

# **Health status assessment of people residing around Kerala Minerals and Metals Ltd.**

**Chavara, Kollam**

## **Report**

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## Executive summary

- ❖ This survey was planned with the objective to study the morbidity and mortality pattern of people residing around KMML in Panmana panchayath and to find out excess morbidity and mortality if any among population around Kerala Minerals and Metals Limited in Panmana in comparison with a similar area.
- ❖ Alappad panchayath was selected as comparison area with similar environmental parameters like Panmana as it has a long coastal boundary like Panmana panchayath. Alappad also stretches along the same coastal line as Panmana, as both areas come under Chavara mines which has as high as 40% heavy minerals extending over a stretch of 23 kms in the coastal belt of Neendakara and Kayamkulam. This comparison will eliminate some background factors which can influence the health of people who live in area near the KMML Titanium Sponge Plant.
- ❖ In the Panmana area, 1240 individuals were surveyed, with the mean age being 41.23 years. Slightly higher number of females were seen reflecting the demographic pattern of Kerala.
- ❖ About 38.3% of households in Panmana reported death in the household in the past 10 years compared to 28.9% in Alappad, significant difference could be made out statistically and on further analysis majority of the deaths were due to cardiovascular diseases in Panmana and geriatric illness in Alappad. No significant difference was identified in deaths due to cancer.
- ❖ A significant association was observed in the occurrence of acute illness in past one year and a higher number was seen in Panmana compared to Alappad with reported occurrence of 25% and 18.35% respectively.

- ❖ Among the chronic diseases, significantly higher frequency was seen in Panmana. When each disease was analysed individually, significant difference could be seen in the proportion of people with Diabetes, COPD, Gastrointestinal diseases, eye, ear, and skin diseases.
- ❖ Logistic regression was done to nullify the interaction of variables and to bring out those factors that are independently significant, upon which respiratory diseases, skin diseases, eye diseases showed a higher occurrence in Panmana than Alappad. But when compared to the Kerala morbidity data, only dermatological conditions showed a higher rate of occurrence.
- ❖ Among the 21 individuals who reported malignancy in the Panmana panchayath, breast cancer was the commonest. No significant difference was seen in the occurrence of malignancy in Panmana and Alappad.

#### **Environmental conditions of the community**

- ❖ About 93.2% of households in Panmana and 96.2% in Alappad were staying in own house mostly pucca structure and majority those surveyed had been living there for more than 30 years. Average household size was 3.5 in Panmana and 3.7 in Alappad, less than State average of 3.9.
- ❖ Regarding the housing conditions, 83.7% in Panmana and 85.8% in Alappad had kitchen separated from rest of the area, the main cooking fuel used was LPG, reported as 98.3% in Panmana and 98.9% in Alappad, Firewood use along with LPG was at a higher rate of 63% in Panmana than Alappad where it was only 25.9%. Own latrines were present in 98.3% of households in Panmana and 98.9% in Alappad.
- ❖ Majority of the households were using piped water supply for consumption which was 95.5% in Panmana and 94.6% in Alappad. In Panmana 71.5 % of households depend on supply from KMML for drinking and cooking. Well water quality was worse in Panmana in

terms of colour, odour, taste, and hardness compared to Alappad as reported by the residents.

- ❖ Many methods of solid waste management were practised in the community among which dumping was the one predominantly adopted. Majority drained liquid waste within the compound.
- ❖ About half of the households (52.1%) reported adverse environmental changes in Panmana which was much higher than Alappad (15.8%).

## Introduction

Health is a state of complete physical, mental, and social wellbeing, not merely the absence of disease defines World Health Organization. Health is depended largely on physical environmental conditions like safe water, clean air, safe working environment to which the people are exposed, socio economic environment to which the person live and the behaviour and characteristics of the person.

Industrial development has a major role in the economic advancement of a nation, through creation of employment opportunities, rapid economic growth, and overall social development through improved access to health care and other services. The greatest disadvantage of establishment of an industry is environmental damage through pollution of air, water, and soil.

Industrial pollution affects both the environment and health and wellbeing of population residing in the nearby residential areas expected to be exposed to pollutant emission from the industrial complexes. Permanent residence in these areas for prolonged periods can add to the risk of diseases including cancers. Any excess occurrence of self-reported morbidity among them will have to be subjected to detailed analysis to rule the effect of pollution.

Kerala Minerals and Metals Limited, a public sector undertaking in Kerala functioning since 1884, is in the coastal belt of Kerala and the uniqueness of this area is this area has one of the best mineral sand deposits in the country. This mineral sand area extends from Neendakara to Kayamkulam extending over a stretch of 23 kms in the coastal belt of Neendakara and Kayamkulam. The same area is known for high background radiation from thorium-containing monazite sand. Kerala Minerals and Metals Limited is situated in Panmana panchayath of Chavara block.

In response to judgement of National Green Tribunal (NGT.A.No.290 of 2013), Government of Kerala entrusted Department of Community Medicine, Government Medical College, Thiruvananthapuram to conduct a health survey to assess the health conditions of people living in and around the area of Kerala Minerals and Metals Limited (KMML), Chavara, Kollam, Kerala. (G1/310/2017, Health and family welfare dated 11.05.2022).

Accordingly, a survey protocol was prepared and with the following broad objectives.

1. To study the morbidity and mortality pattern of people residing in Panmana Panchayath, in the immediate vicinity of Kerala Minerals and Metals Limited in, Chavara, Kollam District.
2. To find out excess morbidity and mortality if any among population around Kerala Minerals and Metals Limited in Panmana in comparison with population residing at least 10km away from KMML but having the same socio-cultural environment of Panmana Panchayath where KMML is located and that of Kerala.
3. To identify risk factors associated with morbidity among people residing around KMML compared to those living away from KMML.

Accordingly, a quantitative survey was conducted to capture the prevailing disease pattern, both acute and chronic along with relevant socio demographic, environmental and spatial characteristics was conducted in Panmana in the vicinity KMML having 23 wards with 50,000 population in 16.85 sq. km.

Figure 1: Area map of Panmana Panchayath

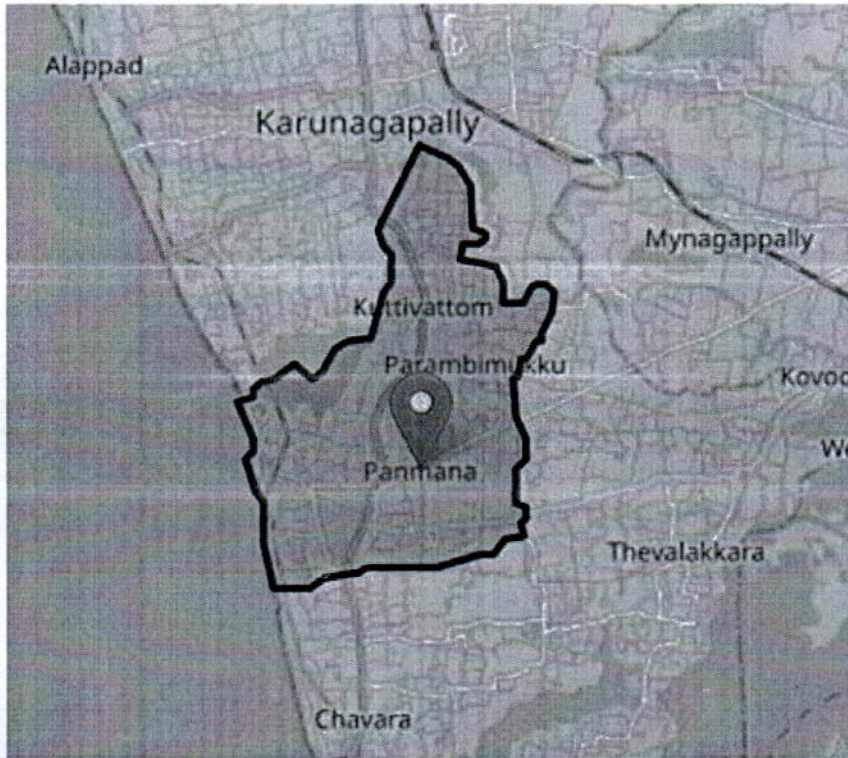
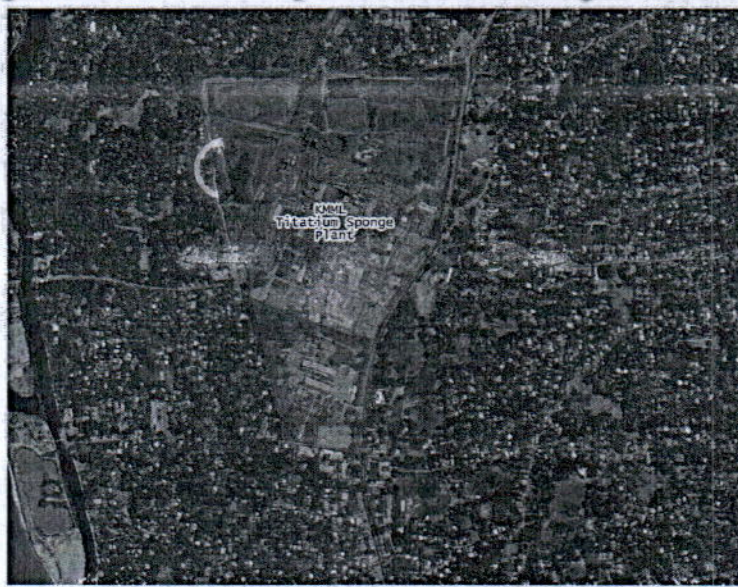


Figure 2: Location of KMML in Panmana Panchayath





To compare the health status of people residing around KMML, and any excess occurrence of acute and chronic morbidity, Alappad Panchayath which is around 13 Km away from KMML was selected. This Panchayath is a 13 Km long narrow strip of land in the coastal belt sandwiched between Arabian sea and the TS canal having a population of 21655 distributed in 16 wards covering an area of 8.49 sq.km were also included in the health survey. This Panchayath is also coming in the coastal area with mineral sand deposition and high background radiation indicating comparability of both the areas along with similar physical environment and socio-cultural conditions.

Figure 3: Area map of Alappad Gram Panchayath



Health survey was conducted by, Department of Community Medicine, Government Medical College Thiruvananthapuram, a team of 30, constituted by Professors, Associate professors, Assistant professors, Junior residents, House surgeons and Nursing students visited the area on 11<sup>th</sup> & 12<sup>th</sup> June 2022 in Panmana Panchayath & information was collected using a pretested semi structured questionnaire. For comparison, details were collected by community survey in Alappad panchayath, Kollam using the same questionnaire. Household and individual details were collected and analysed.

## **Survey Methodology**

Cross sectional study design was adopted for the survey, total number of households needed for the survey was found out by calculating sample size based on the prevalence of morbidity status of Kerala Population as 24.5% obtained from key indicators of social consumption in India: Health collected through 75<sup>th</sup> round of survey by National sample survey organization conducted during 2017-18 and published in 2019, with alpha error of 5% and absolute precision of 4, and design effect of 3, a total of 1240 individuals from 355 households were surveyed. Alappad areas is first stratified to include population from the whole panchayath area and design effect of 1.5 was taken, and 681 individuals from 183 households in Alappad were included as study subjects.

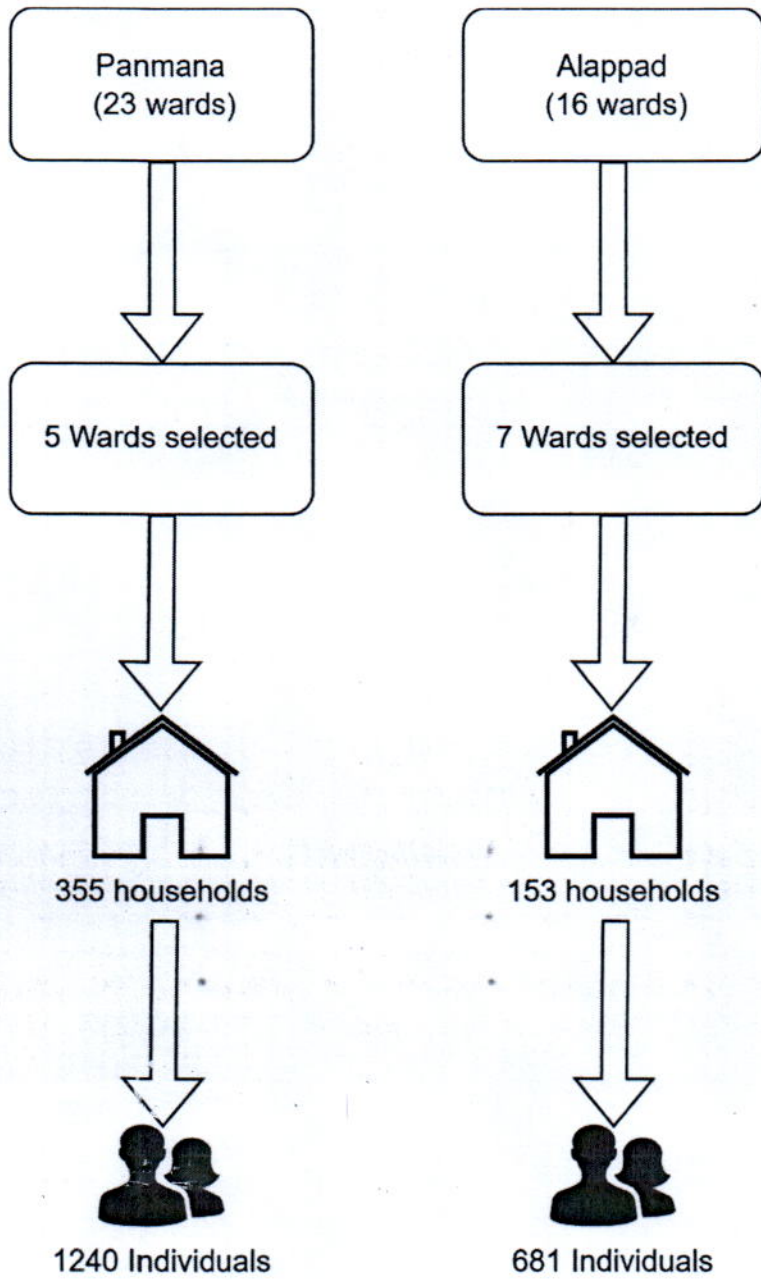


Figure 4 : Spatial map showing the location of households surveyed in Panmana and Alappad for morbidity assessment.

