Spatial Clustering and Its Contextual Determinants of Acute Respiratory Infections among Under-five Children and Its Association with Mother's Knowledge and Household Environmental Condition: A Study of Rural West Bengal and India

A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Doctor of Philosophy in Population Studies

By

KOUSTAV GHOSH

Under the Guidance/Supervision of

Dr. Atreyee Sinha Chakraborty

&

Under the Co-guidance/Co-supervision of

Prof. Anjali Radkar

At

Education : An Ennobling Influence

Gopal Krishna Gokhale

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Pune, Maharashtra 411004

June 2025

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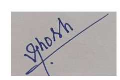
June 2025

DECLARATION

I, Koustav Ghosh, unequivocally declare that the PhD thesis titled "**Spatial Clustering and Its Contextual Determinants of Acute Respiratory Infections among Under-five Children and Its Association with Mother's Knowledge and Household Environmental Condition: A Study of Rural West Bengal and India**" is an original work conducted by me under the esteemed guidance of **Dr. Atreyee Sinha Chakraborty and Prof. Anjali Radkar** madam at the Gokhale Institute of Politics and Economics (GIPE). This research is registered under the Registration Number PhD202013.

I assert with confidence that this thesis has not been submitted in whole or in part for any other degree or diploma at any other university or institute. The research findings and analyses presented herein are the result of my own independent work, undertaken with the utmost academic integrity and adherence to ethical standards.



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Date: 17th June 2025

Koustav Ghosh

CERTIFICATE

This is to certify that the thesis entitled **"Spatial Clustering and Its Contextual Determinants of Acute Respiratory Infections among Under-five Children and Its Association with Mother's Knowledge and Household Environmental Condition: A Study of Rural West Bengal and India"** submitted by **Koustav Ghosh**, Registration Number **PhD202013**, to the Gokhale Institute of Politics and Economics (GIPE), Pune, for the award of the degree of Doctor of Philosophy (Ph.D.), is a record of original and independent research work carried out by him under our supervision and guidance.

To the best of our knowledge, this thesis embodies the work of the candidate and has not been submitted in part or full for any other degree or diploma of any university or institution. The thesis is worthy of consideration for the award of the Ph.D. degree in accordance with the regulations of the Institute.

Place: Pune, Maharashtra
Date: 17th June 2025

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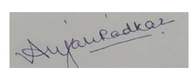

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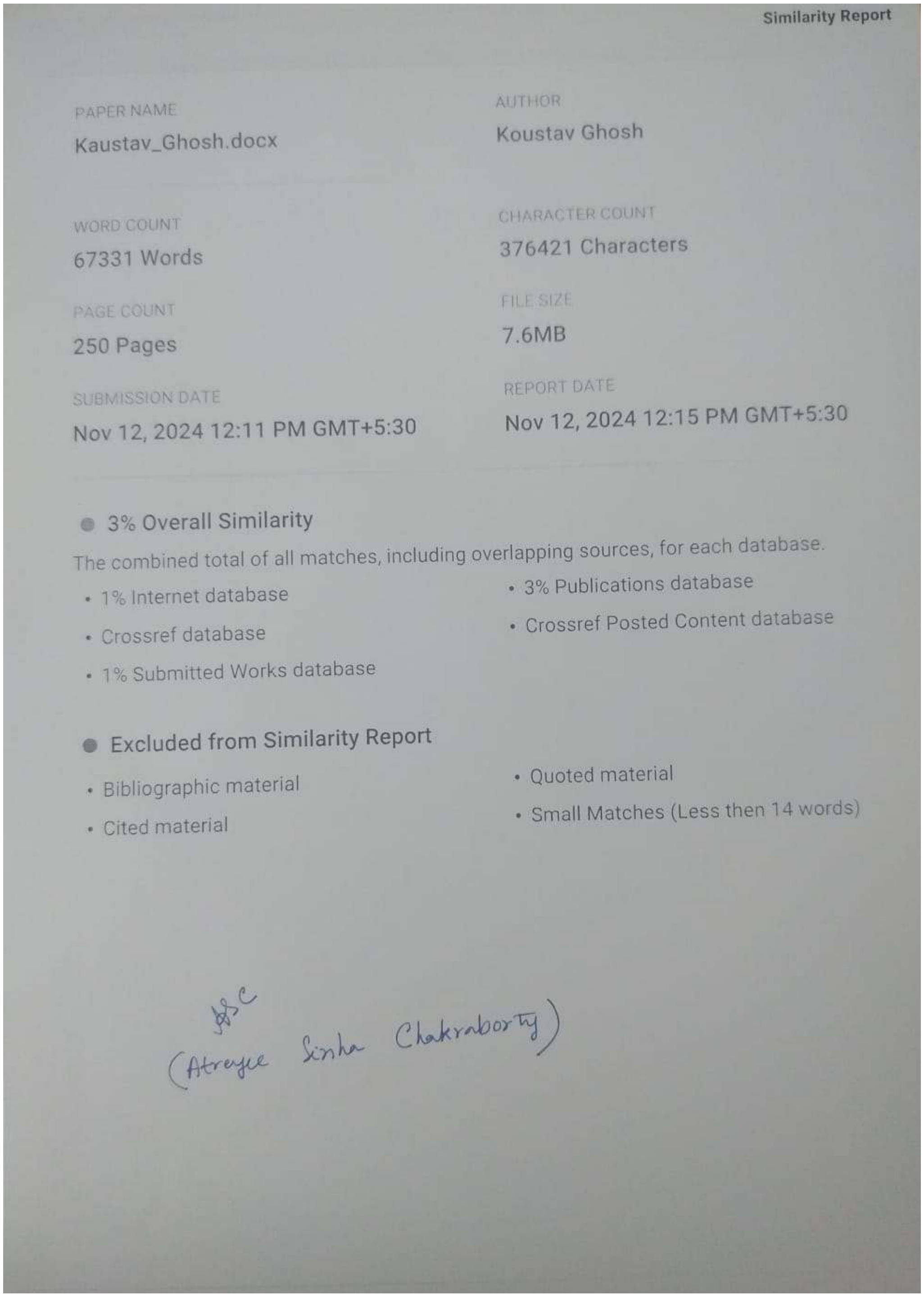

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Dedicated to My Family

I dedicate this work to my beloved parents, who, despite growing up in a village in West Bengal and not having the opportunity to complete primary education, instilled in me the values of perseverance, resilience, and a profound respect for learning. Their own lives are a testament to the strength of spirit and determination, and their unwavering belief in the power of education has been the foundation of my journey to this PhD.

Through countless sacrifices and unrelenting support, they have given me opportunities they themselves were not afforded, enabling me to reach heights that once seemed impossible. This achievement is as much theirs as it is mine. I am eternally grateful for their guidance and love, which have been my constant source of strength and inspiration.

I am equally grateful to my wife, whose unwavering support, patience, and love have been my anchor throughout this journey. Her constant encouragement and quiet strength helped me persevere through the most challenging moments. This achievement is as much hers as it is mine, and I remain deeply thankful for her presence and belief in me.

ACKNOWLEDGEMENT

The completion of this PhD thesis marks the culmination of a remarkable four-year journey, one that has been enriched by the support, guidance, and encouragement of many individuals to whom I am deeply grateful.

First and foremost, I would like to express my profound gratitude to my esteemed guides, Dr. Atreyee Sinha Chakraborty and Prof. Anjali Radkar. Their unwavering support, insightful guidance, and constant encouragement have been invaluable throughout this research. Their expertise and patience have greatly influenced my academic and personal growth, for which I am truly thankful.

I am also deeply indebted to the Gokhale Institute of Politics and Economics (GIPE). The academic environment, the vast resources of the library, and the support provided through the monthly presentations and expert comments have significantly helped me improve my research. The institute has offered an exceptional platform to pursue my academic interests and achieve my research goals.

My sincere thanks go to the PhD Coordinators, Dr. Rajesh Danane, Dr. Manisha Shinde, and Dr. K.S. Hari, whose efficient management and support have been instrumental in navigating the administrative aspects of my doctoral program. Their commitment to ensuring a smooth and conducive research journey is greatly appreciated.

