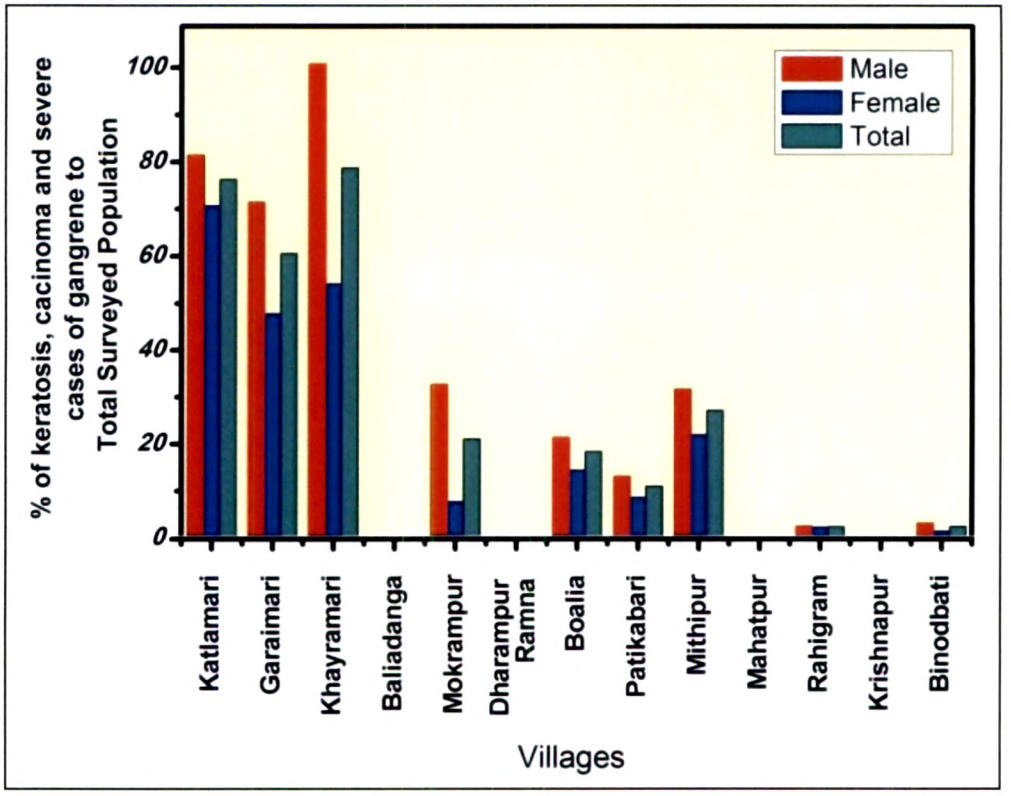


Fig. 4.29: Village wise Percentage of Keratosis, Carcinoma and Gangrene

cases of *gangrene* (78.69%, 76.24% and 60.48% respectively). Other than these villages, *Dharampur Ramna* village of *Hariharpara* block and *Boalia* village of *Bhagawangola-2* block had 27.17% and 21.08% of affected persons (Fig.4.29) .

Like other villages, males were more affected than the females. In the village of *Katlamari (Raninagar-2)* had highest percentage of male affected persons (100.78%). In other villages like *Garaimari* village of *Domkal* and *Khyaramari* village of *Jalangi* 81.40% and 71.38% of males were affected. In *Garaimari* village of *Domkal* block, *Khayramari* village of *Jalangi* block and *Katlamari* village of *Raninagar-2* block 70.59%, 54.11% and 47.79% respectively of females were affected (Fig. 4.36a & 36b).

In *Boalia* village of *Bhagawangola-2* block and *Mithipur* village of *Raghunathganj-2* block, the males share was 82.93% and 72.73% respectively. In the

villages of *Patikabari* village of *Nawda* block and *Garaimari* village of *Domkal* the percentage of affected females were 45.45% and 44.19% respectively (Fig.4.36a, 4.36b, 4.36c and 4.36d).