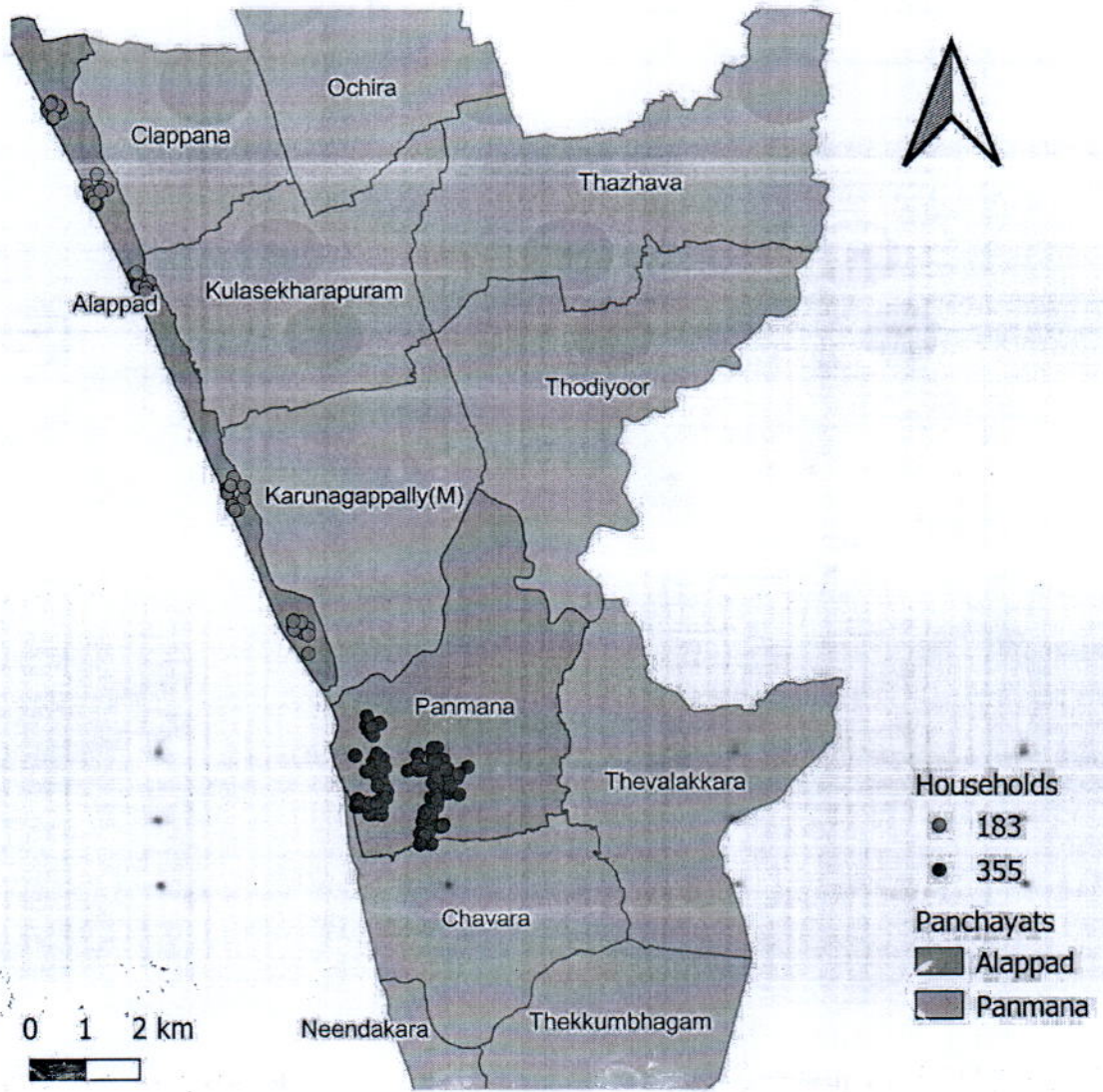
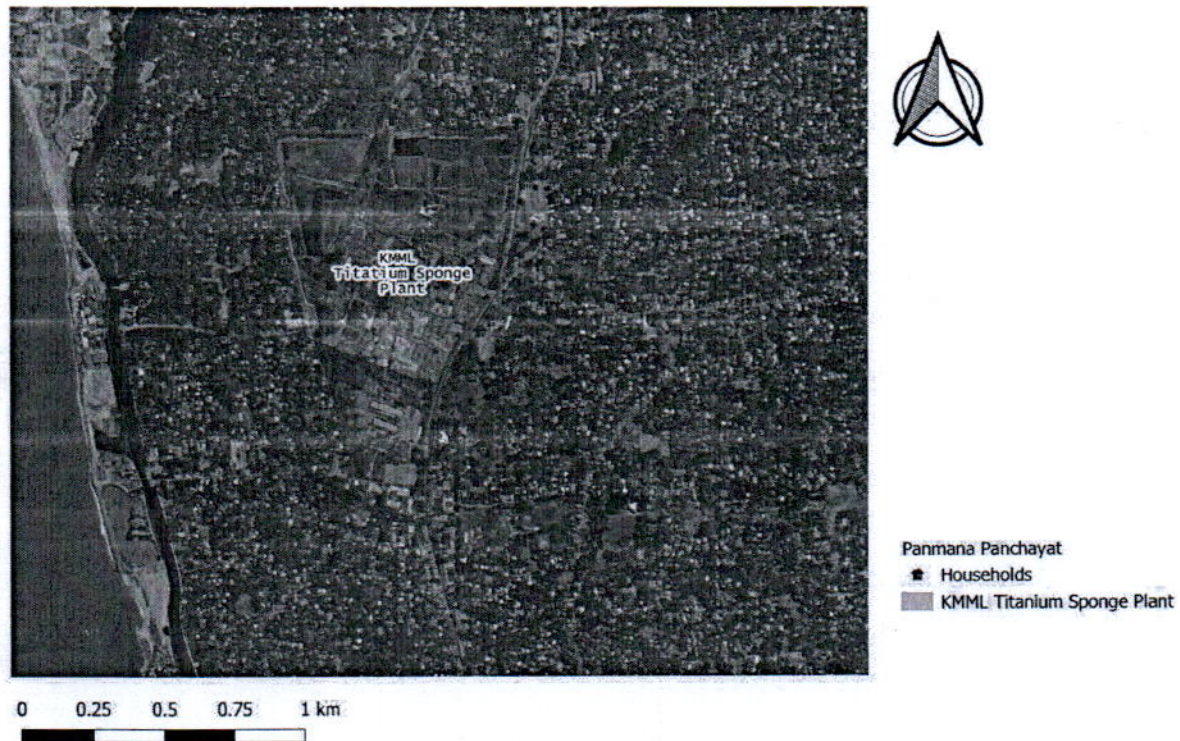


Figure 5 : Spatial map showing the location of 355 surveyed household and its position in relation to location of KMML.



Individuals who have been residing in the same location for at least a period of 6 months those who gave consent were included in the survey.

## Data collection technique

The study tool - semi structured, validated questionnaire for quantitative estimation of morbidity and mortality. Each team comprised of 3-4 individuals including a doctor, nurse, middle level service provider from the nearest primary health centre was deployed for collecting both epidemiological and spatial data. Epidemiological variables included socio demographic parameters, self-reported acute and chronic health conditions respiratory and skin conditions, fertility, cancers, acute diseases, chronic diseases as well as mortality data were collected.

## Data analysis

Data entry was done in excel sheet and analysed using SPPSS software, all qualitative variables were summarised as percentages and quantitative variables summarized as mean and standard deviation. Univariate analyses were done to find out any significant difference in occurrence of acute and chronic morbidity among permanent residents of Panmana in comparison with Alappad and that of Morbidity of Kerala obtained from 75<sup>th</sup> round of National Sample survey Organization. In univariate analysis, chi square test was used to test significant difference in occurrence of disease in both areas' association P value of <0.05 was taken as significant. Logistic regression was done to calculate adjusted odds ratio and p value to adjust for confounding effects if any in the result

## RESULTS

### I. Baseline details of the survey

Assessment of self-reported morbidity and mortality were collected from a total of 538 houses from Panmana and Alappad areas of Kollam District of which 355 (66%) from five wards of Panmana Panchayath where KMML is located and 183 (34%) from Alappad Panchayath located 15km away from KMML. 1240 individuals from Panmana and 681 individuals from in Alappad were participated in the survey.

*Table 1: Distribution of wards of Panmana included in the study (N=355)*

<i>Ward (Panmana)</i>	<i>Number of Households</i>	<i>Percentage (%)</i>
15	59	16.6
16	61	17.2
18	86	24.2
19	85	24.0
20	64	18.0
<b>Grand Total</b>	<b>355</b>	<b>100.0</b>

*Table 2: Distribution of wards of Alappad included in the study(N=183)*

<i>Ward (Alappad)</i>	<i>Household Frequency</i>	<i>Percentage (%)</i>
3	40	21.9
5	40	21.9
7	31	16.9
10	24	13.1
11	16	8.7
14	24	13.1
15	8	4.4
<b>Grand Total</b>	<b>183</b>	<b>100</b>

## II. Details of households participated in the survey.

A total of 355 households from Panmana and 183 households from Alappad participated in the study. Characteristics of households participated from both areas in the survey were as follows.

### Details of residence in the locality

#### II. a. Ownership of house

Table 3: Distribution of houses based on ownership.

Ownership of Residential house	Panmana		Alappad		TOTAL	
	Number	Percentage	Number	Percentage	Number	Percentage
Own house	331	93.2	176	96.2	507	94.2
Rented house	18	5.1	6	3.3	24	4.5
Received from Govt. scheme	6	1.7	1	0.5	7	1.3
<b>TOTAL</b>	<b>355</b>	<b>100</b>	<b>183</b>	<b>100</b>	<b>538</b>	<b>100</b>

Housing is one of the major basic needs of any population, ownership of a dwelling unit is a key indicator of socio-economic development of any society. Majority (95.5%) of households surveyed have own house in the locality of which 1.3 % of houses received from Government schemes. 94.9% in Panmana Panchayath and 95.5% in Alappad are residing in their own house. As per Kerala's report of NSS socio economic survey 75<sup>th</sup> round published by Department of Economics and statistics, only 90% households in Kerala have own dwelling unit. Proportion of households having own dwelling houses were high in surveyed areas and Alappad is in a better position than Panmana and State in this regard. Only very few households were 4.5% living in rented houses in the surveyed area. Rented house dwellers were more in Panmana area (5.1%) compared to Alappad (3.3%)



## II. b. Duration of stay in the locality.

Table 4: Mean duration of residence in the area

	Panmana	Alappad
Mean years of residence in the area	29.04 ± 19.4	33.08 ± 18.9
Minimum years	0.5	1
Maximum years	100	80

All individuals who are physically staying in the area for at least six months were included in the survey. Most of them were residing in the surveyed area for many years, the mean duration of stay in the locality was 29 years in Panmana and 33 years in Alappad.

Table 5: Distribution based on years of stay in the locality.

Years of stay in the locality	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Less than 1year	9	2.5	2	1.1
01-10 years	50	14.1	20	10.9
10-30 years	164	46.2	78	42.6
30-60 years	107	30.1	67	36.6
More than 60 years	25	7.0	16	8.7
<b>Total</b>	<b>355</b>	<b>100.0</b>	<b>183</b>	<b>100</b>

Majority of households both in Panmana (83.4%) and Alappad (88%) are living in the area for more than 10 years. In Panmana where KMML is located, one third of households (37.1 %) were living there for more than three decades. Compared to Panmana, higher percentage (45.3%) of households reported to have stayed in Alappad for more than 30 years.

## II. c. Distribution of houses based on family size.

Mean number of family members in Panmana was  $3.5 \pm 1.42$  and ranged between 1 and 9 members. Similarly, in Alappad region, mean number of family members was  $3.78 \pm 1.45$  and ranged between 1 and 10 members. The communities showed similar family structure, but the size was smaller in Panmana than Alappad.

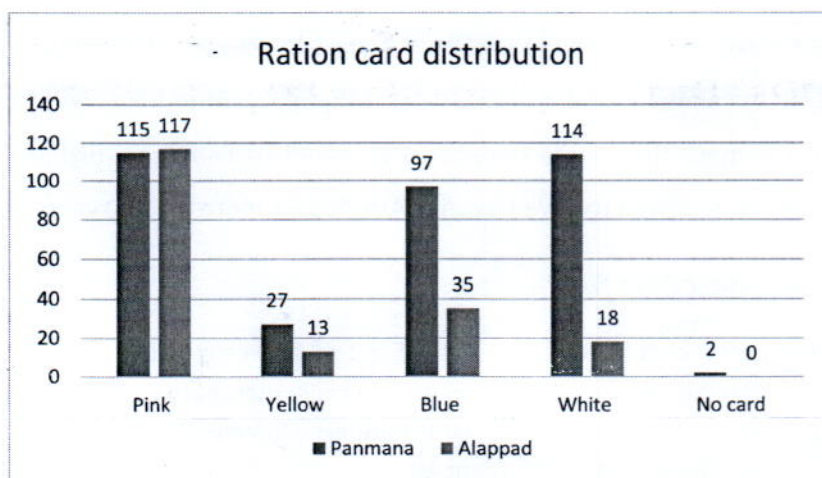
### III. Economic status

Table 6: Distribution of households based on possession of ration card.

Ration card colour	Group	Panmana		Alappad	
		Number	Percentage	Number	Percentage
Yellow	Most economically backward	27	7.6	13	7.1
Pink	Below poverty line	115	32.4	117	63.9
Blue	Above poverty line	97	27.3	35	19.1
White	Non-priority	114	32.1	18	9.8
No Ration card		2	0.6	0	0
Total		355	100.0	183	100

Economic status was assessed based on colour of ration card they possess. Very few households in Panmana (7.6%) and Alappad (7.1%) belonged to most economically backward sections of society availing benefits of Antyodaya Anna Yojana. Households from Panmana have better economic status compared to Alappad as evidenced by 59.3% of households in Panmana belonged to above poverty line, among them 32.1% belonged nonpriority group. Alappad panchayath is having the same socio environmental conditions of Panmana but two thirds of households were below poverty line.