I would like to express my sincere gratitude to Prof. Chander Shekhar (IIPS, Mumbai) and Dr. Bal Govind Chauhan (GIPE) for their invaluable expertise and constructive feedback during my synopsis presentation. I am also thankful to the reviewer for their insightful comments, which have greatly enriched the quality of my work.

I extend my heartfelt thanks to the International Institute for Population Sciences (IIPS) for providing access to the NFHS data, which has been crucial to my research.

I am fortunate to have had the company of wonderful colleagues and friends, whose camaraderie and intellectual discussions have enriched my research experience. Special thanks to my friends Sofia, Thomas, Ravi, Banashree, and Parul, who have been a constant source of support and encouragement, helping me overcome numerous challenges during this journey.

I would like to acknowledge my colleagues at the Population Research Centre (PRC) for their invaluable assistance and support. Their contributions have been indispensable in the successful completion of this thesis. My sincere thanks also go to Apyayee Shil, Preeti Dhillon madam, whose guidance and encouragement have been immensely valuable throughout my research journey.

I am deeply grateful to my family for their unwavering support. To my parents, who, despite limited educational opportunities in our village in West Bengal, instilled in me the values of perseverance and a love for learning this achievement is as much theirs as it is mine. To my sisters, thank you for your encouragement and belief in my potential. And to my wife, whose patience, understanding, and constant support have been my strength throughout this journey. I could not have done this without each of you by my side.

Place: Pune, Maharashtra
Date: 17th June 2025 Koustav Ghosh

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List of Abbreviations

AOD - Aerosol Optical Depth

ARI - Acute Respiratory Infection

AWCs - Anganwadi Centers

CEB - Census Enumeration Block

CHC - Community Health Center

CSPro - Census and Survey Processing System

DH - District Hospital

DHS - Demographic and Health Surveys

DLHS-District Level Household Survey

ESDA - Exploratory Spatial Data Analysis

FO - Field Organization

GIS - Geographical Information System

GNI - Gross National Income

GWR - Geographically Weighted Regression

HDI - Human Development Index

HDR - Human Development Report

IAY - Indira Awaas Yojana

ICDS - Integrated Child Development Services

IIPS - International Institute for Population Sciences

IMR-Infant mortality rate

LISA - Local Indicators of Spatial Autocorrelation

LMICs - Low and Middle-Income Countries

LRIs - Lower Respiratory Tract Infections

MoHFW - Ministry of Health and Family Welfare

MoPNG - Ministry of Petroleum and Natural Gas

NFHS - National Family Health Survey

NHM - National Health Mission

NNMR-Neonatal mortality rate

OLS - Ordinary Least Squares

PHC - Primary Health Center

PM2.5 - Particulate Matter (with a diameter of 2.5 micrometers or smaller)

POSHAN - Prime Minister's Overarching Scheme for Holistic Nutrition

PPS - Probability Proportional to Size

PSU - Primary Sampling Unit

RLEGP - Rural Landless Employment Guarantee Programme

RSV - Respiratory Syncytial Virus

SC - Scheduled Caste

SC - Sub-Center

SDGs - Sustainable Development Goals

SDH - Sub-District Hospital

SEM - Spatial Error Model

SLM - Spatial Lag Model

SRS - Sample Registration System

ST - Scheduled Tribes

U5MR - Under-Five Mortality Rate

URIs - Upper Respiratory Tract Infections

UTs - Union Territories

WHO - World Health Organization

Abstract

Background:

Acute respiratory infections (ARIs) are common respiratory diseases among under-five children in the world. ARIs are responsible for 15 percent of all deaths of children aged less than 5 years globally. Sustainable Development Goals (SDGs 3.2) aim to reduce the deaths from preventable diseases among newborn babies and children by the year 2030 in the world. In low and middle-income countries (LMICs), a substantial proportion of childhood deaths are attributed to easily preventable and treatable illnesses such as acute respiratory infection (ARI), diarrhea, and malaria. It has been estimated that around 5.5 million children under the age of five years died from preventable diseases in 2017. Approximately 73 percent of children died from African (49%) and Southeast Asian (24%) countries. In India, the prevalence of ARI has decreased from 5.8 percent to 2.8 percent from 2006 to 2021. However, the prevalence of ARIs increased 2.7 percent to 2.8 percent between the year 2016 to 2019 (NFHS-IV & V). Hence, India has not achieved the target of reducing child mortality by two-thirds between 1990 and 2015, as envisaged in the Millennium Development Goal 4 (MDG, 2015). The present research aims to investigate the geographical variation and prevalence of ARIs and its associated contextual risk factors. These factors include environmental conditions and mothers' knowledge related to ARIs in rural West Bengal and across India as a whole.

Data Source and Methodology:

Data Source: The present study has utilized both primary and secondary sources of data. The National Family Health Survey, a high-level dataset, has been used as a secondary source of data to fulfill our study objectives. Primary data has been collected from rural West Bengal based on the prevalence of ARI in Purba Bardhman, we have estimated 302 sample size for our study with a 5 percent nonresponse rate. A total of 296 samples have been utilize for the final analysis.

Methodology:

Spatial clustering analysis: Univariate Moran's I and Bivariate Moran's I computed to identify the spatial clustering across the districts in India.

Spatial Regression Model: To establish the relationship between ARI prevalence and

contextual correlates, we have applied and compared regression models: Ordinary Least Square (OLS), Spatial Error Model (SEM) and Spatial Lag Model (SLM) and using Geoda.

Statistical analysis: The study used descriptive statistics and bivariate analysis, including the Chi-square test, to obtain initial results. Logistic regression models were used to identify the factors associated with ARI.

Results:

Spatial prevalence and clustering of ARI among children in India: Over the study period, the prevalence of ARI has decreased from 5.8 percent to 2.8 percent from 2006 to 2021. However, the prevalence has slightly increased from 2.7 to 2.8 percent from 2016 to 2021. The absolute change in the prevalence of ARI was computed to measure the difference between 2016 and 2021. Delhi reported the highest increase in prevalence (3.2%) while Chandigarh showed the highest decrease (-2.5%). The 16 states and union territories, such as Manipur, Andaman & Nicobar Islands, Telangana, Karnataka, Sikkim, Lakshadweep, Madhya Pradesh, Odisha, Maharashtra, Rajasthan, Bihar, Assam, Kerala, Andhra Pradesh, and NCT of Delhi, recorded an increase in the prevalence rate of this condition. The spatial analysis indicates that approximately 36% of districts (254 out of 707) in India reported a prevalence of ARI higher than the national average of 2.8 percent. Moran's I=0.27 ($p<0.001$) indicates that spatial clustering exists in the prevalence of ARI among children across the districts in India. As a result, it detects 58 hot-spot and 66 cold-spot districts in India. Most of the hot-spot districts are from Uttar Pradesh, Maharashtra, Panjab, Delhi, Jammu & Kashmir, Odisha and Assam. The highest univariate Moran's I among the predictors was the concentration of Particle Matter 2.5 (Moran's I=0.953, $p <0.001$), followed by smoking exposure in the household (Moran's I=0.81; $p<0.001$), mothers' smoking behaviour (Moran's I = 0.778, p-value = 0.001), and poor household (Moran's I=0.769; $p<0.001$) respectively.
Spatial regression model estimates, that districts with higher instances of household smoking exposure, mothers with asthma/respiratory infection, children born with low birth weight, children who had diarrhea in the past 2 weeks, and increased concentrations of particulate matter 2.5 have a higher likelihood of having children infected with ARI.
The concentration curves significantly overlap, indicating similar inequality in ARI across years and residential areas

Contextual risks associated with ARI in India and rural West Bengal: After considering household environmental characteristics, it was found that children residing in pucca houses

(AOR: 0.74; 95% CI: 0.62-0.88) were less likely to get ARI than those living in kuchha houses. The primary study revealed that households located near the muri mill (AOR:2.2; 95% CI: 1.22-2.79) in rural West Bengal have an increased risk of childhood ARI. In addition, individuals living in households with contact with pets (AOR:3.3; 95% CI: 1.17-9.35) or domestic animals demonstrated a greater risk of acute respiratory infections than those without such contact. Furthermore, the results indicate that the availability of smoking members in the household (AOR:1.13; 95% CI:1.06-1.19) and the unavailability of a separate kitchen increases the risk of childhood ARI. Children of mothers with diseases or asthma are at double the risk of ARI to their children compared to those without these conditions. Our study also illustrates that the risk of ARI among children is lower for those interviewed in the rainy season than in the winter. Based on our study conducted in rural West Bengal, it was established that households with an annual income ranging from Rs. 50,000 to 75,000, and >Rs. 75,000, manifested a decreased risk of childhood ARI in contrast to households with an income falling below a certain threshold. Maternal characteristics such as smoking behavior, education, mass media exposure, and maternal respiratory/asthma illness were found to have a significant ($p < 0.05$) relationship with the development of their children's ARI. When considering a child's characteristics, our study highlighted that age, sex, nutrition status, and history of diarrhoea and birth weight are significant ($p<0.05$) factors for ARI in India and rural West Bengal as well as in India.