Table 4.23: Percentage of Keratosis, Carcinoma and Severe Gangrene Symptoms

Sr. No.	Block Name	Village Name	(%) of Keratosis and Carcinoma and to surveyed Population			(%) of Keratosis and Carcinoma and to Effected Population	
			Male	Female	Total	Male	Female
1	Raninagar-2	Katlamari	100.78	54.11	78.69	67.45	32.55
2	Domkal	Garaimari	81.40	70.59	76.24	55.81	44.19
3	Jalangi	Khayramari	71.38	47.79	60.48	63.50	36.50
4	Berhampur	Balia Danga	21.48	14.41	18.38	65.59	34.41
5	Beldanga-1	Mokrampur	13.10	8.62	10.95	62.26	37.74
6	Hariharpara	Dharampur Ramna	31.72	22.00	27.17	62.07	37.93
7	Bhagawangola-2	Boalia	32.69	7.73	21.08	82.93	17.07
8	Nawda	Patikabari	2.51	2.24	2.38	54.55	45.45
9	Raghunathganj-2	Mithipur	3.19	1.44	2.40	72.73	27.27
10	Bhagawangola-1	Mahatpur	0.00	0.00	0.00	0.00	0.00
11	Burwan	Rahigram	0.00	0.00	0.00	0.00	0.00
12	Lalgola	Krishnapur	0.00	0.00	0.00	0.00	0.00
13	Sagardighi	Binodbati	0.00	0.00	0.00	0.00	0.00

Source: Calculated from the Primary Data Collected from Field Source:

The incidence of *keratosis* was low in the blocks of *Hariharpara* (13.35%), *Berhampur* (10.08%) and *Beldanga-1* blocks (7.02%) with male dominancy. In *Raninagar-2, Domkal* and *Jalangi* blocks, affected persons were 43.85%, 39.09% and 31.73% respectively. *Raghunatguanj-2* and *Nawda* blocks ranged between 0.2% to 2%. No person was showing the signs of *Keratosis* in the villages of *Mahatpur*

(*Bhagawangola-1*), *Binodbati* (*Sagardighi*), *Krishnapur* (*Lalgola*) and *Rahigram* (*Burwan*).

In *Garaimari* village of *Domkal* block, *Katlamari* village of *Raninagar-2* block and *Khayramari* village of *Jalangi* block 36.07%, 34.84% and 28.76% of people showed signs of *carcinoma* in different parts of the body. Once again there was dominance of males (Table 4.23) (Fig.4.30). Severe case of gangrene with was observed in the villages of *Garamari* and *Boalia* (Fig. 4.37, Fig. 4.38a and 4.38b).

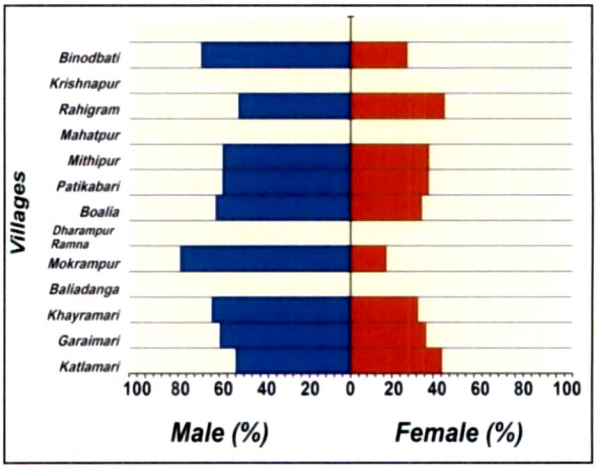


Fig. 4.30: Gender wise % of Persons Having Keratosis and Carcinoma

4.6 Income wise Distribution of Affected and Non-affected Person:

Income is considered to be one of the parameter of social well being,where the level of income indicates the person's ability to obtain amenities. The mean monthly

family income was calculated for both affected and non affected persons. It was observed from the result that, the income of non-affected persons varied between ₹ 821/- *(Sagardighi)* to ₹ 7370/- *(Beldanga-1)* (Fig.4.24). On the other hand, the income of the affected persons ranged from ₹ 2566 *(Raghunathganj-2)* to ₹ 8719 *(Bhagawangola-2)*. The mean per capita monthly income of the affected persons was higher than the affected person in the blocks of *Hariharpara, Bhagawangola-2, Nawda* and *Bhagawangola-1*. In the above said blocks the income of the non-affected persons was ₹ 2521/-, ₹ 3584/-, ₹ 4593/- and ₹ 5095/- while it was ₹ 8228/-, ₹ 8719/-, ₹ 5328/- and ₹ 5125/- among the affected persons. In the blocks of *Beldanga-1, Jalangi* and *Domkal,* the difference between the non affected and affected persons was much more distinct.