Figure 6: Ration card possession in population



#### IV. Housing conditions

##### IV. a. Type of house

Table 7: Distribution of houses based on type of house.

Type of house	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Kutcha	9	02.5	5	2.7
Semi Pucca	85	23.9	29	15.8
Pucca	79	22.3	73	39.9
Pucca Concrete	182	51.3	76	41.5
Total	355	100.0	183	100.0

Among households surveyed, about 73% in Panmana and about 81 % in Alappad dwells in houses with pucca structure and half of households in Panmana had houses of pucca concrete building. 89% of households in Kerala had houses with pucca structure based on report of NSS socio economic survey, 76<sup>th</sup> round. Compared to Kerala data, pucca house dwellers were less in both the surveyed areas. In both the areas together, kutcha house dwellers constituted only 2.5%.

##### IV. b. Distribution of living rooms

The mean number of living rooms in Panmana was 2.95 (SD – 1.041) with a minimum and maximum of 1 and 7. Meanwhile, the mean number of living rooms was 2.63 (SD – 1.018) with a minimum and maximum of 1 and 8 in Alappad area.

Table 8: Distribution of houses based on number of living rooms in the house.

Number of living rooms	Panmana		Alappad	
	Number	Percentage	Number	Percentage
1 room	14	03.9	21	11.6
2 rooms	107	30.1	62	33.9
3 rooms	151	42.5	72	39.3
4 rooms	59	16.6	25	13.7
5 or more	24	06.7	3	01.6
Total	355	100.0	183	100.0

Households in Panmana have better living conditions than Alappad. 96% of households in Panmana and 89% in Alappad lived in houses with at least two living rooms. Big houses with 5 or more living rooms were also high in Panmana (6.7%) than Alappad (1.6%)

#### IV. c. Overcrowding

Table 9: Distribution of houses based on overcrowding in the house.

Overcrowding	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Present	25	7.0	33	18.0
Absent	330	93.0	150	82.0
<b>Total</b>	<b>355</b>	<b>100.0</b>	<b>183</b>	<b>100.0</b>

Overcrowding was assessed based on number of persons per living room, it was only 7% in Panmana. Alappad had higher percentage (18%) of households with overcrowding.

#### IV. d. Distribution based on presence of separate kitchen.

Table 10: Distribution of houses based on presence of separate kitchen.

Kitchen	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Separate kitchen present	297	83.7	157	85.8
Separate kitchen absent	58	16.3	26	14.2
<b>Total</b>	<b>355</b>	<b>100.0</b>	<b>183</b>	<b>100.0</b>

Indoor air pollution is a common reason for respiratory morbidity having separate kitchen would reduce the risk of inhalation of dust and fumes from firewood burning thereby respiratory problems. In Panmana 83.7% and in Alappad 85.8% of households were having kitchen separated from living rooms and other areas of the houses.

#### IV. e. Distribution based on cooking fuel used.

Table 11: Distribution of households based on type of fuel used for cooking (more than one)

Type of fuel used for Cooking	Panmana		Alappad	
	Number	Percentage	Number	Percentage
LPG	344	96.9	181	98.9
Firewood	221	62.3	92	25.9
Kerosene	0	0.0	1	0.5
Biogas	3	0.8	0	0

Majority of households were using more than one fuel for cooking. Nearly all the households were using LPG in their kitchen, its use was 97% in Panmana and 99% in Alappad. Use of firewood as cooking fuel was about 62% in Panmana and 26% in Alappad. Use of firewood was 2.4 times among households in Panmana compared to Alappad. This implies that the chances of indoor air pollution and inhalation of fumes and chances of respiratory problems are likely to be higher in Panmana than Alappad.

#### V. Sanitary conditions

##### V. a. Distribution based on type of water source in Panmana.

Table 12: Distribution based on type of water used in Panmana households (multiple sources of water)

Panmana	For Drinking		For Cooking		For Washing		For Bathing	
	N	%	N	%	N	%	N	%
Own well	19	5.3	20	5.6	45	12.7	47	13.2
KMML supply	254	71.5	253	71.3	171	48.2	176	49.6
Piped water by KWA	86	24.2	86	24.2	153	43.1	142	40.0
Others	5	1.4	4	1.1	13	3.7	12	3.4
Total	355	100	355	100	355	100	355	100

In Panmana area, majority households (94%) use piped water for drinking and cooking purpose. There were two sources of piped water in this area. About 70% of households had piped water supplied by Kerala Minerals and Metals Limited and the remaining 24% by the Govt. through Kerala Water authority. Four fifth of the households use piped water for all purposes. Only about 5% of households are fully depended on ground water from their own well for all their needs. In areas of industrial establishments, chances of soil and ground water pollution are likely to be high, in such places the possibility of well water contamination is quite high and the safer alternative would be piped water supply. In Panmana area, Kerala Minerals and Metals Ltd. is supplying potable piped water in the residence.

#### V. b. Distribution based on type of water source in Alappad.

Table 13: Distribution based on type of water used in Alappad households (multiple sources of water)

Alappad	For Drinking		For Cooking		For Washing		For Bathing	
	N	%	N	%	N	%	N	%
Own well	7	3.8	9	4.9	18	9.8	15	09.2
KMML supply	0	0	0	0	0	0	0	0
Piped water	173	94.6	173	94.6	163	89.1	166	90.8
Pipe + Well	3	1.6	1	0.5	2	1.1	2	0
<b>Total</b>	<b>183</b>	<b>100%</b>	<b>183</b>	<b>100</b>	<b>183</b>	<b>100</b>	<b>183</b>	<b>100</b>

In Alappad, 95% of households uses piped water supply for drinking and cooking purposes. Here also 5% depend on their own well for all purposes and 5% use both sources i.e., piped water for drinking and cooking and well water for washing and bathing.

In both the surveyed areas, 93-95% of households use potable piped water for drinking and cooking purpose, but the source is different. In Panmana mainly supplied by KMML and in Alappad by Kerala water authority. In both the areas, if there are problems with safety and acceptability of well water, it is easy to switch to safe water source available in the locality.

### V. c. Reason for using water sources other than well water available in the locality.

Table 14: Distribution based on reported issues of water source in the locality.

Reported issues of water source	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Colour	144	40.6	17	9.3
Taste	87	24.5	7	5.1
Odour	59	16.6	2	1.1
Hardness	67	18.9	2	1.1
Availability	39	11.0	16	8.7
Not reported	0	0	139	84.7
<b>Total</b>	<b>355</b>	<b>100.00</b>	<b>183</b>	<b>100.00</b>

According to Kerala State Council for Science, Technology and Environment data open well density is higher in coastal region (200/sq.km) than in mid land (150/sq.km) high land (70/sq.km) region. Both the surveyed areas are in the coastal belt, even with higher density of wells in the locality, majority of households in both the areas were using piped water for all their daily needs. There were multiple issues reported for not using well water available in the locality.

All households in Panmana reported various issues with water available from natural sources in the locality, commonest being presence of colour (40.6%) followed by taste (24.5%) odour (16.6%) and hardness (11%).

About 85% in Alappad reported availability of piped water as the reasons for choosing different water source. Only about 9.3% reported presence of colour followed by taste (5%).

In Panmana reported quality of well water in terms of colour, taste, odour hardness etc were clearly worse than that in Alappad.

#### V. d. Distribution households based on presence of own latrine.

Table 15: Distribution of households based on presence of own latrine.

Own Latrine	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Present	349	98.3	181	98.9
Absent	6	1.7	2	1.1
Total	355	100.0	183	100

Almost all households in both the areas had better sewage disposal facilities, all of them had own latrine at their residence. Only 6 households in the Panmana (1.7%) and 2 in Alappad (1.1%) lacked own latrine facility. Availability of own latrine in the surveyed area is comparable to NSS socio economic survey report of Kerala in which among the households 98.2 % have own latrine for exclusive use of the household.

#### V. e. Solid waste management

Table 16: Distribution of households based on household solid waste management methods.

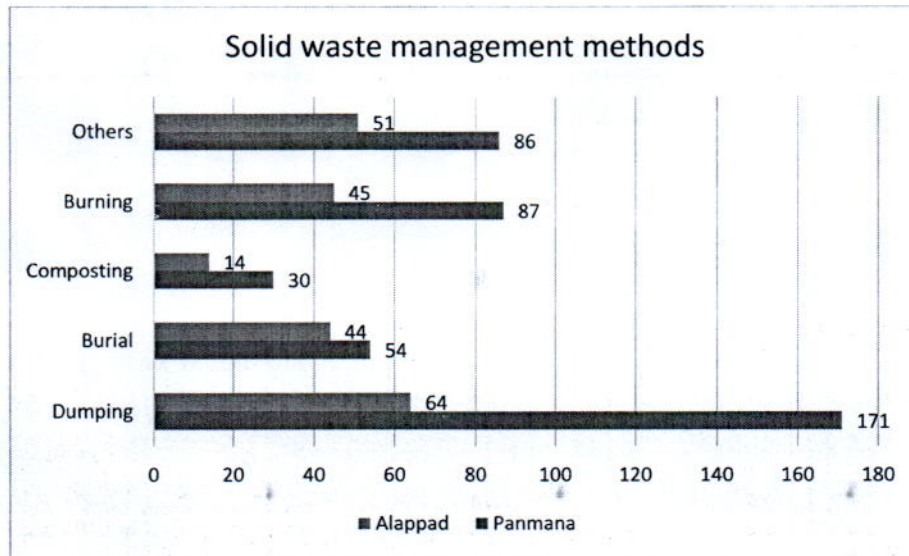
Method of disposal of solid waste	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Dumping	171	48.2	64	35.0
Burial	54	15.2	44	24.0
Composting	30	8.5	14	7.6
Burning	87	24.5	45	24.6
Others	86	24.2	51	27.9
Total	355	100.0	183	100.0

Multiple methods of solid waste management were adopted by the households in both Panmana and Alappad areas. Commonest method used was dumping (48.2% in



Panmana and 35% in Alappad) followed by burning (24.5%) and burial (15.2% in Panmana and 24.0 % in Alappad). The least opted method being composting in both areas. Dumping as method of garbage disposal in surveyed areas were less common compared to NSS socio economic survey report in which 63.9% of households in Kerala dispose their garbage by dumping.

Figure 7: Solid waste management methods in households



Indiscriminate dumping and burial of mixed waste with both biodegradable and non-biodegradable items and burning of plastic waste can lead to harmful health and environmental effects. Widespread community-based health education programs are needed for segregated collection at source and sanitary disposal of different types of solid waste generated at household level. Popularization of composting and safe handling of plastic waste through reduce use, reuse, and recycle are urgently needed in the surveyed areas.

## V. f. Liquid waste disposal:

Table 17: Distribution of households based on liquid waste management methods.

Liquid waste disposal methods	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Soakage pit	98	27.6	58	31.7
Drained inside compound	158	44.5	95	51.9
Drained outside compound	73	20.6	33	18.0
Drained to common drain	27	7.6	3	1.6
Others	5	1.4	1	0.5
<b>Total</b>	<b>355</b>	<b>100.0</b>	<b>183</b>	<b>100.0</b>

Very few households are using more than one method for liquid waste disposal. Half of the households drain the waste inside the compound in both Panmana (44.5%) and Alappad (52%) followed by draining to outside the compound. Liquid waste was properly disposed using soakage pit by 27.6% of households in Panmana and 31.7% in Alappad.

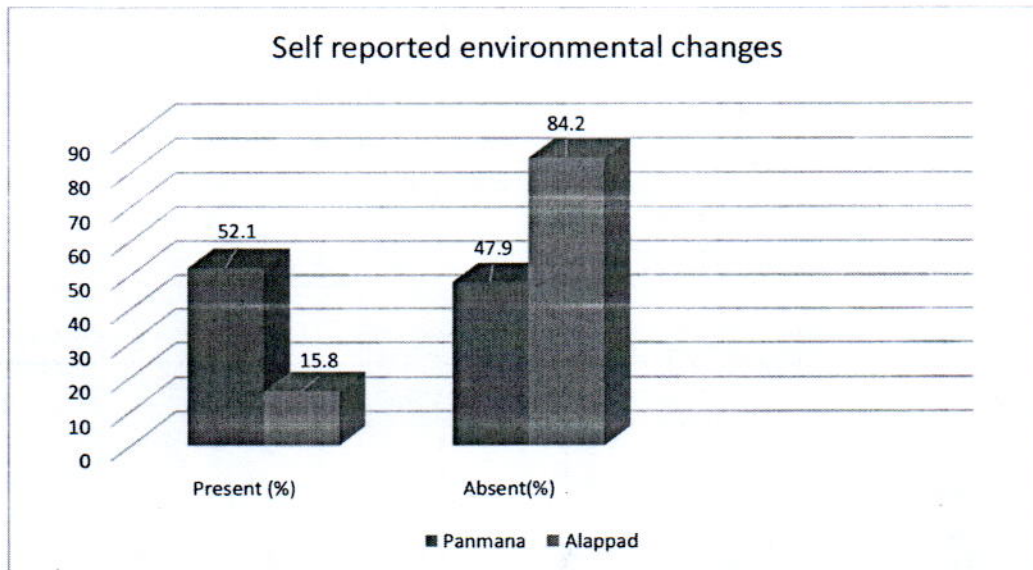
## VI. Self-reported environmental changes

Table 18 : Distribution of households based on self-reported environmental changes.

Self-reported environmental changes	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Present	185	52.1	29	15.8
Absent	170	47.9	154	84.2
<b>Total</b>	<b>355</b>	<b>100.0</b>	<b>183</b>	<b>100.0</b>

Households were asked about their observation on self-reported changes in the environment in their locality. Such changes were reported by 52.1% of households in Panmana where KMML is located. In Alappad only 15.8% reported changes in the environment.

Figure 8: Frequency of self-reported environmental changes



## VII. Details of Mortality

### VII. a. Death in the household in the last 10 years

Table 19: Distribution of households based on reported occurrence of death in last 10 years.