Determinants of Treatment Seeking Behaviour in India: The study revealed that the prevalence of children suffering from ARI seeking treatment from a health facility/provider has decreased from 78 percent in 2016 to 56 percent in 2021 in India. The Western region (62.6%) has the highest percentage of treatment- seeking behaviour, while the Central region (44.3%) has the lowest among all the regions.

Children in rural areas, wealthiest wealth quantile, households with female heads had higher odds of having treatment-seeking behaviour of ARI compared to those with male heads. The present study also indicated that children, whose parents claimed taking transport is a problem had lower odds of having treatment-seeking behaviour than those with no transport problem. Research shows that mothers who are exposed to the media are more likely to seek healthcare for their children when they have symptoms of acute respiratory infection (ARI) compared to mothers who have not been exposed to the media. Children belonging to the Central region had significantly lower odds, whereas the East and Western Region had significantly higher odds of having treatment-seeking behaviour compared to children belonging to the North Region.

Economic Burden and Treatment Seeking Behaviour of ARI: The average expenditure for the treatment of ARI in individual families is Rs. 1363/-. In public health facilities, the average expenditure was reported to be Rs. 520. Meanwhile, private health facilities had notably higher treatment costs (Rs. 2170). Similarly, The average expenditure for the treatment of ARI among BPL and APL families is Rs. 1588 and Rs. 1196/- respectively.

Approximately 44 percent of children experienced acute respiratory infection (ARI) symptoms for more than 5 days, 37 percent for 3 days, and 19 percent for 4 days, respectively. It was found that around 90 percent of children received treatment, while 10 percent did not. Among those who received treatment, 49 percent of children sought treatment from public health facilities, whereas 51 percent sought treatment from private health facilities. Additionally, 30 percent of children experienced delays in their treatment. It was observed that certain groups were more prone to delays in seeking treatment. Specifically, SC/ST groups (38.9%), BPL (30%) households, extended (36.4%) and nuclear (30%) families, households with less than 4 members (42.9%), and younger age (0-23 months) were more susceptible to delays in seeking treatment compared to their counterparts.

Knowledge, Attitude and Practice (KAP) of Mothers on Acute Respiratory Tract Infection: The study revealed that around 41 percent of mothers have poor knowledge regarding ARI. However, the majority of mothers (54.4%) exhibit positive attitudes. Despite this, 55.7 percent are engaged in poor practices related to ARI management. Around 61 percent of mothers have an average level of KAP regarding ARI. The findings of this study underscore the significant role maternal knowledge, attitudes, and practices (KAP) play in influencing the occurrence of ARI among children in rural West Bengal.

Conclusion:

The study highlighted 16 States/UTs with increased ARI prevalence from 2016 to 2021. So, policymakers should focus on setting a state-specific policy to control the prevalence and burden of diseases in India. The study also identified 58 hot-spot districts and the contextual factors that contribute to a ARI. It found that living in a kuchha house, exposure to smoking in the household, living near a rice or muri (puffed rice) mill, contact with pet or domestic animals, mothers with respiratory illness/asthma, cooking inside the house but not in a separate kitchen, and the winter season increased the risk of ARI among children in India. So based on our study findings, our study recommends to public health programs implement a district and state-level policy to prevent the incidence and burden of ARI in India. The knowledge, attitudes, and practices of mothers have been found to play a crucial role in preventing ARI in their children. An initiative on awareness generation sessions at the PHC and SC in the community on the symptoms and treatment of ARI could be an impactful initiative. This information will help districts level policy formulation and advocacy, which can, in turn, play an important role in reducing child morbidity and mortality due to ARI. This may help achieve the country's SDG target of 3.2 by 2030.

CHAPTER 1
Introduction, Review of Literature, and Objectives

1.1 Introduction

Children are humanity's seeds for the future and a God-given gift or hope. They deserve our undivided attention. A nation's future and progress depend entirely upon the best health of its youngsters. Children are essential to a nation's future and deserve optimal physical, mental, and emotional development. Children are the strongest pillar of any country. So, the best health status of children is a must and a gemstone for the nation's progress.

Safeguarding and enhancing the well-being of children is critically important. Over the last few decades, we have witnessed remarkable advancements in enhancing the health of young children and decreasing their mortality rate. The number of children dying before the age of 5 was reduced by half from 2000 to 2017 (WHO, n.d). However, much work remains to be done to improve children's health outcomes. The world faces a dual challenge. Over half of child deaths result from preventable or treatable conditions due to lack of access to healthcare and limited quality of life. Children must have a stable environment, good health, protection, and opportunities to learn and grow. One of the most crucial investments a society can make is in its children, which is vital for creating a brighter future.

1.1.1 Acute Respiratory Infections (ARIs) among children

Acute respiratory infection constitutes a major challenge to the public health system, especially in developing countries, and is one of the leading causes of morbidity and mortality among children under five years of age (Yadav et al., 2013; Gahlot et al., 2015). ARIs are airway infections, from the nostrils to the alveoli (Ghimire et al., 2022). The Multiple Indicator Cluster Surveys (MICS) described ARI among children based on their mother's perceptions. It is defined as breathing faster than usual with short, quick breaths or difficulty breathing, excluding children with only a blocked nose (WHO, 2022).

Acute respiratory infections (ARIs) are divided into two types (***Figure 1.1***): upper respiratory tract infections (URIs) and lower respiratory tract infections (LRIs) (Simoes et al., 2011). The upper respiratory tract comprises the air passages from the nostrils down to the larynx's vocal cords, including the sinuses and the middle ear. The lower respiratory tract consists of the airways that continue from the trachea and bronchi to the bronchioles and the alveoli.

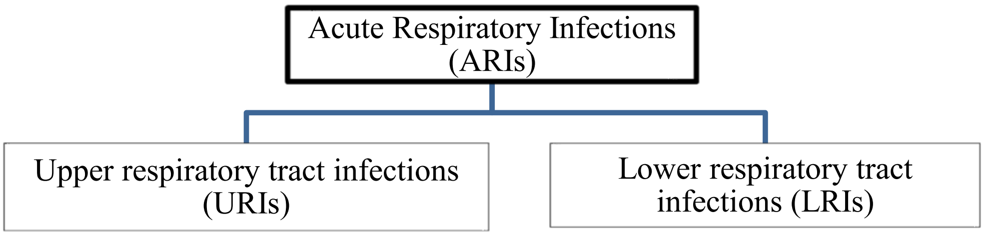


Figure 1.1: Type of Acute Respiratory Infection (ARI)

1.1.2 Upper Respiratory Tract Infections (URIs)

The respiratory rate is an essential clinical indicator for diagnosing acute LRI in children who are coughing and breathing rapidly. The presence of lower chest wall indrawing is a sign of more severe disease (Mulholland et al., 1992; Shann et al., 1984). RSVs are the most common cause of seasonal viral LRIs, followed by parainfluenza viruses. As safe and effective vaccines are available, it is crucial to investigate the epidemiology of influenza viruses in children in developing countries. Before the widespread adoption of the measles vaccine, the measles virus significantly contributed to respiratory-related illnesses and deaths among children in developing countries.