In *Beldanaga-1*, the mean per capita income of the non affected persons was ₹ 7370/- while it was ₹ 6119/- among the affected persons. Similar pattern can be observed in the blocks of *Jalangi* and *Domkal* where the income of the non affected and affected persons was ₹ 4274/- and ₹ 3972/- respectively and ₹ 3972/- and ₹ 2832/- respectively. In the block of *Raghunathganj -2*, similar pattern was observed (₹ 3042/- among non affected person and ₹ 2566/- among affected person). The blocks of *Raninagar-2* and *Berhampur* did not show any significant variation in income level of the two categories of persons. In rest of the

Table 4.24: Per Capita Monthly Income of Affected and Non-affected Persons.

Villages	Non-affected income	Affected Income
Katlamari	4419.12	4259.95
Garaimari	3946.36	2832.69
Khayramari	4247.21	3972.65
Baliadanaga	4515.79	4175.92
Mokrampur	7370.21	6119.19
Dharampur		
Ramna	2521.21	8228.61
Boalia	3594.41	8719.58
Patrikabari	4593.74	5328.21
Mithipur	3042.49	2566.67
Mahatpur	5095.03	5125.00
Rahigram	2894.50	0.00
Krishnapur	5183.22	0.00
Binodbati	821.61	0.00

Source: Calculated from the Primary Data Collected from Field

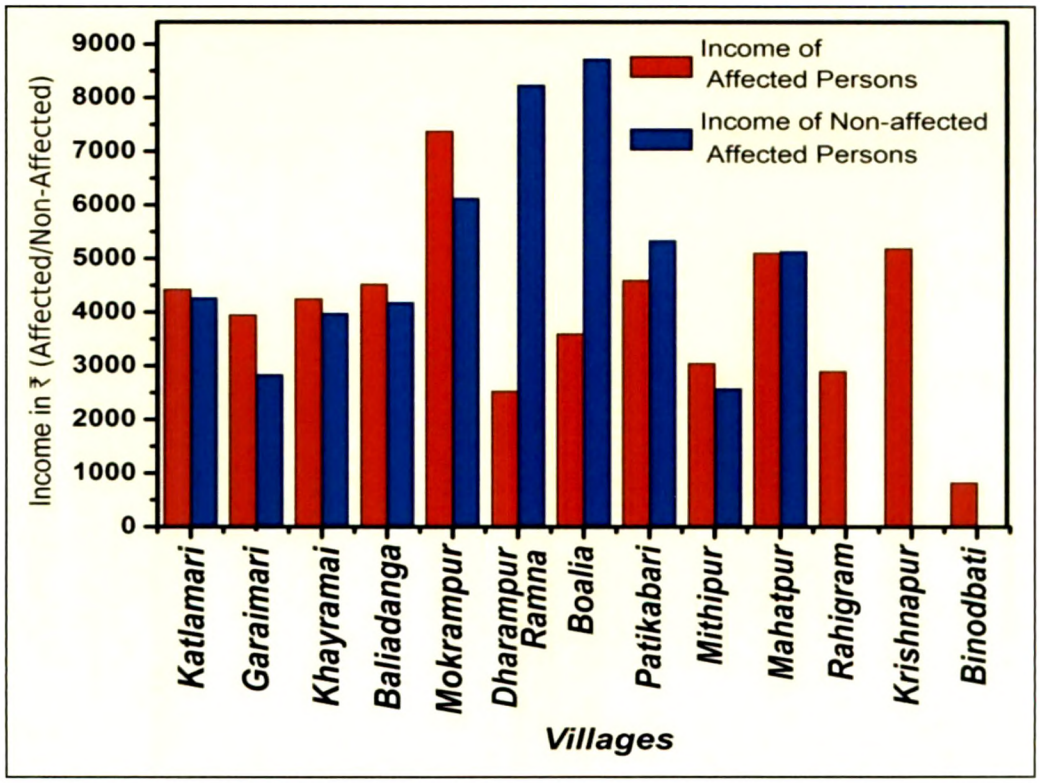


Fig. 4.31: Village wise Per-capita Monthly Income of Affected and Non-Affected Persons