Self-reported deaths in households in last 10 years	Panmana		Alappad		Chi square	P value	OR (95% CI)
	Number	%	Number	%			
Present	136	38.3	53	28.9	4.6304	0.031	1.52 (1.03-2.23)
Absent	219	61.7	130	71.1			
<b>Total</b>	<b>355</b>	<b>100.0</b>	<b>183</b>	<b>100.0</b>			

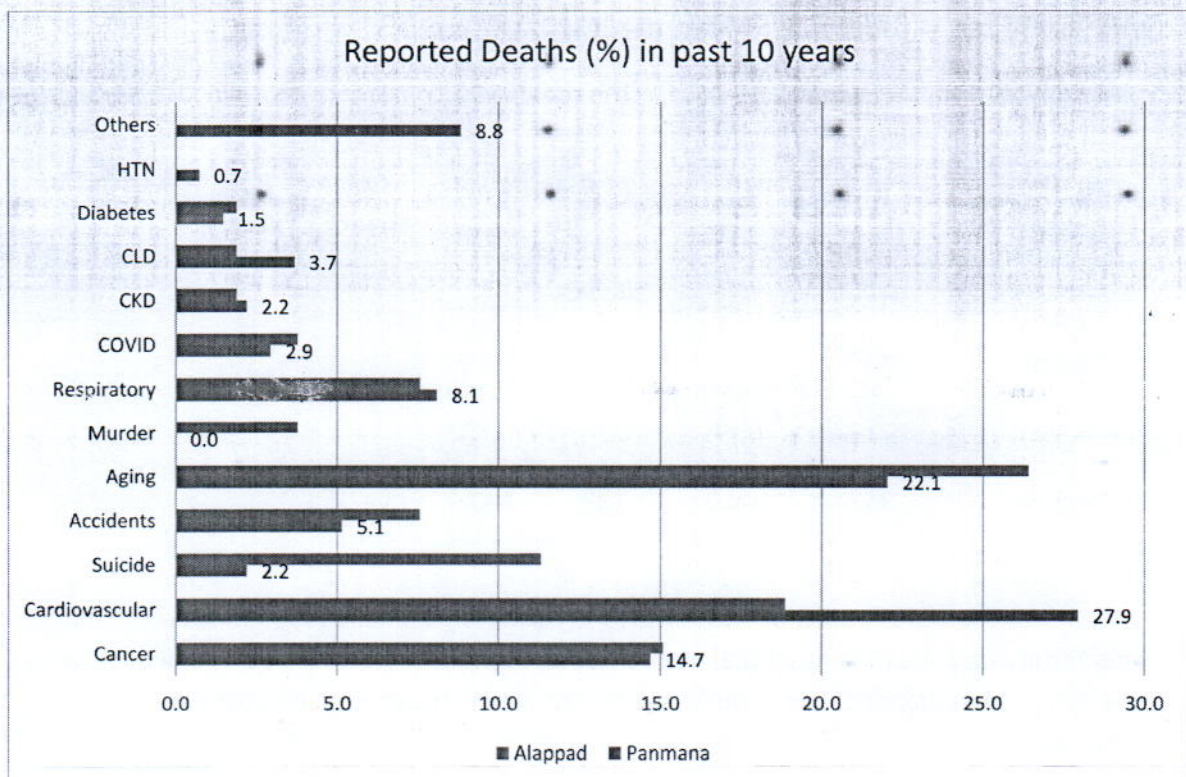
Among reported deaths, 136 deaths occurred in Panmana (355 households) and 53 deaths in Alappad (183 household). Proportion of mortality occurred in Panmana appears to be higher than Alappad. Significantly higher mortality is reported in Panmana region during the past 10 years

## VII. b. Reported cause of death.

Table 20: Distribution of reported cause of death in last 10 years

Cause of Death	Panmana		Alappad	
	N	%	N	%
Cancer	20	15.1	8	14.7
Cardiovascular	38	18.9	10	27.9
Suicide	3	11.3	6	2.2
Accidents	7	7.5	4	5.1
Aging	30	26.4	14	22.1
Murder	0	3.8	2	0.0
Respiratory	11	7.5	4	8.1
COVID	4	3.8	2	2.9
CKD	3	1.9	1	2.2
CLD	5	1.9	1	3.7
Diabetes	2	1.9	1	1.5
HTN	1	0.0	0	0.7
Others	12	0.0	0	8.8
<b>Total</b>	<b>136</b>	<b>100</b>	<b>53</b>	<b>100.0</b>

Figure 9: Reported cause of death in percentage



When we consider the mortality occurred during the last 10 years in the regions, Panmana has 10.9% and Alappad has 7.8%. The further description of the data shows that Panmana region has higher cardiovascular mortality when compared with Alappad region (27.9% vs 18.9%). Alappad has a higher proportion death reported due to ageing when compared with Panmana region. Cancer as a cause of death in deaths that occurred in Panmana was 15.1% and Alappad was 14.7%

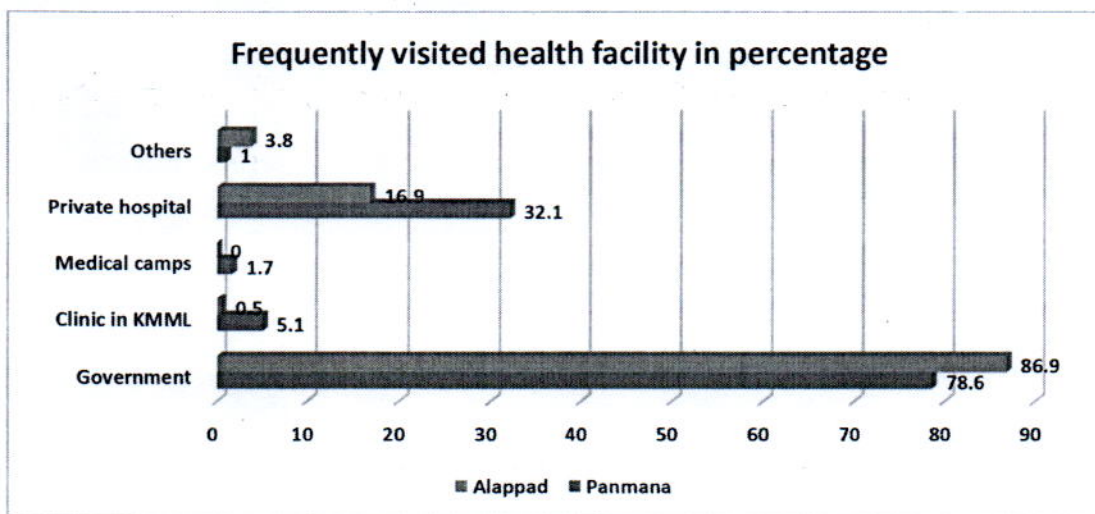
#### VIII. Frequently visited health facility:

Table 21: Distribution of households based on frequently visited health facility.

Health facility visited frequently	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Government	279	78.6	159	86.9
Clinic in KMML	18	5.1	1	0.5
Medical camps	6	1.7	0	0
Private hospital	114	32.1	38	16.9
Others	7	1.0	7	3.8
Total	355	100.0	183	100.0

Individuals of both areas had access to multiple health care facilities, majority sought care from government hospitals, 78.6% sought care from Govt facility in Panmana and 86.9% in Alappad. Only 5.1% of households in Panmana were utilizing medical care service from clinic conducted by KMML. Health care utilization from private hospitals were more in Panmana (32.1%) than Alappad (16.9%).

Figure 10: Frequently visited health facility in percentage.



## IX. Socio Demographic characteristics

### IX. a. Household size

Table 22: Details of individuals participated in the survey.

Participation in the survey	Panmana	Alappad
Total households	355	183
Total participants	1240	681
Average household size	3.5	3.7

Among the total 355 households surveyed in Panmana, there were 1240 members with average household size of 3.5, Alappad area, a total of 681 members from 183 houses were surveyed. Average household size in Alappad was 3.7 which is slightly higher than Panmana.

### IX. b. Distribution according to Age

Table 23: Age distribution of individuals

	Panmana	Alappad
Mean Age (years)	41.32 ± 21.15	39.79 ± 20.81
Range (years)	0.25 - 97	0.25 - 92
Total	1240	681

Mean age of individuals in Panmana and Alappad were  $41.32 \pm 21.15$  and  $39.79 \pm 20.81$  respectively. Participants from Panmana were relatively older than those from Alappad.

Figure 11: Age group distribution of individuals

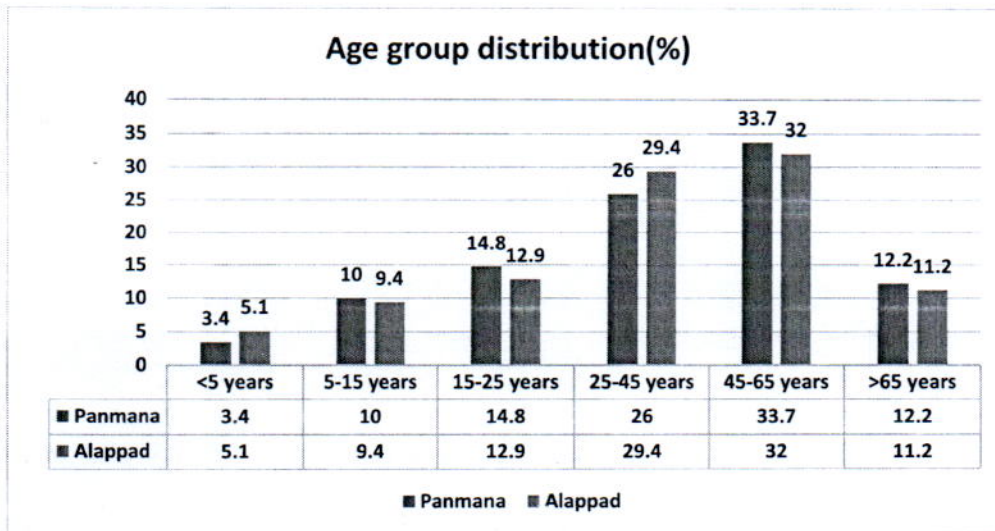


Table 24: Comparison of age distribution with Kerala population (Source: Census 2011)

Age category in years	Panmana		Alappad		Kerala Percentage 2.11 census
	Number	Percentage	Number	Percentage	
Under 5	42	03.4	35	5.1	19%
5-15	124	10.0	64	9.4	
15-25	183	14.8	88	12.9	
25-45	322	26.0	200	29.4	70%
45-65	418	33.7	218	32.0	
Above 65	151	12.2	76	11.2	12%
<b>Total</b>	<b>1240</b>	<b>100.0</b>	<b>681</b>	<b>100.0</b>	

Age wise distribution of population is comparable in both the areas. Like the Kerala population, proportion of 15-65 age group were more. Proportion of elderly population is comparable to Kerala's 2011 census. Lower proportion of under 15 population in both Panmana and Alappad areas compared to the Kerala population.

### IX. c. Gender distribution of individuals

Table 25: Distribution of individuals based on gender.

Gender category	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Male	613	49.4	339	49.8
Female	627	50.6	342	50.2
Total	1240	100.0	681	100.0

Slightly higher proportion of females is seen in both areas like the sex distribution in Kerala (F:M= 1.12:1) (Source: NFHS 5)

### IX. d. Education status of individuals

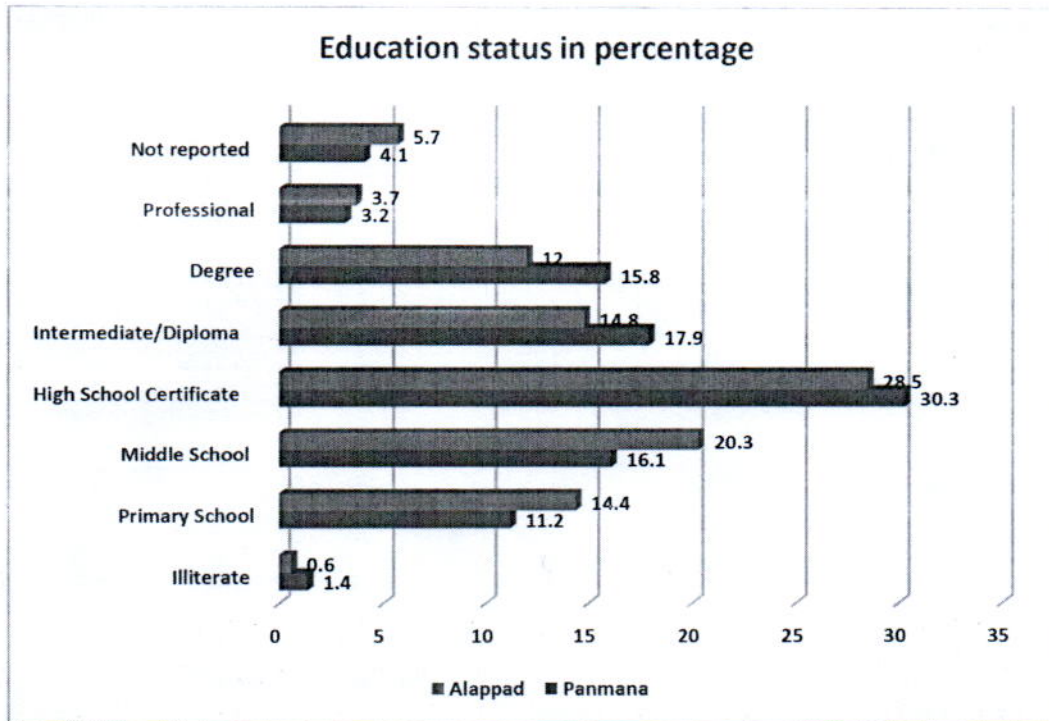
Table 26: Distribution of individuals based on education status.

Education status	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Illiterate	17	1.4	4	0.6
Primary School	139	11.2	98	14.4
Middle School	199	16.1	138	20.3
High School Certificate	376	30.3	194	28.5
Intermediate/Diploma	222	17.9	101	14.8
Degree	196	15.8	82	12.0
Professional	40	3.2	25	3.7
Not reported	51	4.1	39	5.7
Total	1240	100.0	681	100.0

Participants from Panmana have better education status than Alappad. In Panmana, 67% had high school certificate or more, but in Alappad it is only 57%. Illiterate population contribute 1.4% in Panmana and only 0.6% in Alappad.