URIs include the following:

- Common colds
- Sinus infections
- Tonsillitis
- Laryngitis

Causes of URIs:

- Common cold
- Acute pharyngitis
- Acute ear infection

1.1.3 Lower Respiratory Tract Infections (LRIs)

In children, the most frequently encountered LRIs are pneumonia and bronchiolitis. The respiratory rate is a crucial clinical sign for identifying acute lower respiratory infections in children who exhibit rapid breathing and coughing. Observing indrawing of the lower chest wall suggests a more serious condition (Mulholland et al., 1992; Shann et al., 1984).

Respiratory Syncytial Viruses (RSVs) are currently the leading cause of viral lower respiratory infections (LRIs), exhibiting a pronounced seasonal pattern. They are followed in prevalence by parainfluenza viruses. Investigating the spread and impact of influenza viruses among children in developing countries is critical, given the availability of effective and safe vaccines. Before the measles vaccine became widely used, measles was the primary viral contributor to respiratory illness and death among children in these regions.

LRIs may impact the airways, leading to conditions like bronchitis, or affect the air sacs at the ends of the airways, resulting in pneumonia. The symptoms of these infections can vary depending on the severity of the diseases.

Symptoms of milder infection: A milder infection may have symptoms similar to those of the common cold, such as:

- a stuffed up or a runny nose
- a dry cough
- a low fever
- a mild sore throat
- a dull headache

Symptoms of severe infection: Symptoms of severe infection may include,

- Chest pain
- A severe cough that may produce phlegm
- Wheezing
- Fever
- Rapid breathing
- Difficulty breathing
- A blue tint to the skin

Severe LRIs: the severe ones include

- Pneumonia
- Bronchitis
- Bronchiolitis and
- Tuberculosis

Infections in the lower respiratory tract are mainly caused by:

- Bacteria like Streptococcus or Staphylococcus aureus
- Viruses, such as the flu or respiratory syncytial virus (RSV)
- Mycoplasma, which are small organisms with characteristics of both viruses and bacteria.
- Fungal infections,

Certain environmental substances have the potential to irritate or inflame the airways or lungs, potentially resulting in an infection. These substances encompass:

- Allergens
- Dust
- Tobacco and smoke
- Air pollution
- Chemicals
- Vapors and fumes

A person's elevated risk of contracting an LRI encompasses:

- being under 5 years old
- a recent cold or flu
- being more than 65 years old
- a weakened immune system
- recent surgery

As it is clear from the above analysis children under 5 years old are more prone to ARI, so this issue requires analysis and discussion at a wide range as it is one of the most relevant issues affecting children's health.

1.1.4 Sustainable Development Goals (SDGs)

In 2015, the United Nations introduced the Sustainable Development Goals (SDGs) with the aim of fostering healthy living and well-being for every child. All 191 member states of the UN committed to strive towards the fulfillment of these goals by the year 2030. The SDGs are comprised of 17 main goals that include a total of 169 specific targets. SDG 3 places a health premium, which aims to promote “healthy lives and well-being for all ages”, supported by 13 targets that span the whole of WHO's activity. Almost the majority of the next 16 goals are directly or indirectly related to health. The new agenda, which is an extension of the Millennium Development Goals (MDGs), aims to be applicable to all countries and focuses on promoting equality to meet the needs of women, children, and the most impoverished and vulnerable individuals. The 17 Sustainable Development Goals (SDGs) announced by world leaders in September 2015 outlined a vision for a world free of poverty, hunger, disease, and insecurity. SDG 3 I.e. “Good Health and Well-Being," encourages governments to enhance health and well-being for people of all ages.

Target 3.2.1 of the SDGs is to eliminate preventable deaths of newborns and children under the age of five by 2030. There are two objectives: firstly, reduce neonatal mortality to at least 12 per 1000 live births in all countries; and secondly, reduce under-5 mortality to at least 25 per 1000 live births in all countries (WHO, 2022).

1.1.5 Under-five Mortality

The under-five mortality rate (U5MR) denotes children who die before reaching the age of 5 per 1000 live births (Black et al., 2016). A "live birth" is defined as the presence of signs of life in the newborn, such as a heartbeat, breathing, or voluntary muscular movements after separation from the mother, regardless of the gestational age (Sullivan & Tureeva, 2002).

Child mortality consists of several subgroups. These are child mortality as deaths less than 6 years after life birth takes place, neonatal mortality as birth to the first month of life and infant mortality as death to the first year of life. Looking at the U5MR in each subgroup, the mortality risk is highest in the neonatal group. According to a review, approximately one-third of all neonatal deaths occur within the first day after birth, and about three-fourths within the first week of life (Jeeva et al., 2016).

According to the level of income, the World Bank classifies the world’s economies into four categories: low-income countries, low-middle-income (LMICs), high-income countries, and upper-middle-income nations. The classification is based on the country's per capita gross national income (GNI) in US dollars (USD) for the previous year. According to the World Bank's most recent data (2023), low-income countries have a GNP per capita of less than \$1085, lower-middle-income countries have a GNP per capita between \$1086 and \$4255, upper-middle-income countries have a GNP per capita between \$4256 and \$13205, and high-income countries have a GNP per capita of $13205 or more (World Bank, 2023). The majority of U5MR deaths occur from preventable or treatable diseases. especially in low- and middle-income countries (LMICs). The basic and most common causes of death among children under 5 are acute respiratory infections (ARI), diarrhoea, malaria, and birth complications (GBD, 2017) Moreover, malnutrition is the leading cause of many U5MR deaths. Approximately 45% of all childhood deaths occurred due to malnutrition in 2017 (WHO,2022). Acute respiratory infections (ARIs) are the most common respiratory diseases among under-five children worldwide. They are responsible for 15% of all deaths of children aged less than 5 years worldwide (WHO,2020).

The U5MR has declined between 2000 and 2009. Worldwide, the annual rate of reduction (ARR) was 1.9 percent in 1990 to 1999, 4 percent in 2000 to 2009, and 3.4 percent in 2010 to 2019 respectively (UN IGME, 2019). While 1 out of every 11 children were unable to see their 5th birthday in 1990s, this proportion had decreased to 1 in 27 in 2019. In between the time U5MR decreased by more than two-thirds in 34 LMICs (UN IGME, 2019). Interestingly, the ratio of neonatal deaths to all child deaths under 5 was 40 percent in 1990, this rate increased to 47 percent in 2019.

1.1.6 Child Mortality (under five) Worldwide Scenario

In the world, since 1990, substantial global progress has been adopted to reduce childhood mortality. As a result, the overall under-5 mortality has declined from 1.26 million to 5 million between 1990 to 2020. Worldwide under-5 mortality rate has decreased by 60 percent, since 1990 i.e 93 to 37 deaths per 1000 live births between 1990 to 2020 (WHO, 2022). While the global under-5 mortality rate has decreased, children in Sub-Saharan Africa (i.e., 74 deaths per 1,000 live births) continue to have the highest mortality rates in the world, i.e., 14 times higher than children in Europe and North America. Sub-Saharan Africa and southern Asia are responsible for more than 80% of the 5 million under-5 mortality in 2020, although accounting for only 53% of worldwide live births. In 2020, only five nations accounted for half of all deaths among children under the age of five ***(Table 1.1)***: Nigeria, India, Pakistan, the Democratic Republic of Congo, and Ethiopia. Nigeria and India account for nearly one-third of all deaths (WHO, 2022).

Table 1.1: Top 10 countries with the highest numbers of deaths (thousands) for children under 5 years, 2020

Country	Under-5 mortality
Nigeria	8.44
India	7.83
Pakistan	3.89
Democratic Republic of the Congo	2.84
Ethiopia	1.73
China	1.21
Indonesia	1.10
United Republic of Tanzania	1.02
Angola	0.91
Bangladesh	0.84

Source: WHO (2022) Factsheet: Child mortality (under 5 years). Available from: https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-under-5-mortality-in-2020

1.1.7 Cases of Under-five Mortality in the World

Globally, infectious disorders such as pneumonia, diarrhoea, and malaria, as well as pre-term birth problems, birth asphyxia and trauma, and congenital malformations, continue to be the primary causes of death among children under the age of five (WHO, 2022). Accessing fundamental measures such as skilled birth, postnatal care, breastfeeding, proper nutrition, vaccines, and treatment for common childhood diseases can save many lives. Malnourished children, especially those suffering from severe acute malnutrition, are at a higher risk of dying from common childhood illnesses such as diarrhea, pneumonia, and malaria. Nutritional issues account for around 45% of all deaths in children under the age of five (WHO, 2022).