blocks like *Burwan, Lalgola* and *Sagardighi* no person was affected with the *arsenicosis*. Hence, the income of the non affected person was ₹ 2894/-, ₹ 5183/- and ₹ 821/- respectively).

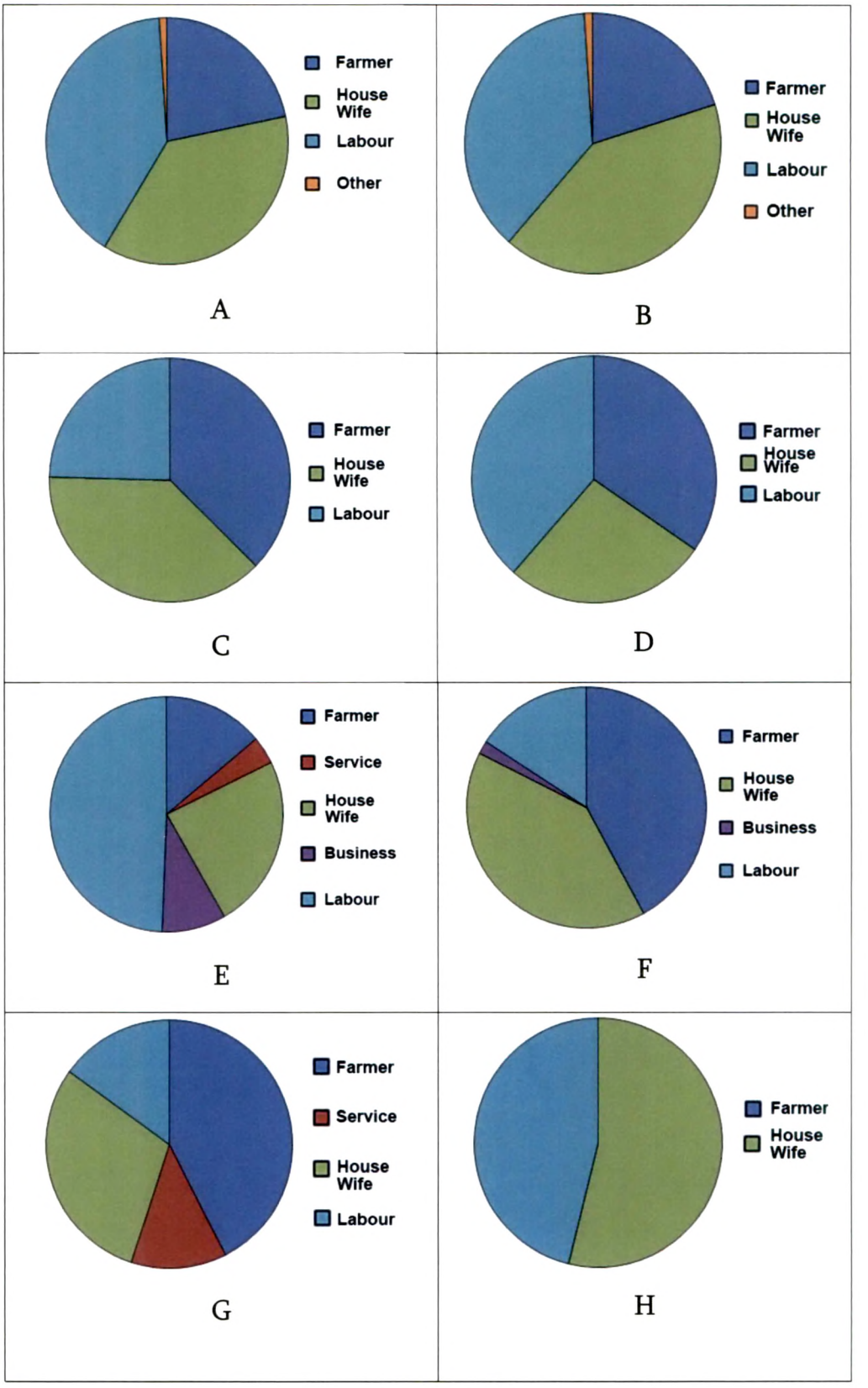
4.7 Occupational Pattern of the Affected Persons:

Farming, labour, service and business were the dominant occupations of the district. The percentage of labour in all the blocks was considerably high. It varied from 15% in *Bhagawangola-2* and *Hariharpara* blocks to 49.36% in *Beldanga-1*, 40.33% in *Raninagar-2* and 46.15% in *Nawda*. Farming was another prime occupation. *Raghunathganj* had highest percentage (44.44%) of farmers who were affected followed by *Bhagawangola-2* (42.50%), *Hariharpara* (40%), *Jalangi* (37.42%), *Berhampur* (34.64%), *Raninagar-1* (21.69%), *Domkal* (20.10%) and *Beldanga-1* (13.92%). Among the affected persons, house wives came next. In *Nawda*, 53.84% of the house wives had *arsenicosis* followed by *Domkal* (41.27%), *Hariharpara* (38.33%), *Jalangi* (38%), *Raninagar-2* (36.94%). *Raghunathganj-2* (33.33%), *Bhagawangola-2* (30%), *Berhampur* (26.79%) and *Beldanga-1* (24.05%) (Fig.4.32).

Table 4.25: Occupational Pattern of the Surveyed Villages in Percentage

Villages	Occupations					
	Farmer	Service	House Wife	Business	Labour	Others
Katlamari	21.7	0.00	36.94	0.00	40.33	1.01
Garaimari	20.10	0.00	41.26	0.00	37.57	1.05
Mokrampur	13.92	3.80	24.05	8.87	49.37	N.A.
Boalia	42.50	12.50	30.00	N.A.	15.00	N.A.
Khayramari	37.42	0.00	38.01	0.00	24.56	0.00
Balia Danga	34.64	0.00	26.80	0.00	38.56	N.A.
Dharampur Ramna	40.00	5.00	38.33	1.67	15.00	N.A.
Patikabari	0.00	0.00	53.85	0.00	46.15	N.A.
Mithipur	44.44	N.A.	33.33	N.A.	22.22	N.A.
Mahatpur	100.00	0.00	0.00	0.00	0.00	0.00

Source: Calculated from the Primary Data Collected from Field


Farmer
House Wife
Labour
Other
A
Farmer
House Wife
Labour
Other
B
Farmer
House Wife
Labour
C
Farmer
House Wife
Labour
D
Farmer
Service
House Wife
Business
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E
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House Wife
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Labour
F
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Service
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Labour
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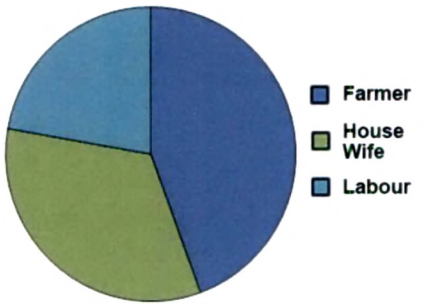
Farmer
House Wife
H



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Sr	Blocks	Villages
A	Raninagar-2	Katlamari
B	Domkal	Garaimari
C	Jalangi	Khayramari
D	Behrampur	Balia Danga
E	Beldanga-1	Mokrampur
F	Hariharpara	Dharma Ramna
G	Bhagawangola-1	Boalia
H	Nawda	Patikabari
I	Raghunathganj-2	Mithipur

Fig. 4.32: Village wise Percentage of Different Types of Occupations Among the Persons Having Symptoms of Arsenicosis

The percentage of people engaged in service was relatively lower. The affected persons whose occupation was business, was found in the block of *Beldanga-1* (8.86%). 12.50% of affected persons engaged in service were found in the block of *Bhagawangola-2*. No affected person was found in *Burwan, Lalgola* and *Sagardighi* blocks.