Figure 12: Education status in percentage



### IX. e. Employment status

Table 27 : Distribution of individuals based on employment status.

EMPLOYMENT STATUS	PANMANA		ALAPPAD	
	Number	Percentage	Number	Percentage
STUDENT	221	17.8	118	17.3
UNEMPLOYED	533	43.0	283	41.6
EMPLOYED	334	27.0	169	24.8
OTHERS	102	8.2	72	10.6
UNKNOWN	50	4.0	39	5.7
TOTAL	1240	100.0	681	100.0

Both in Panmana and Alappad, only one fourth of study population reported to have regular job. Students constitute 17% of surveyed population. Majority were reported as unemployed in both areas.

#### IX. f. Marital status

Table 28: Distribution of individuals based on marital status.

Marital status	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Unmarried	188	15.2	54	7.9
Married	765	61.7	441	64.8
Divorced	9	0.7	5	0.7
Widow/ Widower	71	5.7	32	4.7
NA	207	16.7	149	21.9
Total	1240	100.0	681	100.0

Majority of individuals in both areas were married. Widow, widower, divorced together constitute 6.4% in Panmana and 5.4% in Alappad

#### X. Personal habits

Personal habits were assessed as declared by participants of the survey. Covid vaccination status as reported were also included.

#### X. a. Distribution according to alcohol and other substance use

Table 29: Distribution of individuals based on personal habits.

Personal habits	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Smoking	66	5.3	56	8.2
Alcohol	136	11.0	127	18.7
Pan chewing	39	3.1	15	2.2
No habits	999	80.6	483	70.9
Total	1240	100.0	681	100.0

Use of alcohol and other substances were less in Panmana (19.4%) than Alappad (29.1%) In both areas, among the different substance usage, commonest being alcohol use (11% in Panmana and 18.7% in Alappad) followed by smoking and pan chewing. Higher number of alcohol and other substance users were there in Alappad.

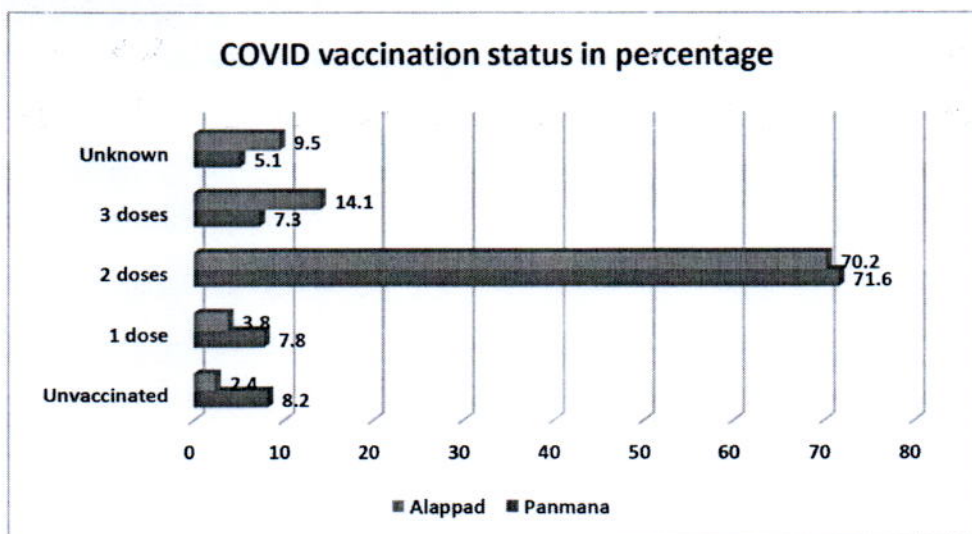
### X. b. Distribution based on covid vaccination status.

Table 30: Distribution of individuals based on covid vaccination status.

Covid vaccination status	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Unvaccinated	101	8.2	16	2.4
1 dose	97	7.8	26	3.8
2 doses	888	71.6	478	70.2
3 doses	91	7.3	96	14.1
Unknown	63	5.1	65	9.5
Total	1240	100.0	681	100.0

Majority of the individuals around 70% in both areas had taken 2 doses of Covid vaccination. Unvaccinated people were more in Panmana (8.2%) than Alappad (2.4%) About 7.3% in Panmana and 14.1% in Alappad received three doses of COVID vaccine

Figure 13: COVID vaccination status in percentage



## XI. Morbidity status of population due to acute illness

### XI. a. Distribution based on Covid disease incidence.

Table 31: Distribution of individuals based on covid disease incidence.

Covid incidence	Panmana		Alappad		$\chi^2$ -value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	249	20.0	162	23.8	3.594	0.058	0.81 (0.64-1.01)
Absent	991	80.0	519	76.2			

Twenty percent of the surveyed population in Panmana and 23.8% in Alappad had covid infection. Higher incidence of covid in Panmana area is not statistically significant.

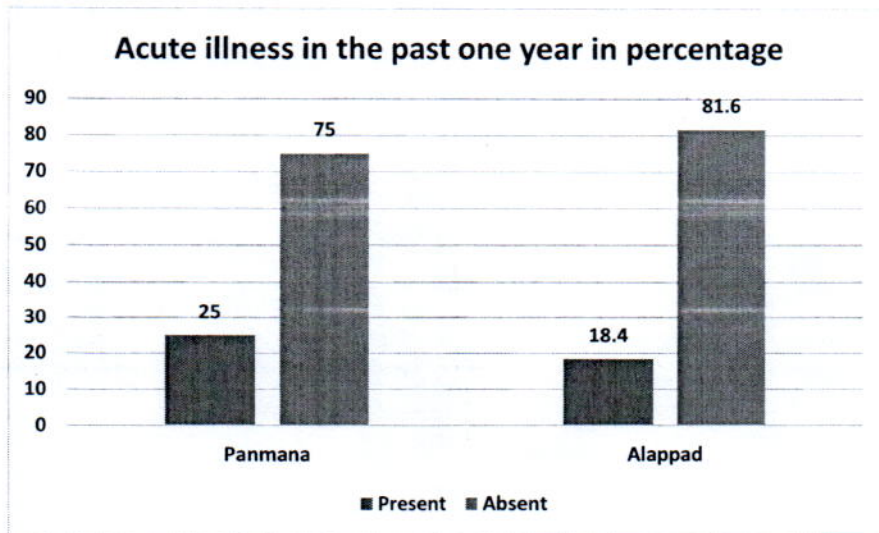
### XI. b. Distribution according to any acute illness in past year

Table 32: Distribution of individuals based on occurrence of any acute illness in past year.

Acute illness	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	310	25.0	125	18.4	11.080	0.001*	1.48 (1.18-1.87)
Absent	930	75.0	556	81.6			

About 25% of participants in Panmana and 18.4% in Alappad reported occurrence of acute illness in the past one year, Panmana had significantly higher incidence of acute illness compared to Alappad.

Figure 14: Acute illness in the past one year in percentage



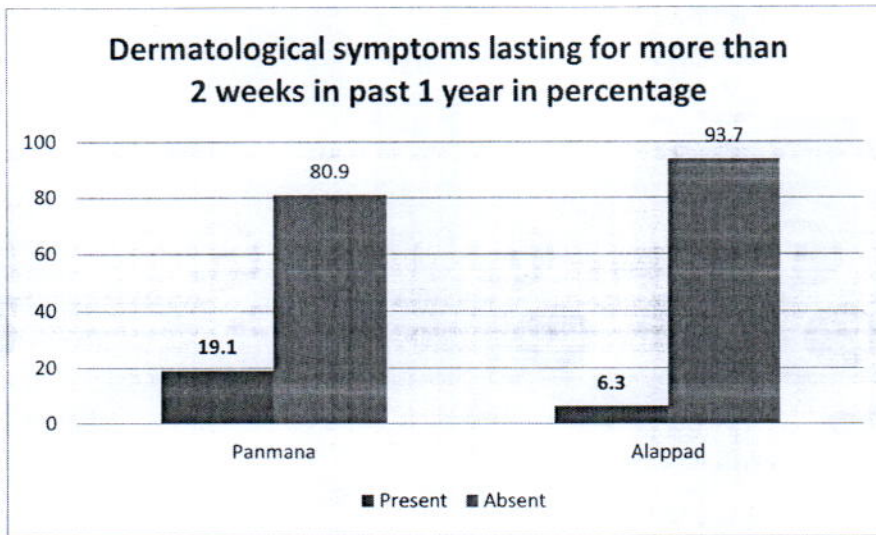
### XI. c. Dermatological symptoms lasting for more than 2 weeks in past 1 year.

Table 33: Distribution of individuals based on presence of dermatological symptoms for more than 2 weeks in last year.

Dermatological symptoms	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	237	19.1	43	6.3	57.831	0.001*	3.51 (2.49-4.93)
Absent	1003	80.9	638	93.7			
Total	1240	100.0	681	100.0			

Reported occurrence of dermatological symptoms lasting for more than 2 weeks during the past one year were 19.1% in residents of Panmana and it was only 6.3% in Alappad. Occurrence of acute dermatological conditions lasted for more than two weeks were 3.5 times in Panmana than Alappad. This increased risk was found to be statistically significant.

Figure 15: Dermatological symptoms lasting for more than 2 weeks in past 1 year in percentage.



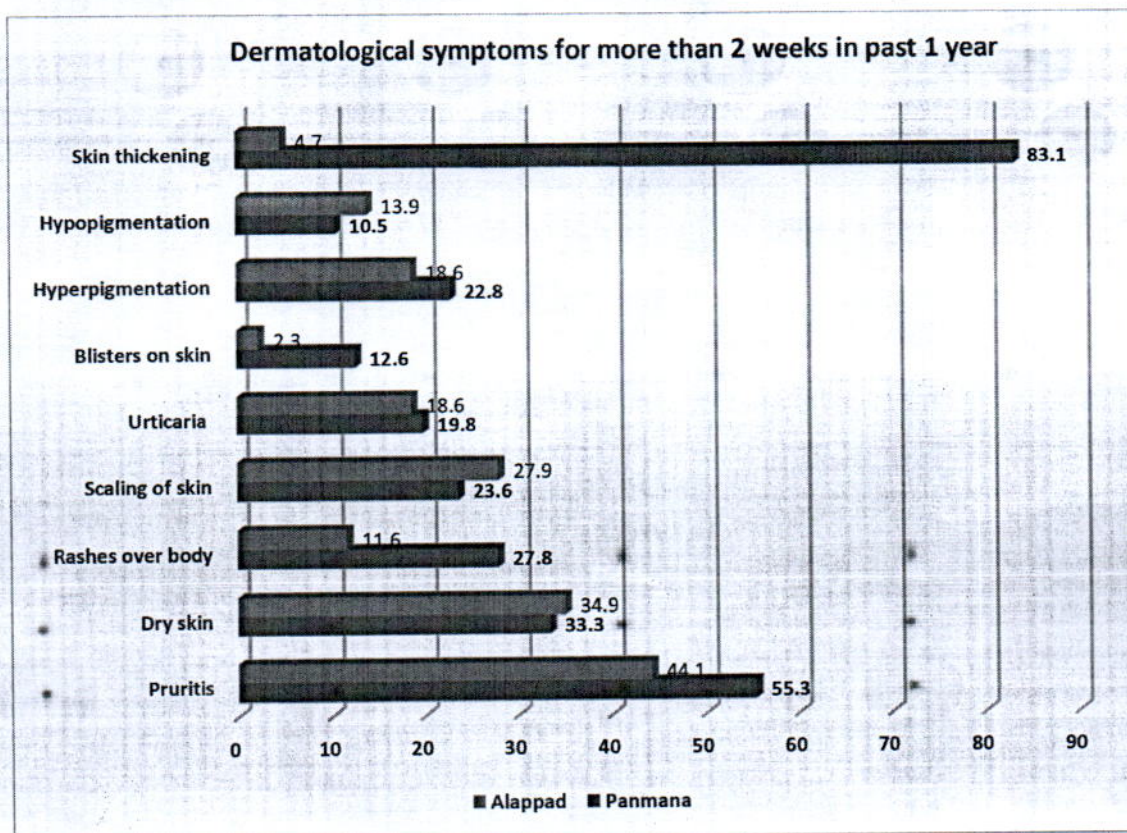
#### XI. d. Types of dermatological symptoms lasting for more than 2 weeks in past 1 year.

Table 34: Distribution of individuals based on type of dermatological symptoms.

Skin symptoms	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Pruritis	131	55.3	19	44.1
Dry skin	79	33.3	15	34.9
Rashes over body	66	27.8	5	11.6
Scaling of skin	56	23.6	12	27.9
Urticaria	47	19.8	8	18.6
Blisters on skin	30	12.6	1	02.3
Hyperpigmentation	54	22.8	8	18.6
Hypopigmentation	25	10.5	6	13.9
Skin thickening	197	83.1	2	04.7
<b>Total</b>	<b>237</b>	<b>100.0</b>	<b>43</b>	<b>100.0</b>

Among residents of Panmana with dermatological symptoms, the major symptoms reported was skin thickening (83.1%) followed by pruritis (55.3%), dry skin (27.8%), Rashes (27.8%) and scaling (23.6). In Alappad, symptoms reported were mainly pruritis (44.1%) dry skin (34.9%) and scaling (27.9%).

Figure 16 : Dermatological symptoms for more than 2 weeks in past 1 year



Residents of Panmana had higher occurrence of dermatological conditions compared to Alappad. Constant exposure to irritants even at permissible level without any risk health consequences may induce hypersensitivity reaction leading to dermatological symptoms like pruritis, dry skin, rashes, scaling leading to skin thickening. So detailed investigation regarding the role of exposure to environmental risk factors of being a resident in the vicinity of KMML needs further detailed examination.