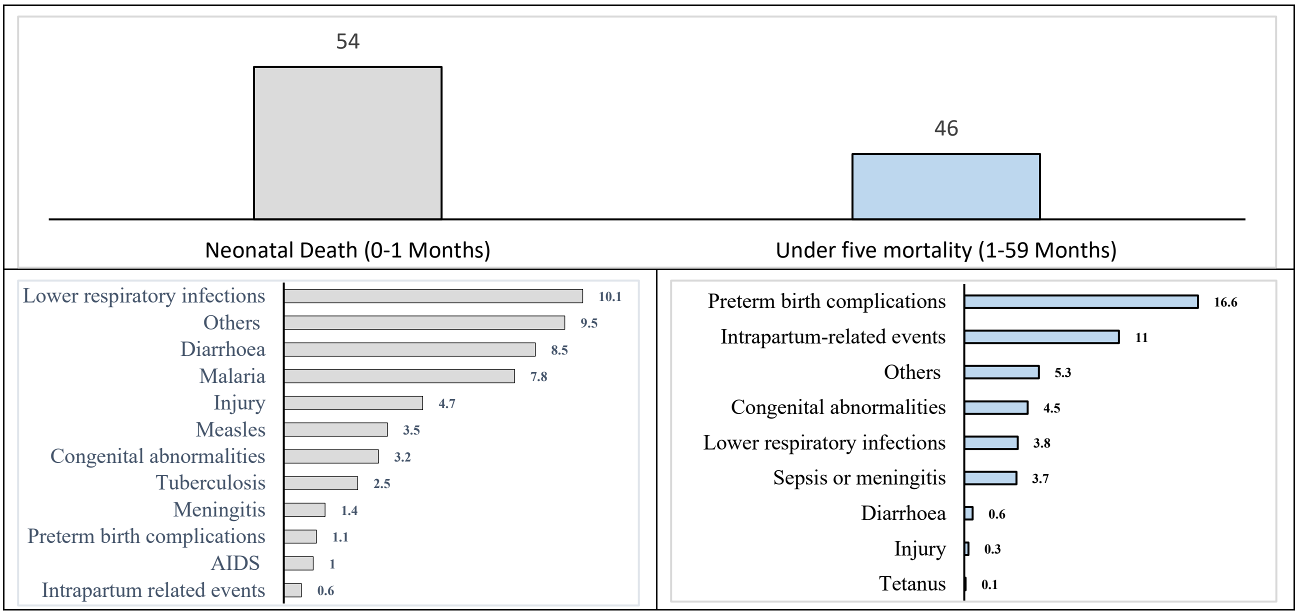


Figure 1.2: Primary causes of death among children under the age of five in the world WHO, 2022)

1.1.8 Child Mortality in India

In 1880, India saw a child mortality rate of 509 deaths for every thousand births among children under five, indicating that more than half of the children born that year did not live beyond their fifth birthday (UN DESA, 2019). This distressing statistic persisted well into the twentieth century. However, from 1900 to 2020, there has been a significant reduction in the child mortality rate, dropping from over 53 percent to just under four percent. During this period, the rate only increased on two occasions: during the Spanish flu pandemic in the year 1910s and in the year 1950s, as India navigated the challenges of gaining independence. The data on COVID-19-related mortality is largely age-dependent, with children and teenagers being the least affected. Children under the age of five account for around 2% of global cases (2 231 276) and 0.1% of global fatalities (1902) (WHO, 2021).

Every year, around 26 million children are born in India. According to the 2011 census, children account for 13% of the total population in the Country. The National Health Mission (NHM) comprehensively integrates interventions that improve child survival and addresses factors contributing to infant and under-five mortality under the child health program. In India, the majority of the children died due to prematurity & low birth weight (29.8%), followed by pneumonia (17.1%), whereas 2.5 percent of children died due to fever or unknown origin (Figure 1.3).

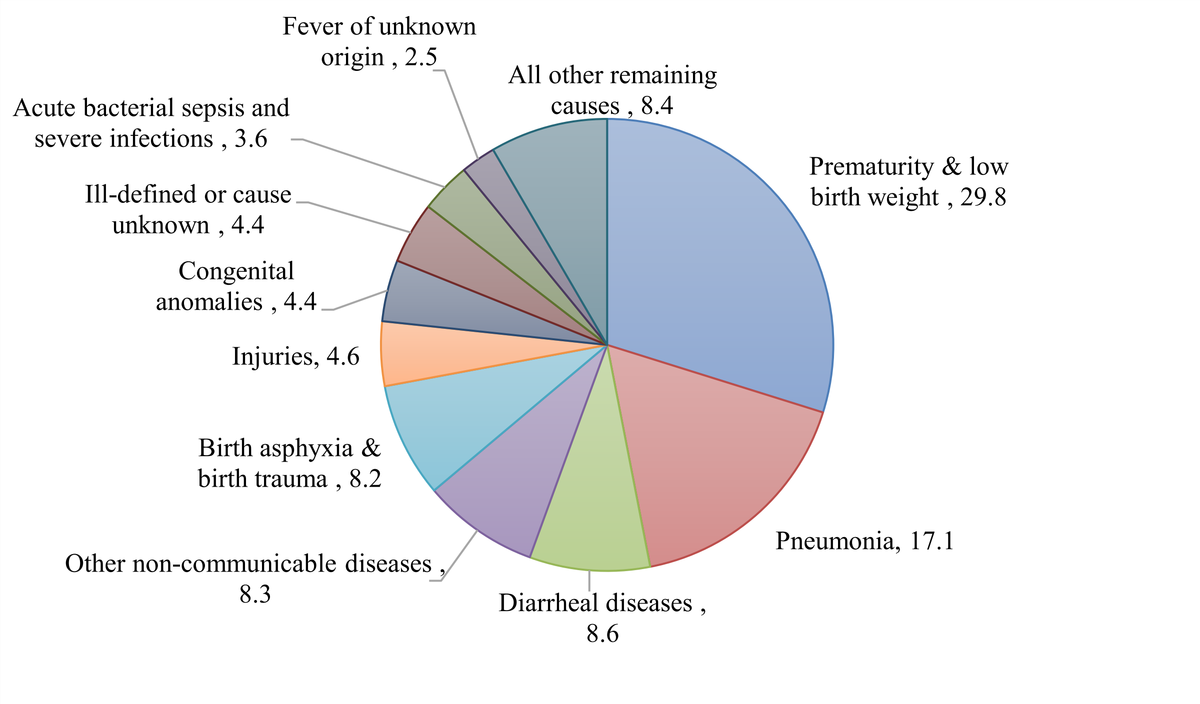


Figure 1.3: Causes of child Mortality in India (SRS Report, 2010-13)

Causes of Infant Mortality in India: Similarly, the major causes of infant mortality in India are prematurity & low birth weight (35.9%), Pneumonia (16.9%) and birth asphyxia & birth trauma (9.9%) (Figure 1.4).