4.8 Discussion:

The general symptoms were dominatingly found in labours and farmers. In most of the cases the issues of *limb pain, hyperpathia,* and *abnormal sweating* was reported in the males largely because they are engaged in heavy jobs. In this respect the symptoms of *cough* and *nausea/vomiting* were reported from large percentage of people. This symptom is generally associated with the living and working condition of the person while in the later case, quality of water plays a major role. During the analysis of the water quality it was observed that the level of *TDS* and *hardness* was considerably high in the whole of the district. During the survey large number of people also complained about the colour and smell of water. The higher *TDS* and *hardness* can disturb the internal process of body and leads to the *nausea* and *vomiting* (**Kanchan**[2] et. al 2009).

Thickening of skin and *skin lesions* was observed in large population. Roughness of palm and feet is one of the initial symptoms of *arsenicosis* but a direct relationship cannot be established in all the cases. Skin lesions to a large extent is related to the quality of water consumed. The consumption of contaminated water for a longer period of time is one of the major cause of different types of skin ailments (**Kanchan**[1] et. al 2009).

A positive relationship existed between the prevalence rate and *arsenic* concentration in groundwater. As the concentration of *arsenic* in groundwater increases the prevalence rate also increases thus a positive correlation existed between the two (+0.63). The only exception in this case was *Berhampur* where *arsenic* concentration in groundwater was considerably lower (0.02 mg/l) but the prevalence rate was 30.24%.

Fig. 4.33: Household Survey

Black and white pigmentation or *melanosis* on different parts of the body was largely found in the affected population. Among the surveyed villages, the *Katlamari* had highest percentage of people suffering with *melanosis.* Among the male population *melanosis* was commonly observed on chest and back. The effect of *arsenicosis* starts with *melanosis* (**Saha** et. al 1999, **Cheng** et al. 2013). In *Rahigram*

village of *Burwan* block, *Krishnapur* village of *Lalgola* block and *Sagardighi* village of *Binodbati* blocks did not showed any cases of *melanosis* in either genders.

Keratosis is another major symptom and is considered to be the next stage of *arsenicosis* (**Squibbs** et. al 1983, **Ravenscroft** 2009). *Keratosis, carcinoma* and severe cases of *gangrene* are associated with longer period of consumption of *arsenic* affected

Fig. 4.34: Cases of Pigmentation on Chest

Fig. 4.35: Arsenic Removal Plants (ARPs)

water with higher concentration. In the present study, *keratosis* was observed among

Fig. 4.36: Cases of Keratosis on Hand and Feet

the people largely in the age groups of 30-49 years.

In most of the case the households used drinking water from shallow hand pumps (30-100 m). However, deeper hand pumps were also noticed (> 500 m). Numerous Arsenic Removal Plants (ARP's) (Fig. 4.35) were present but a few of them were not functioning properly. These ARP's were mostly associated with the *activated*

alumina (Chen et al. 2007), which need periodic backwashing to remove the layer from there surface.

It was also found that in different part of the villages the hand pumps were coloured as red and blue indicating unsafe and safe drinking water sign. Present study showed that, there is considerable change in the concentration of *arsenic* in groundwater in different seasons. Thus, it is necessity of periodic testing of the groundwater mot only for *arsenic* but different geochemical parameters. The safe marked hand pumps would be periodically checked to ensure the safe drinking water condition.

Fig.4.37: Cases of Keratosis and Gangrene on Feet

Fig. 4.38: Cases of Gangrene on Hand and Feet

Resume: In this chapter, an effect of arsenic on human health was analysed. It was observed that, eastern portion of the district had higher prevalence rate than the western portion. This region also showed higher concentration of arsenic in groundwater. Age and gender wise distribution of prevalence rate depicted the fact that the age group between 30-50 years had higher percentage of affected persons with male dominance. Labours and farmers were largely affected by the arsenic contamination. It was also found that, the per-capita monthly income of the affected persons were less than the non-affected persons. The following chapter focused upon the groundwater modeling for the identification of the vulnerability zones of groundwater of Murshidabad District.