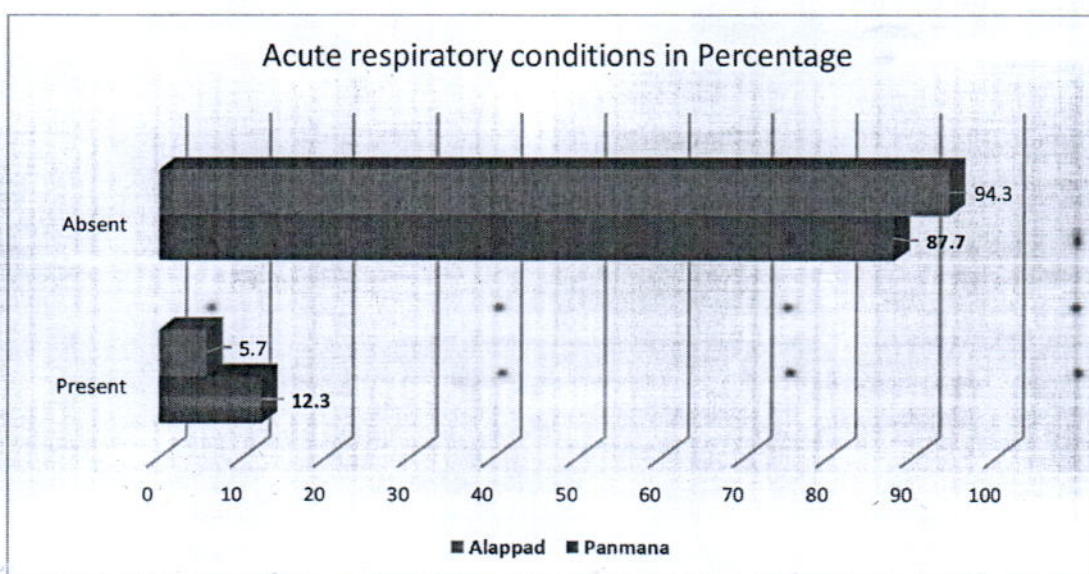
### XI. e. Respiratory symptoms for more than 2 weeks in last 1year

Table 35: Distribution of individuals based on presence of respiratory symptoms for more than 2 weeks in last year.

Respiratory symptoms	Panmana		Alappad		X <sup>2</sup> value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	153	12.3	39	5.7	21.63	0.0001*	2.31
Absent	1087	87.7	642	94.3			(1.61-
Total	1240	100.0	681	100.0			3.33)

Acute respiratory conditions lasted for more than 2weeks during last one year were 12.3% among participants from Panmana, which was 2.3times higher compared to Alappad and the occurrence was statistically significant.

Figure 17: Acute respiratory conditions in Percentage





### XI. f. Types of respiratory symptoms for more than 2 weeks in last 1 year

Table 36: Distribution of individuals based on type of respiratory symptoms.

Types of Respiratory symptoms	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Breathlessness on exertion	107	69.9	24	61.5
Haemoptysis	11	7.2	0	0
Chest pain	30	19.6	5	12.8
Breathlessness at rest	41	26.8	10	25.6
Palpitations	40	26.1	11	28.2
Persistent cough	55	35.9	16	41.0
Total	153		39	

Among the respiratory symptomatic, common symptoms being breathlessness on exertion, breathlessness at rest, persistent cough chest pain in both the areas.

## XII. Morbidity due to cardiovascular diseases

Cardiovascular diseases include all diseases classified under National Programme for prevention & Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS)

### XII. a. Prevalence of chronic diseases

Table 37: Distribution of individuals based on presence of chronic diseases.

Chronic diseases	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	647	52.2	296	43.5	13.35	0.001*	1.42
Absent	593	47.8	385	56.5			(1.18-
Total	1240	100.0	681	100.0			1.71)

Self-reported prevalence of chronic diseases was affected about half of the population among the two places surveyed, Panmana had significantly higher prevalence of 52.2% than 43.5% in Alappad.

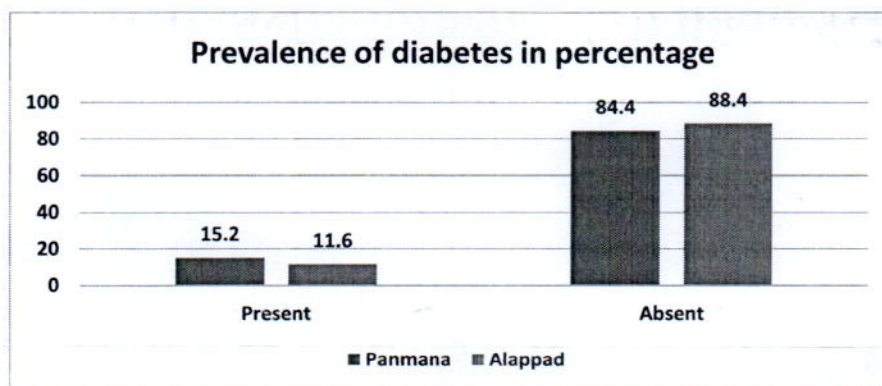
### XII. b. Reported prevalence of Diabetes mellitus.

Table 38: Distribution of individuals based on presence of Diabetes Mellitus

Diabetes	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	188	15.2	79	11.6	4.65	0.031*	1.36
Absent	1052	84.4	602	88.4			(1.03-
Total	1240	100.0	681	100.0			1.81)

Residents of Panmana have 15.2% prevalence of self-reported diabetes and 11.6% in Alappad. Difference the prevalence of diabetes is found to be statistically significant.

Figure 18: Prevalence of diabetes in percentage



## XII. c. Reported prevalence of Hypertension.

Table 39: Distribution of individuals based on presence of Hypertension.

Hypertension	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	275	22.2	133	19.5	1.84	0.175	1.17 (0.93 – 1.48)
Absent	965	77.8	548	80.5			
Total	1240	100.0	681	100.0			

About one fifth of the population reported to have hypertension, observed difference in prevalence of hypertension in Panmana (22.2 %) and Alappad (19.5%) was not statistically significant.

## XII. d Reported Prevalence of Dyslipidaemia

Table 40: Distribution of individuals based on presence of Dyslipidaemia.

Dyslipidemia	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	170	13.7	90	13.2	0.092	0.762	1.04 (0.79- 1.37)
Absent	1070	86.3	591	86.8			
Total	1240	100.0	681	100.0			

There is equal prevalence of dyslipidaemia in Panmana and Alappad. Among the three major risk factors of cardiovascular diseases, highest prevalence was reported for Hypertension followed by Diabetes and Dyslipidaemia. Even though the prevalence of self-reported hypertension and diabetes were more among residents of Panmana, significant difference was reported only for diabetes. Such difference was not found in dyslipidemia.

## XII. e Reported Prevalence of Heart Diseases

Table 41: Distribution of individuals based on presence of heart diseases.

Heart Diseases	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	66	5.3	38	5.6	0.057	0.811	0.95 (0.63- 1.43)
Absent	1174	94.7	643	94.4			
Total	1240	100.0	681	100.0			

One in twenty persons in the surveyed area reported to have heart disease. No difference in the of heart disease in Panmana and Alappad

## XII. f. Reported Prevalence of Stroke

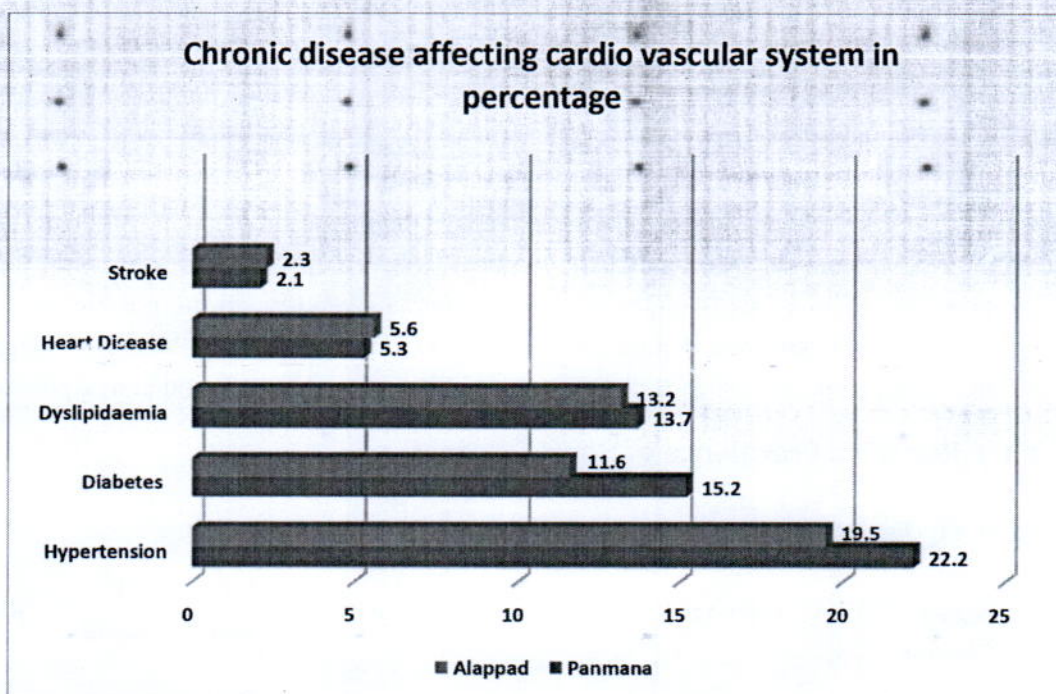
Table 42 : Distribution of individuals based on presence of Stroke.

Stroke	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	26	2.1	16	2.3	0.131	0.717	0.89 (0.47- 1.67)
Absent	1214	97.9	665	67.7			
Total	1240	100.0	681	100.0			

Prevalence of stroke was 2% in both areas.

## XII. e. Prevalence of chronic diseases affecting cardiovascular system.

Figure 19: Chronic disease affecting cardiovascular system in percentage.



There was high reported prevalence of lifestyle diseases affecting cardiovascular system which has high risk of mortality and disability, and the risk was comparable in both

the areas. Residence in the vicinity of an industry did not have a higher risk of cardiovascular disease in Panmana. Active interventions are required to prevent and control hypertension, diabetes, and dyslipidaemia to prevent development of permanent disability due to cardiovascular disease and stroke and premature mortality.

### XIII. Reported Prevalence of Chronic respiratory morbidity

#### XIII. a. Reported Prevalence of Chronic Obstructive Pulmonary Disease (COPD)

Table 43: Distribution of individuals based on presence of chronic obstructive pulmonary disease (COPD)

COPD	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	41	3.3	7	1.0	9.368	0.002*	3.29
Absent	1199	96.7	674	99.0			(1.47-
Total	1240	100.0	681	100.0			7.35)

About 3.3 % of residents of Panmana reported to have Chronic obstructive pulmonary disease (COPD) compared to 1% in Alappad. This difference in prevalence was statistically significant.

#### XIII. b. Reported Prevalence of Asthma

Table 44: Distribution of individuals based on presence of Asthma.

Asthma	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	43	3.5	27	4.0	0.309	0.578	0.87
Absent	1197	96.5	654	96.0			(0.53 –
Total	1240	100.0	681	100.0			1.42)

Occurrence of asthma is slightly lower in Panmana (3.5%) compared to Alappad (4%); this difference is not significant.

Both indoor and outdoor air pollution have a significant role in the development of chronic obstructive pulmonary diseases and asthma in any population

#### XIV. Reported prevalence of chronic diseases affection other systems

##### XIV. a. Self-reported Prevalence of Congenital disease

Table 45: Distribution of individuals based on presence of Congenital disease.

Congenital disease	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	26	2.1	7	1.0	3.03	0.08	2.07 (0.89- 4.81)
Absent	1206	97.9	674	99.0			
Total	1240	100.0	681	100.0			

Even after long duration of residence in the vicinity of an industry in Panmana, the occurrence of congenital disease was only 2.1% and no significant increase in congenital diseases compared to Alappad.

##### XIV. b. Self-reported occurrence of Seizure episodes in the past

Table 46: Distribution of individuals based on presence of Seizure episode in the past.

Seizure episode	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	17	1.4	5	0.7	1.57	0.21	1.88 (0.69- 5.13)
Absent	1223	98.6	676	99.3			
Total	1240	100.0	681	100.0			

Reported incidence of seizure episodes in the past was 1.4% in Panmana and 0.7% in Alappad. No significant difference in occurrence was noted in the surveyed area.

#### XIV. b. Self-reported occurrence of Neurological Disorders

Table 47: Distribution of individuals based on presence of Neurological Disorders

Neurological conditions	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	27	2.2	11	1.6	0.72	0.397	1.35
Absent	1213	97.8	670	98.4			(0.66-
Total	1240	100.0	681	100.0			2.74)

No significant difference in the occurrence of neurological disorders in Panmana (2.2%) and Alappad (1.6%)

#### XIV. c. Self-reported occurrence of Thyroid disorders

Table 48: Distribution of individuals based on presence of Thyroid disorders.

Thyroid disorders	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	104	8.4	42	6.2	3.084	0.079	1.39
Absent	1136	91.6	639	93.8			(0.96-
Total	1240	100.0	681	100.0			2.02)

Occurrence of thyroid disorders slightly higher in Panmana (8.4%) than Alappad (6.2%) but this difference is not statistically significant.

#### XIV. d. Reported occurrence of Psychiatric illness

Table 49: Distribution of individuals based on presence of Psychiatric illness.

Psychiatric illness	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	8	0.6	4	0.6	0.024	0.878	1.10
Absent	1232	99.4	677	99.4			(0.33-
Total	1240	100.0	681	100.0			3.66)

Occurrence of psychiatric illnesses were only 0.6% and no statistical difference was found in the incidence of psychiatric illness.

#### XIV. e. Reported presence of Liver Diseases

Table 50: Distribution of individuals based on presence of Liver Diseases

Liver Diseases	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	10	0.8	5	0.7	0.030	0.863	1.10
Absent	1230	99.2	676	99.3			(0.37-
Total	1240	100.0	681	100.0			3.23)

Liver disease among surveyed population were only 0.8% in Panmana and 0.7% in Alappad and no significant difference was found.



#### XIV. f. Self-Reported Gastrointestinal disease

Table 51: Distribution of individuals based on presence of Gastrointestinal disease.

Gastrointestinal disease	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	37	3.0	7	1.0	7.515	0.006*	2.95
Absent	1203	97.0	674	99.0			(1.31-6.67)
Total	1240	100.0	681	100.0			

Residents of Panmana reported gastrointestinal diseases among 3% of population, which is three times higher than Alappad where only 1% reported about occurrence of gastrointestinal diseases. Significantly higher occurrence of gastrointestinal diseases in residents of Panmana area needs further detailed evaluation

#### XIV. g. Self-Reported presence of renal diseases

Table 52 Distribution of individuals based on presence of renal diseases.