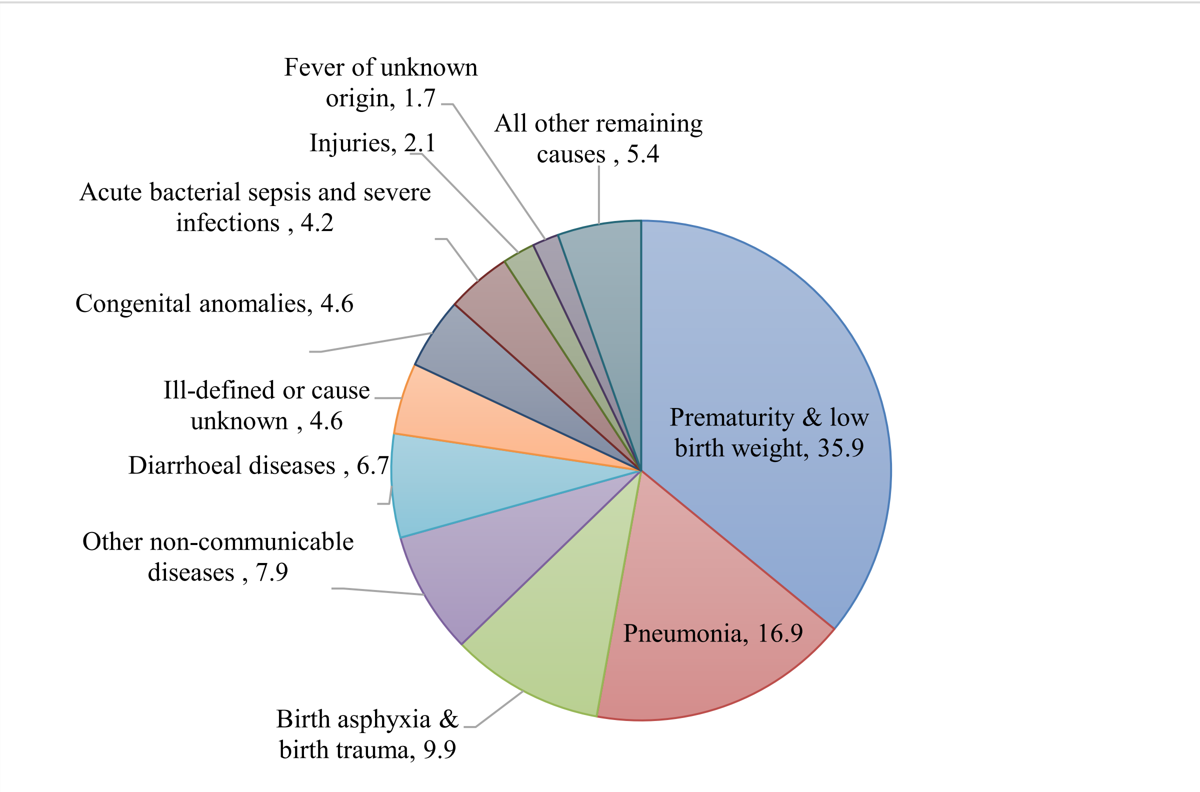


Figure 1.4: Causes of Infant Mortality in India (Sample Registration System Report, 2015-17)

Causes of Neo-natal Mortality in India: Around 46.1 percent of neo-natal death has occurred due to prematurity & low birth weight (46.1%) followed by birth asphyxia & birth trauma (13.5%) and neonatal Pneumonia (11.3%) (Figure: 1.5).

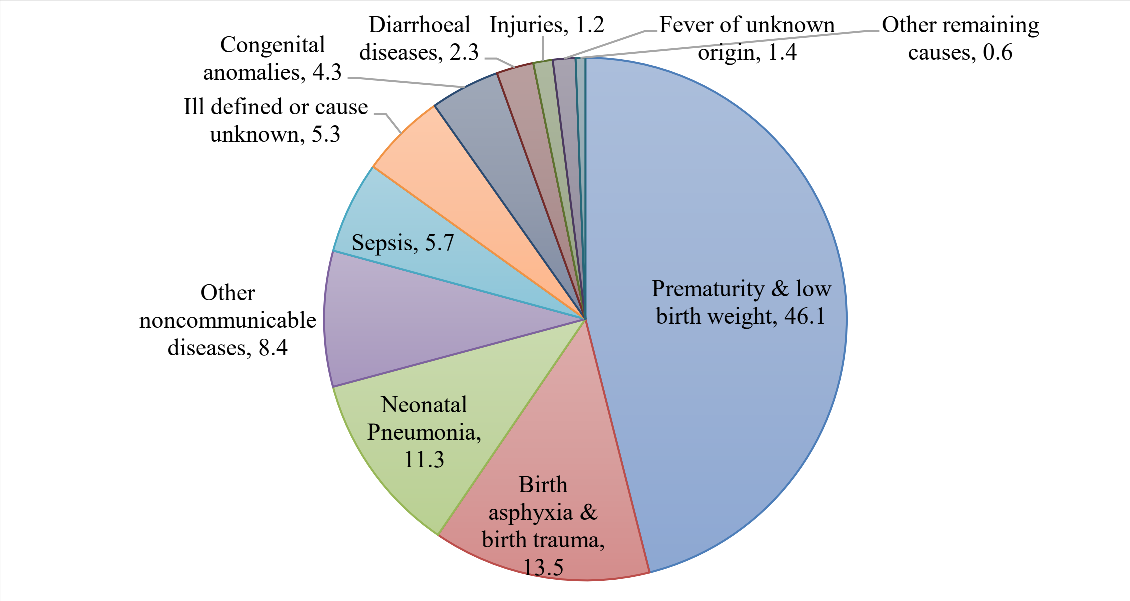


Figure 1.5: Causes of Neo-natal Mortality in India (SRS, 2015-17)

1.2 Literature Review

The SDGs aim to reduce the deaths from preventable diseases among newborn babies and children U5 years by the year 2030 in the world (Dahan & Gelb, 2015). In low and middle-income countries (LMICs), a substantial proportion of childhood deaths are attributed to easily preventable and treatable illnesses such as ARI, diarrhoea, and malaria (WHO, 2022; Daniel et al., 2008). It has been estimated that around 5.5 million children under the age of five years died from preventable diseases in 2017 (Hug et al., 2018). Approximately 73 percent of children died from African (49%) and Southeast Asian (24%) countries due to ARI (Anteneh & Hassen, 2020). Various studies have looked into ARI among under 5 children from different dimensions starting from its spatial spread, determinants, consequences and many of them have come out with policy implications both a micro and macro level.

ARI is one of the leading causes of childhood illnesses, often resulting in serious health complications and accounting for 20 percent of deaths among children under five in the world (WHO, 2022). According to the Global Burden of disease (GBD) report in 2017, a lower respiratory infection is responsible for 704,000 deaths in children younger than five years (GBD, 2017). Acute respiratory infection is not only the cause of death but is also the leading cause of years of life lost due to premature mortality and one of the most frequent reasons for hospitalization (Lozano and Foreman, 2012).

World wide, the highest rates of ARI are observed in the regions of Southeast Asia and Africa (Troeger et al., 2018). In 2016, across these two regions, lower respiratory infections led to the deaths of an estimated 652,572 children under the age of five, out of a total of 68.06 million reported episodes. India is listed among the top 15 nations facing the highest rates of pneumonia incidents and associated mortality among children (Troeger et al., 2018; Hasan et al., 2022). Every year, about 400,000 children under five years of age succumb to diseases related to ARI in India. (Hasan et al., 2022).

A study by Anteneh and Hassen in 2020 found that the incidence of ARI is associated with various factors related to children's demographics, their parents' socioeconomic background, place of residence, and the household environment in which they grow up. Children's age, birth weight, cooking fuel used in the household, and higher altitude above sea level were important factors that impact on childhood ARI (Anteneh & Hassen, 2020).

Several factors can influence a child's health, including their age, sex, underlying diseases, the type of infection, environmental factors, family socio-economic status, and the healthcare system and type of care they receive (Jackson et al., 2013; Wonodi et al., 2012). Previous systematic reviews have documented the link between pneumonia mortality in children and individual risk factors, such as insufficient breastfeeding (Horta & Victora, 2013; Lamberti et al., 2012), malnutrition, and indoor air pollution from solid fuels (Bruce et al., 2013).

The ARI in children can be influenced by various factors. These include the type of housing, parental smoking history, respiratory infections among family members, nutritional status of the children, and the type of cooking fuel used in the household (Tazinya et al., 2018; Nair et al., 2013; Naz & Agho, 2017; Langbein, 2017; Amha & Worku, 2018).

The studies in Bangladesh and India found that the prevalence of ARI is relatively higher among young children, children who suffer from anaemia, low birth weight, and those non-exclusively breastfed (Budge et al., 2014; Hasan & Richardson, 2017; Prajapati et al., 2012; Sheikh Quyoom Hussain et al., 2014). The risk of the ARI was higher among boys as compared to girls (Savitha, 2018; Nair et al., 2013)

A study by Varghese and Muhammad (2023) recommends conducting future research using multilevel regression models, as community, district, and state-level factors may influence results (Varghese & Muhammad, 2023).

1.2.1 Risk Factors Associated with ARI

The prevalence of childhood ARI in is associated with various household, socio-economic, maternal, and child characteristics. Identifying the risk factors for acute respiratory infections (ARI) is crucial for reducing the associated mortality and morbidity burden. Previous studies have identified various household, socioeconomic, maternal, and child characteristics as risk factors for this infection.

Household environment:

Research indicates that children from rural areas and low-income families are more susceptible to ARI (Sultana et al., 2019). This higher risk has been attributed to the disadvantaged socio-economic status of these households in rural settings, a finding that aligns with studies from other low and middle-income countries (Sultana et al., 2019; Harerimana et al., 2016).

Household air pollution is found to be the major environmental risk factor of acute lower respiratory tract infection (ALRI) in children as it increases the risk by 78% (pooled OR = 1.78 (95% CI 1.45-2.18)) and is responsible for half a million deaths in young children every year (Jary et al., 2016; Dherani et al., 2008). A systematic review indicates that respiratory diseases such as asthma, rhinitis, and mortality are linked to biomass fuel, tobacco smoking, particulate matter, coal dust, and other pollutants, including ozone, nitrogen dioxide, and sulfur dioxide. (Cortes-Ramirez et al., 2021). A comparative study in Wuhan, China, shows that a reduction in environmental tobacco smoke, household coal use and kitchen smoke causes a significant decrease in respiratory symptoms in children like wheezing, cold and cough, bronchitis, phlegm, asthma (Meng et al., 2021). Environmental tobacco smoke exposure is found to reduce lung function, thereby causing ARI (Meng et al., 2021; Singh et al., 2022; Vanker et al., 2017), whereas the use of coal as household cooking fuel and space heating causes respiratory diseases due to incomplete combustion and poor ventilation (Meng et al., 2021; Smith, 2002). As per WHO 2018, about 50% of pneumonia-related deaths in children under 5 years are due to inhalation of particulate matter (soot) from indoor air pollution (Sollari Lopes et al., n.d.). Under 5 children who are living in households, solid biomass fuel usage and second-hand smoke (SHS) exposure have an 11% (95% CI 1.06-1.17) higher likelihood of suffering from ARI as compared to those residing in households using clean cooking fuel and without SHS (Singh et al., 2022). A similar study in Bangladesh shows a statistically significant association between solid fuel consumption and the occurrence of ARI in children's households (Adhikari et al., n.d.). Cheap and highly polluting solid fuels, such as wood, coal, straw, and animal dung, are primary energy sources for cooking and heating in developing countries, leading to acute respiratory infections in children. (Adhikari et al., n.d.; Hassen et al., 2020; Singh et al., 2022). Other risk factors also include a lack of sanitation system (Akinyemi & Morakinyo, 2018), malnutrition, cooking smoke, which are related to low income and illiteracy and lack of doors and windows in households for ventilation (Adhikari et al., n.d.; Hassen et al., 2020; Ujunwa & Ezeonu, 2014). Large family sizes of more than 5 siblings residing in a home cause overcrowding and malnourishment, due to which there is a significant chance of pneumonia (Hassen et al., 2020; Ujunwa & Ezeonu, 2014). A multilevel analysis (Lutpiatina et al., 2022) showed ARI in children to be related to the smoking habits of family members, use of mosquito coils, occupancy density, and nutritional status (Taksande & Yeole, 2016). Living in houses with poor quality material is also found to be significantly associated with high-risk ARI, pneumonia and bronchiolitis.(Akinyemi & Morakinyo, 2018). Residential density and inadequate ventilation are also significant risk factors for acute respiratory diseases (Akinyemi & Morakinyo, 2018; Hidayah et al., 2017). Another study (Salmaddiina et al., 2022) reveals that the incidence of ARI in children under five years old is closely associated with residential areas (Rural OR 2.2, 95%CI 1.1-4.3), smoke exposure (OR 4.7, 95% CI 1.8-12.4), and roof materials. Children with mothers exposed to second-hand tobacco smoke during pregnancy were 2.05 times (p=0.08) more likely to suffer from ARI (Shibata et al., 2014).

Socio-economic factors:

Studies on the household wealth index found that children from rich families were less vulnerable to ARI symptoms, while those from poorer households were more susceptible (Pinzón-Rondón et al., 2016; Lutpiatina et al., 2017; Ramani et al., 2016; Imran et al., 2019; Kanté et al., 2015).

Maternal factors:

Contemporary literature has reported a significant association between maternal illiteracy, knowledge base, access to mass media, and the incidence of ARI (Ramani et al., 2016; Tazinya et al., 2018). However, other study found that the association between maternal education and ARI prevalence was insignificant (Goel et al., 2012). Mothers with limited or no education had a higher risk of contracting ARI (Tazinya et al., 2018; Geberetsadik & Berhane, 2015). Prakash (2014) found that a mother's caste, religion, and tribal status, which serve as indicators of her social class, are significantly linked to the occurrence of ARI in Indian children (Prakash,2014).

Considering maternal characteristics, maternal asthma was found to be a significant risk factor for acute respiratory infections (ARI) among children (Savitha et al., 2007; Mahalanabis et al., 2002; Ramani et al., 2016). since children typically spend most of their time indoors, they are more vulnerable to contracting infections from family members with respiratory illnesses (Savitha , 2018). A case-control study in Calcutta found that children have a two to three-fold higher risk of having ARI if their parents or siblings have an asthmatic history (Mahalanabis et al., 2002).

Characteristics of Children:

Many studies have found that malnourished children have a higher risk of contracting ARI compared to children with normal nutrition status (Savitha et al., 2007; Prajapati et al., 2012; Bawankule et al., 2017). Moreover, Children who experienced diarrhea recently were found to be at a higher risk of contracting infections. This correlation was also noted in recent research carried out in both India and Ethiopia (Hasan et al., 2022; Merera, 2021). A recent episode of diarrhoea may indicate weakened immunity, making the child more susceptible to further infections. Moreover, the studies found that the risk of ARIs among children decreases with increasing age (Merera, 2021). Children aged 48-59 months have a lower risk of infection compared to younger age groups (Sultana et al., 2019; Imran et al., 2019; Nshimiyimana et al., 2022; Geberetsadik et al., 2015). The susceptibility of young children to illness may be due to their immature immune systems (UNICEF, 2004). Many studies have identified that male children are at a higher risk of ARI (Hasan et al., 2022; Sultana et al., 2019; Ramani et al., 2016; Goel et al., 2012; Choube et al., 2014). One probable reason for this is the higher tendency of male children to play outside the home, exposing them to infected aerosols from the surrounding outdoor environment compared to female children (Savitha, 2018). Another reason for the high vulnerability of boys could be genetic, or there could be higher reporting by mothers for boys due to gender bias, potentially causing them to notice symptoms of the disease among boys (Sultana et al., 2019).

1.2.2 Economic Burden and Treatment Seeking Behaviour of ARI

ARIs impose a significant burden on children (Krishna et al., 2015). The most common cause of mortality and morbidity in children under five years of age is ARI, resulting in a high economic cost and being the primary cause of children's admission to health services. ARIs also place a significant economic burden on health systems and individual families in developing countries. Recent estimates have shown that among children under 5 years old, the median direct cost of ARI was US$135 in private institutions and US$54 in public institutions (Peasah et al., 2015). Research conducted in Bangladesh and Pakistan has revealed that the average treatment cost for one episode of pneumonia is $13 for outpatient services and between $71 and $235 for severe cases requiring hospitalization. Additionally, it was found that 75% of households spend over half of their monthly expenses on hospital stays. (Hussain et al., 2006; Alamgir et al., 2010).