	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	22	1.8	8	1.2	1.028	0.311	1.52
Absent	1218	98.2	673	98.8			(0.67-3.43)
Total	1240	100.0	681	100.0			

Reported occurrence of renal disease was comparable in Panmana (1.8% and Alappad (1.2%)

#### XIV. h. Self-Reported presence of Musculoskeletal disorders

Table 53: Distribution of individuals based on presence of Musculoskeletal disorders.

Musculoskeletal disorders	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	112	9.0	56	8.2	0.361	0.548	1.10
Absent	1128	91.0	625	91.8			(0.79-1.55)
Total	1240	100.0	681	100.0			

Musculoskeletal diseases were common in Surveyed areas. Around 9.0% of the population in Panmana and 8.2% in Alappad. No significant difference was found in the prevalence of Musculo skeletal disorders in Panmana.

#### XIV. i. Self-Reported presence of Eye diseases

Table 54: Distribution of individuals based on presence of Eye diseases.

Eye diseases	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	162	13.1	50	7.3	14.661	0.0001*	1.897
Absent	1078	86.9	631	92.7			(1.36-
Total	1240	100.0	681	100.0			2.64)

Occurrence of eye diseases were more among residents in Panmana (13.3%) than Alappad (7.3%) to the level of two times to Alappad. Prevalence of eye diseases were significantly higher in Panmana.

Mean age of study participants were around 40 Years and about 45 % of population were above the age of 45 years. So higher prevalence of eye diseases in Panmana should be interpreted with caution because exposure to industrial pollutants along with advancing age and exposure to terrestrial radiation can have significant role in occurrence of eye diseases.

#### XIV. j. Self-Reported presence of Ear Diseases

Table 55: Distribution of individuals based on presence of Ear Diseases

Ear Diseases	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	40	3.2	10	1.5	5.355	0.021*	2.24
Absent	1200	96.8	671	98.5			(1.11-
Total	1240	100.0	681	100.0			4.50)

Ear diseases were reported to be higher in Panmana (3.2% than Alappad (1.5%))

## XV. Dermatological morbidity

### XV. a. Self-Reported presence of chronic skin diseases

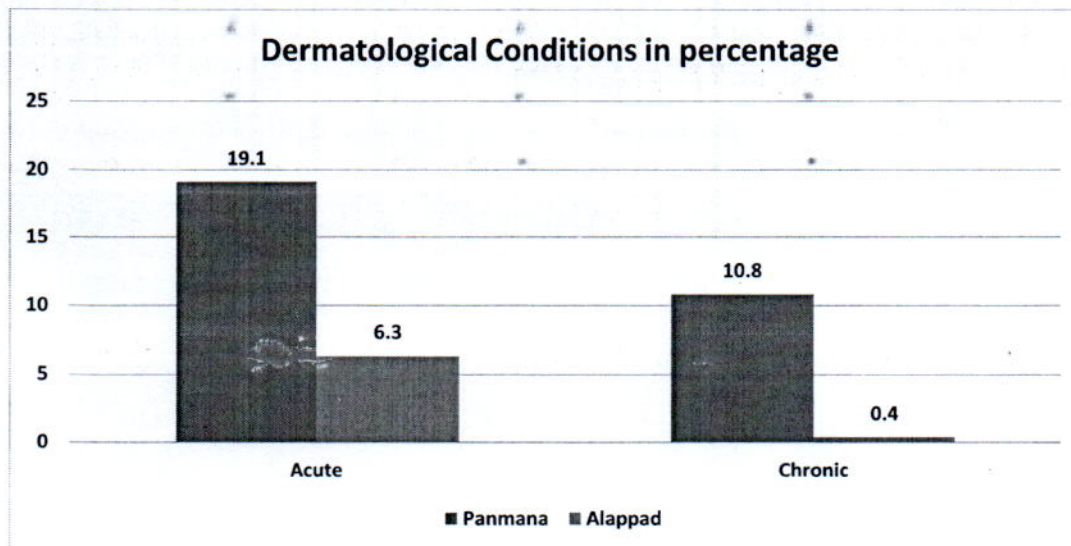
Table 56: Distribution of individuals based on presence of chronic Skin diseases.

Chronic skin diseases	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	134	10.8	23	0.4	32.33	0.0001*	3.46 (2.20- 5.46)
Absent	1106	89.2	658	96.6			
Total	1240	100.0	681	100.0			

Occurrence of chronic skin disease were present in 10.8% of population in Panmana and in Alappad only 0.4% had the problem. The risk of development of Chronic skin conditions being a resident of Panmana 27 times compared to Alappad.

### X. b. Comparison of acute and chronic dermatological diseases

Figure 20: Dermatological conditions in percentage



Occurrence of dermatological conditions were higher in population residing in the vicinity of KMML in Panmana compared to Alappad. Acute dermatological disorders were 3 times and chronic dermatological conditions were 27 times higher in Panmana than Alappad. Both were statistically significant.

## XVI. Self-reported occurrence of Malignancy

### XVI. a. Reported occurrence of Malignancy.

Table 57: Distribution of individuals based on prevalence of malignancy.

Malignancy	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	21	1.7	5	0.7	3.030	0.082	2.33
Absent	1219	98.3	676	99.3			(0.87 –
Total	1240	100.0	681	100.0			6.21)

Occurrence of malignancy was 1.7% Panmana and 0.7% in Alappad. Occurrence of malignancy showed no significant association with the area of residence.

### XVI. b. Type of reported malignancy

Table 58: Distribution of individuals based on type of malignancy.

Malignancy	Panmana		Alappad	
	Number	Percentage	Number	Percentage
Lung	2	9.5	0	0
Breast	11	52.38	1	20
Oral cavity	2	9.52	0	0
Prostate	0	0	1	20
Bone	1	4.76	0	0
Endometrium	2	9.5	0	0
Others	3	14.28	3	60
Total	21	100	5	100

Among the malignancies reported in Panmana, Breast cancer was the highest followed by others.

## XVII. Regression analysis

Regression using variables found significant in univariate analysis.

	<i>P value</i>	<i>Adjusted OR</i>	<i>95% C.I. for adjusted OR</i>	
			<i>Lower</i>	<i>Upper</i>
<i>Respiratory disease</i>	<b>.012*</b>	1.680	1.120	2.522
<i>Skin disease</i>	<b>.000*</b>	2.591	1.752	3.832
<i>Eye disease</i>	<b>.013*</b>	1.591	1.105	2.292
<i>Asthma</i>	<b>.024*</b>	.530	.306	.921
<i>Gastrointestinal disease</i>	.052	2.305	.993	5.347
<i>Chronic disease</i>	.707	.956	.755	1.210
<i>Diabetes</i>	.325	1.174	.853	1.617
<i>COPD</i>	.089	2.101	.894	4.938
<i>Ear disease</i>	.225	1.575	.756	3.283
<i>Skin disease</i>	.057	1.679	.984	2.865

Multi variable analysis by logistic regression was done with all those factors which had a significantly higher association in univariate analysis. Multi variable analysis showed Respiratory disease, Skin diseases, and Eye disease had significantly higher occurrence among population stayed around Kerala Minerals and Metals Ltd. in Panmana

## XVIII. Obstetric and gynaecological morbidity

Information on obstetric and Gynaecological morbidity were computed from all female participants in the survey. Details of 627 female from Panmana and 342 from Alappad were collected.

### XVIII. a. Prevalence of menstrual irregularities

Table 59: Prevalence of menstrual irregularities

Menstrual irregularities	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	145	23.1	71	20.8	1.216	0.27	1.205 (0.865- 1.678)
Absent	356	56.8	210	61.4			
NA	126	20.1	61	17.8			
Total	627	100.0	342	100.0			

Menstrual irregularities were reported by 23.1% of female participants from Panmana and 20.8% from Alappad. Increased proportion observed in Panmana was not statistically significant.

### XVIII. b. Reported incidence of spontaneous abortion

Table 60: Reported incidence of spontaneous abortion

Spontaneous abortion	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	150	23.9	91	26.6	0.653	0.419	0.878 (0.641- 1.203)
Absent	351	56.0	187	54.7			
NA	126	20.1	64	18.7			
Total	627	100.0	342	100.0			

Incidence of spontaneous abortion were relatively low in Panmana (23.9%) than Alappad (26.6%), but the observed difference was not statistically significant

### XVIII. c. Reported incidence of recurrent abortion

Table 61: Reported incidence of recurrent abortion

Recurrent abortion	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	14	2.2	10	2.9	0.526	0.469	0.737(0.322-1.687)
Absent	399	63.6	210	61.4			
NA	214	34.2	122	35.7			
Total	627	100.0	342	100.0			

Female population in the surveyed area reported about the occurrence of recurrent abortion in the past. Panmana areas reported 2.2% incidence of spontaneous abortion and in Alappad it was 2.9%.

### XVIII. d. Reported incidence of preterm delivery

Table 62: Reported incidence of preterm delivery

Preterm delivery	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	19	3.0	06	1.8	1.433	0.231	1.750 (0.692-4.424)
Absent	608	97.0	336	98.2			
Total	627	100.0	342	100.0			

The reported incidence of preterm delivery was 3% in Panmana and 1.8% in Alappad. This difference was not statistically significant.

### XVIII. e. Infertility treatment

Table 63: Infertility treatment

Infertility treatment	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	29	4.6	27	7.9	4.315	0.038	0.561 (0.323- 0.973)
Absent	383	61.1	200	58.5			
NA	215	34.3	115	33.6			
Total	627	100.0	342	100.0			

A significantly lower proportion of females from Panmana (4.6%) took infertility treatment compared to Alappad (7.9%). Exposure to air pollutants known to affect fertility of both men and women consequently more and more people seek infertility treatment. Most of the people living around KMML are being there for many years even then, the proportion of females who sought infertility treatment was significantly lower in Panmana.

### XVIII. f. Assisted delivery including caesarean section.

Table 64: Assisted delivery including caesarean section.

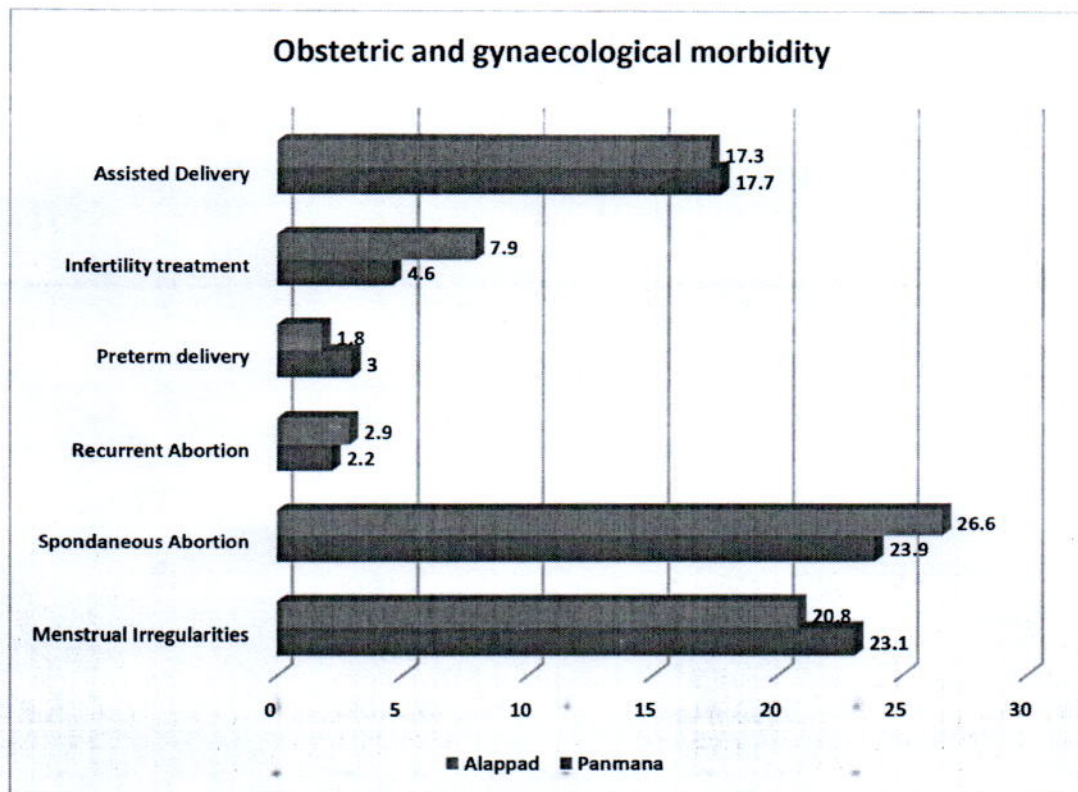
Assisted delivery including caesarean	Panmana		Alappad		$\chi^2$ value	P value	Risk
	Number	Percentage	Number	Percentage			
Present	111	17.7	56	17.3	0.765	0.385	1.182 (0.812- 1.720)
Absent	275	43.6	164	50.6			
NA	241	38.7	104	32.1			
Total	627	100.0	324	100.0			

Incidence of assisted delivery including caesarean section was about 17% in both the areas.



### XVIII. g. Obstetric and gynaecological morbidity status summary

Figure 21: Obstetric and gynaecological morbidity status summary



Even though obstetric and gynaecological issues were higher in Panmana, except history of infertility treatment no significant association with the area could be elicited. About infertility treatment, people from Panmana had significantly lesser incidence of infertility treatment than Alappad.

## XIX. Comparison of morbidity of Panmana and Alappad population with Kerala population

Table 65: Comparison of morbidity of Panmana and Alappad population with Kerala population

<b>Morbidity</b>	<b>Panmana (%)</b>	<b>Alappad (%)</b>	<b>Kerala (%)</b>
<i>Diabetes mellitus</i>	15.2	11.6	25
<i>Hypertension</i>	22.2	19.5	35
<i>COPD</i>	3.3	1	10
<i>Asthma</i>	3.5	4	8.1
<i>Stroke</i>	2.1	2.3	4.2
<i>CAD</i>	5.3	6.2	12.2
<i>Thyroid disorder</i>	8.4	6.2	8.69
<i>Psychiatric disorders</i>	0.6	0.6	11.36
<i>Renal diseases</i>	1.8	1.2	3.2
<i>Skin diseases</i>	10.8	0.4	2.4
<i>Musculoskeletal diseases</i>	9.0	8.2	2.4
<i>Congenital disease</i>	2.1	1	1.7
<i>Malignancy</i>	1.7	0.7	0.13

In general, both acute and chronic diseases were less prevalent in both the study areas compared to morbidity status of Kerala. Very few diseases like diseases of skin, malignancy, musculoskeletal diseases rated high than State average.

(Source: NHM, Kerala disease burden profile, Cancer registry, Kerala mental health survey)

### Results at a glance

Baseline details	Panmana	Alappad	Remarks
Houses surveyed	355	183	
Population covered	1240	681	
<b>Baseline details of households participated in the survey</b>			
Possession of own house	93.2%	96.2%	Most of them own residential house in the locality, comparable to Kerala data in which 94.4% in rural area own house (Source: NSS socio economic survey 76 <sup>th</sup> report)
Mean duration of stay in the household	29.04 ± 19.4	33.08 ± 18.9	30 years of average duration of stay in a locality is sufficiently long enough to have health effects due to suspected exposure to environmental health risks
Years of stay in the locality for more than 10 years	83.4%	88.0%	
Years of stay in the locality for more than 30 years	37.1%	45.3%	
Socio economic status -below poverty line	40%	71%	Households of Panmana are having better economic status as evidenced by possession of ration card
Average household size	3.5	3.7	Less than state average, in rural Kerala has household size of 3.9 (Source: NSS socio economic survey 76 <sup>th</sup> report)
<b>Housing conditions</b>			
Pucca house*	73.6%	81.4%	Less compared to Kerala data in which 89.1% in rural area had pucca house (Source: NSS socio economic survey 76 <sup>th</sup> report)
Medium size house with 2-3 living rooms	72.6%	73.2%	
Overcrowding in house	7.0%	18.0%	
Availability of separate kitchen	83.7%	85.8%	Inhalation of fumes from firewood burning can increase the risk of respiratory diseases. Two third population in Panmana were using firewood along with LPG
LPG use in the kitchen	96.9%	98.9%	
Firewood use in the kitchen	62.3%	25.9%	
<b>Sanitary conditions</b>			
Availability of own latrine	98.3%	98.9%	Comparable to Kerala data (Source: NSS socio economic survey 76 <sup>th</sup> report)
Piped water for drinking & cooking	95.5%	94.6%	Higher percentage compared to Kerala. 95% uses piped water for consumption either drinking or cooking. In Panmana 71% of consumption need is met by KMML.
Drinking water from KWA	24.2%	94.6%	
Drinking water from KMML	71.5%	0	

Proportion of households Reported on Issues of ground water available in the locality	89%	15.3%	Majority in Panmana reported issues like change in colour, taste, odour for ground water available in the locality. This needs further enquiry to identify its cause and its effects on environment
Solid waste disposal by dumping	48.2%	35.0%	In rural Kerala 63.9% dispose waste by dumping (Source: NSS socio economic survey 76 <sup>th</sup> report)
Solid waste disposal by burial	15.2%	24.0%	Urgent attention required for segregated, collection and proper disposal of solid waste generated by households
Solid waste disposal by burning	24.5%	24.6%	
Liquid waste drained to soakage pit or common drain	37.2%	32.2%	Proper wastewater draining needed in these areas
Environmental changes perceived by households	52.1%	15.8%	Half of households living in the vicinity of KMML in Panmana reported changes in the environment

### Health conditions of population in surveyed area

	Panmana	Alappad	Remarks
<b>Mortality in the past 10 years</b>			
Households with self-Reported mortality in the past 10 years in	33.4%	26.2%	The major cause of death in Panmana area was cardiovascular and in Alappad was age related as reported by participants
Total deaths in the past 10 years	136	53	
% Visited Govt. health facility frequently	78.6%	86.9%	Utilization was high compared to Kerala data in which only 51.8% among rural population (Source: NSS 75 <sup>th</sup> round (NSS K1 (75/25.0))
<b>General characteristics</b>			
Mean age of participants	41.32 ± 21.15	39.79 ± 20.81	Both areas are comparable
Females: Male	1.02:1	1.01:1	Kerala F:M 1.12:1 (Source: National Family Health Survey 5)
Education – High school or above	67%	57%	Higher in Panmana
Smoking	5.3%	8.2%	Smoking and alcohol use are low in Panmana
Alcohol use	11.0%	18.7%	
Received at least 2doses of COVID vaccine	78.9%	84.3%	Low in Panmana

<b>Acute morbidity status of population</b>			
Covid incidence	20.0%	23.8%	High in Panmana
Acute illness in the past 1year	25.0%	18.4%	
Dermatological symptoms lasting for more than 2 weeks in past 1 year	19.1%	6.3%	
Respiratory symptoms for more than 2 weeks in last 1year	12.3%	5.7%	
<b>Chronic diseases</b>			
Prevalence of chronic diseases	52.2%	43.5%	Higher occurrence of acute and chronic Respiratory infection, Acute and chronic skin diseases and Eye disease were reported among people in Panmana.  Occurrence of Asthma was less compared to Alappad.
Diabetes mellitus	15.2%	11.6%	
Hypertension	22.2%	19.5%	
Dyslipidaemia	13.7%	13.2%	
Heart Diseases	05.3%	05.6%	
Stroke	02.1%	02.3%	
COPD	03.3%	01.0%	
Asthma	03.5%	04.0%	
Congenital diseases	02.1%	01.0%	
Seizure episodes in the past	01.4%	0.7%	
Neurological Disorders	02.2%	01.6%	
Thyroid disorders	08.4%	06.2%	
Psychiatric illness	0.6%	0.6%	
Liver Diseases	0.8%	0.7%	
Gastrointestinal disease	03.0%	01.0%	
Renal diseases	01.8%	01.2%	
Musculoskeletal disorders	09.0%	08.2%	
Eye diseases	<b>13.1%</b>	<b>07.3%</b>	
Ear Diseases	03.2%	01.5%	
Chronic skin diseases	<b>10.8%</b>	<b>0.4%</b>	
Malignancy	01.7%	0.7%	
<b>Reproductive health issues</b>			
Menstrual irregularities	23.1%	20.8%	No excess reproductive morbidity in Panmana. A significantly lower number of people from Panmana sought infertility treatment
Spontaneous abortion	23.9%	26.6%	
Recurrent abortion	02.2%	02.9%	
Preterm delivery	03.0%	01.8%	
Infertility treatment	04.6%	07.9%	
Assisted delivery including caesarean	17.7%	17.3%	

**Advantages of the Study:**

1. Each data collection team had a qualified medical person to ensure the quality of health-related information collected.
2. The tool was prepared by a team of public health experts after thorough deliberations.
3. Health staff from the PHCs in the concerned areas ensured smooth collection of data. The support of DMO Kollam was valuable.
4. Robust data cleansing to ensure accurate results.

**Limitations of the study:**

1. Since the people around KMML are sensitised about the pollution issues there is a possibility of over reporting of illnesses.
2. The acute and chronic illness data were mostly self-reported and cross verification with documents was not possible in majority of instances.
3. The findings need to be corroborated with other evidence like air and ground water quality assessed by agencies like pollution control board.

**Recommendations:**

1. There is increased occurrence of dermatological, ophthalmic, and respiratory health problems in residents of Panmana than in Alappad. But when comparing this with the State data only dermatological problems are higher. This may be either due to environmental exposure to pollutants or due to hypersensitivity to the pollutants within the permissible level. This needs further detailed evaluation by considering whether these pollutants can cause dermatological conditions even within the permissible levels.
2. Lifestyle diseases are more in Panmana compared with Alappad, so there is a need to have specific health promotional program activities focused to reduce the burden of lifestyle diseases.
3. Issues with quality of well water has been reported by the residents, measures need to be taken to ensure availability of safe water to the entire population residing around KMML for their various needs. Currently the availability of piped water supply is only to 95% of population under study.
4. Ensure proper implementation of environmental protection measures around KMML plant in accordance with existing norms (taking into consideration air, soil and ground water quality assessment by Pollution Control Board) to safeguard the environment.

### Investigating Team

Dr Anuja U, Prof & HOD  
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Dr Bini M, Associate Professor Sociology  
Dr Rethesh K H, Assistant Professor  
Dr Aneesh T S, Assistant Professor  
Dr Chintha S, Assistant Professor  
Dr Libu G K, Assistant Professor  
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Dr Tony Lawrence, Assistant Professor  
Dr Siju N S, Assistant Professor  
Dr Ramiz Raja A, Assistant Professor  
Dr Devraj R, Assistant Professor  
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Dr Anitha Abraham, Assistant Professor  
Dr Ajith Chakravarthy, Assistant Professor  
Dr Prathibha Raj, Lecturer  
Mrs Sreelekha, Lecturer in Biostatistics  
Mrs Rethika, Lecturer in Sociology



### Survey Team members

Dr Retheesh K H, Assistant Professor	Dr Karthik, Intern
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Dr Tenny George P, Junior Resident	Mr Prasanth, Artist
Dr Rahul S, Junior Resident	Mr Shajahan, JLA
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Dr Radhika, Intern	Mrs Usha, Entomological Assistant
Dr Bipin, Intern	Dr Abhiram, Intern
Dr Ajith Kumar, Intern	Dr Jackson, Intern
Dr Augustine, Intern	

Along with Field staff from CHC Chavara & PHC Alappad

**ANNEXURE 1**  
**HEALTH SURVEY – Part 1 Household**  
*(Please encircle the options)*

H
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Sl. No	P / A	T	T	H	H	I	I
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Investigator's Name: \_\_\_\_\_

Contact number: \_\_\_\_\_

1. Name of the respondent..... Mob.....
2. Panchayath..... Ward Number: .....
3. House number.....
4. Years of residence in this locality? \_\_\_\_\_
5. House ownership 1. Own house      2. Rented House      3. Received from Govt. scheme.
6. Type of house 1. Kutcha      2. Semi Pucca      3. Pucca      4. Pucca concrete
7. Total family members: 1      2      3      4      5      6      7      8
8. Colour of ration card: 1. Pink      2. Yellow      3. Blue      4. White      5. No card
9. Number of living rooms 1      2      3      4      5      6      7      8
10. Separate Kitchen      1. Present      2. Absent
11. Own sanitary latrine      1. Present      2. Absent

**Source of water**

12. For drinking: 1. Own well      2. KMMLsupply      3. Piped water      4. Others (specify
  13. For cooking: 1. Own well      2. KMMLsupply      3. Piped water      4. Others (specify
  14. For washing 1. Own well      2. KMMLsupply      3. Piped water      4. Others (Specify
  15. Bathing: 1. Own well      2. KMMLsupply      3. Piped water      4. Others (Specify
  16. Reason for using different source of water for different purpose \_\_\_\_\_
- Change in 1. Colour      2. Taste      3. Odour      4. Hardness      5. Availability
6. NA

Others \_\_\_\_\_

**Environment Assessment**

17. Solid waste disposal: 1. Dumping 2. Burial 3. Composting 4. Burning  
5. Others

18. Liquid waste disposal 1. Soakage pit 2. Drained inside compound.  
3. Drained outside the compound 4. Drained to common drain 5. Others

19. Cooking fuel 1. LPG 2. Firewood 3. Kerosene Stove 4. Biogas

20. Self-reported environmental changes - 1. Present 2. Absent,  
if present specify \_\_\_\_\_

21. Number of deaths in family in past 10 years 1. Yes 2. No (specify)

Age (years)	Gender	Cause of death	*Document

Gender - 1. Male 2. Female 3. Transgender

\*Supporting Document - 1 Present 2 Absent

22. Monthly family income .....

23. Self-rated Health score (0 -100) \_\_\_\_\_

24. Health facility frequently visited: 1. Govt facility 2. Clinic in  
KMML 3. Medical Camps by Panchayath 4. Private hospital 5 others  
specify \_\_\_\_\_



48. Thyroid disease 1. Yes 2 No 3. If yes Duration in years) .....
49. Psychiatric illness 1. Yes 2 No 3. If yes Duration in years) .....
50. Any liver diseases 1. Yes 2 No 3. If yes Duration in years) .....
51. Gastrointestinal 1. Yes 2 No 3. If yes Duration in years) .....
52. Any renal diseases 1. Yes 2 No 3. If yes Duration in years) .....
53. Musculoskeletal 1. Yes 2 No 3. If yes Duration in years) .....
54. Eye disease 1. Yes 2 No 3. If yes Duration in years) .....
55. Ear disease 1. Yes 2 No 3. If yes Duration in years) .....
56. Skin disease 1. Yes 2 No 3. If yes Duration in years) .....

**Have you had any of these symptoms for more than 2 weeks in the past 1 year:**

**Respiratory**

*Put tick mark (✓) in adjacent boxes.*

Breathlessness on exertion		Haemoptysis		Chest pain	
Breathlessness at rest		Palpitations		Persistent cough	

**Skin**

Pruritis		Dry skin		Rashes over body	
Scaling of skin		Urticaria		Blisters on skin	
Hyperpigmentation		Hypopigmentation		Skin thickening	

57. Have you ever diagnosed with any kind of malignancy? 1. Yes 2.No
58. If yes, what kind 1.Lung 2.Breast 3. Thyroid 4. Oral cavity  
5.Skin 6. Prostate 7. Bone 8. Endometrium 9.Liver 10. Others,  
specify \_\_\_\_\_

**Only for female above 15 years**

59. Menstrual irregularities 1. Yes 2 No
60. Any history of spontaneous abortions 1. Yes 2 No , which month? \_\_\_\_\_
61. Any history of recurrent abortion 1. Yes 2 No
62. Any history of Infertility treatment 1. Yes 2 No
63. Details of last Delivery 1. Preterm 2.Term 3.NA
64. Type of last delivery 1. Normal 2. Assisted 3. Caesarean  
4.NA
65. Birth weight of children (in kgs) 1. Child1 \_\_\_\_\_ 2. Child2 \_\_\_\_\_ 3. Child3 \_\_\_\_\_  
4. Child4 \_\_\_\_\_