"Health Seeking Behaviour" is a complex procedure. It is a decision-making process to seek perfect treatment for health (Prakash, 2014). Health-seeking behaviour is influenced by several factors, including individual or household attitudes, proactivity, awareness, and willingness to seek healthcare. Socioeconomic, sociocultural, and demographic traits are often overlooked when developing healthcare policies or programs. As a result, new healthcare services schemes could not achieve their goal. It is also far from community acceptance (Sing and Gupta, 1996; Prakash, 2014). Thus, health-seeking behaviour is directed by socio-economic, sociocultural, and demographic factors that influence health behaviour (Prakash, 2014).

Caretakers play a crucial role in identifying infection symptoms and providing prompt and appropriate care (Astale & Chenault, 2015; WHO, 2021). It is essential to administer a full course of antibiotics promptly to prevent pneumonia-related deaths (WHO, 2021). The decision to seek healthcare is influenced by various factors such as socioeconomic, sociocultural, and demographic factors (Prakash, 2014; Shaikh & Hatcher, 2005). Previous research has shown that maternal education positively impacts healthcare-seeking behaviour (Prakash, 2014; Abdulkadir et al., 2016). Additionally, evidence suggests that socioeconomic status, family size, and proximity to healthcare facilities also affect healthcare-seeking behaviour (Prakash, 2014; Abdulkadir et al., 2016; Sultana et al., 2019; Astale & Chenault, 2015; Okwaraji et al., 2012).

A study conducted in India demonstrated that sex differentials exist in the healthcare-seeking behaviour of parents, and female children are less likely to receive treatment (Prakash, 2014; Varghese & Muhammad, 2023). Nevertheless, this result conflicts with other research, which found no disparities based on gender or suggested that girls are more likely to be treated (Taffa & Chepngeno, 2005; Sultana et al., 2019).

Numerous studies have shown that a long distance to healthcare facilities, absence of transport options, and inferior road conditions negatively affect the use of health services (Astale & Chenault, 2015; Okwaraji et al., 2012; Shiferaw et al., 2013).

The relationship between a mother's age and her likelihood of seeking medical treatment shows a negative trend. Women in their middle ages are more inclined to pursue treatment compared to those in older age groups. Conversely, older mothers tend to seek medical care for their ill children more frequently than younger mothers do. This could be attributed to the fact that younger mothers generally possess less knowledge and experience regarding child healthcare practices (Ghosh, 2005; Prakash, 2014).

The level of education attained by mothers plays a crucial role in the health outcomes of their children. Studies have found that mothers who are educated are more proactive in seeking medical treatment for their children, especially in cases of acute respiratory infections (ARI), compared to those who are not. The trend shows that the most educated women are the most likely to pursue the highest level of medical care for their children, while those without education are the least likely. Research by Irma T. Elo in 1992 and Bhanu E. Nirula in 1994 has highlighted that in many developing countries, a mother's education is strongly linked to higher survival rates among children (Elo, 1992; Nirula, 2005). This correlation can be attributed to educated mothers' superior understanding of nutrition, disease, and treatment options, as noted by Prakash in 2014 (Prakash, 2014). Furthermore, women with higher education levels not only contribute more to the family's income but also secure a stronger position within the family dynamic. Education enhances women's cognitive abilities, enabling them to communicate more effectively with healthcare professionals. Education also promotes changes in attitudes, behaviours, and ideologies, leading to an increased awareness of healthy practices. As Shireen J. Jejeebhoy pointed out in 1995, educated women are more inclined to utilize modern healthcare services and embrace contemporary medicines and health practices (Jejeebhoy, 1995; Prakash, 2014).

1.2.3 Knowledge, Attitude and Practice (KAP) of Mothers on ARI

Children are the strong pillar of the best nation, and improved health status of children is crucial for the progress of a nation. ARI is a significant public health concern, particularly in developing countries such as India, where a large portion of the population lives in poverty, resides in slums, and is at risk of contracting life-threatening illnesses. Children under the age of five are especially susceptible to these infections. Maintaining the healthiest possible status for children has placed a significant economic burden on developing countries. Therefore, the prevention and control of ARI is a critical step, starting with raising awareness among mothers and family members. Control of ARI is a major public health problem in developing countries. One in five mothers cannot understand pneumonia because of its similar symptoms to fever, cough, and hypertension (Farhad et al., 2014). On the other hand, One-third of mothers do not seek care for acute respiratory infections and pneumonia in children under the age of five (Al-Noban & Elnimeiri, 2022). Effective health education programs must be designed based on society's knowledge, attitude, and practices (KAP) (Farhad et al., 2014). Good knowledge related to ARI helps reduce the risk of morbidity and mortality in children under five years old (Farhad et al., 2014; Chan et al. 2012).

ARI is not only the cause of death but is also the leading cause of years of life lost due to premature mortality and one of the most frequent reasons for hospitalisation (Lozano & Foreman, 2012; Nair et al., 2013). ARI is an acute respiratory tract infection usually caused by viruses or bacteria (Manh et al., 2023). This is one of the most common diseases in children under 5 years old, with the average episodes of ARIs in children under 5 years old being approximately 3.27 times per year (Ramani et al., 2016) and accounting for 35.7-44.9% of reasons why children visit the outpatient department (Demissie et al., 2021). Although the safe, effective, and affordable interventions recommended by the WHO have been implemented, pneumonia mortality has decreased from 4 million in 1981 to just over one million in 2013, Pneumonia still accounts for approximately twenty percent of mortalities in children under five years of age worldwide (WHO, 2014), especially in developing countries (Nair et al., 2013). Many factors influence morbidity and mortality due to ARIs, including the child's health, environmental conditions, socioeconomic status, the caregivers, and the health systems (Nair et al., 2013; Sonego et al., 2015; Uwaezuoke et al., 2016). Of these factors, Knowledge, attitudes, and practices (KAPs) regarding care for children with ARIs among caregivers, who are usually mothers, have an essential influence on the morbidity and mortality caused by ARIs in children under 5 years of age (Sonego et al., 2015). Furthermore, the mothers' KAPs are related to many socioeconomic factors (Al-Saleh et al., 2020). Thus, assessing the KAPs of mothers caring for children with ARIs and analysing the factors affecting mothers' KAPs when caring for children with ARIs can make health education programs for the management of children with ARIs more effective (Alexandrino et al., 2017; Papaevangelou et al., 2012). Previous studies have documented differences in the results of assessments of mothers' KAPs (Bham et al., 2016; Kumar et al., 2012; Ramani et al., 2016) and factors affecting maternal KAPs regarding ARIs. (Alluqmani, Aloufi, & Al Abdulwahab, 2017; Bham et al., 2016; Kumar et al., 2012). A study by Bham et al. (2016) found that mothers' knowledge of ARI symptoms, worsening environmental conditions, aggravating factors, and complications was satisfactory. The study took a total of 335 children for the analysis. The most common symptom perceived was a cough, mainly worsening during the winter season; the most aggravating factor was dust; the most common complication was Pneumonia, and most mothers opted for a medical practitioner for treatment. Self-medication was practised by 58 per cent, and paracetamol was frequently used as medicine (Bham et al., 2016).

Another study by Khan et al. in 2018 found that mothers have good Knowledge of ARI symptoms, worsening environmental conditions, aggravating factors and complications (Khan et al., 2018). Most of the mother's attitude towards ARI was appropriate with consultation with a qualified medical practitioner. All over the world, the average ARI experience of the child is 6-8 spells in a year (Bham et al., 2016).

In rural West Bengal, a study found that acute respiratory infections (ARI) were the most frequent morbidity (38.6%) present in the population, followed by undernutrition (27.7%), pallor (27.7%), worm infestation (14.9%), skin disease (12.8%), and diarrhea (12.8%) (Paramanik et al., 2015).

A study based on Gujarat revealed that 35 per cent of mothers preferred private healthcare facilities for treatment, with a higher preference in urban areas at 58.4%. Additionally, 71 percent of mothers favoured allopathic treatment. Only 41 percent of mothers perceived diseases as serious, with a higher percentage in urban areas at 54 percent. Furthermore, 51 percent of mothers were illiterate, with 70% of them residing in rural areas, and 70 percent of the mothers were housewives (Prajapati et al., 2012).

A study by Koranath & Nair (2024) conducted in Telangana found that 94.50% of mothers had a good awareness of Acute Respiratory Infection (ARI). The study found a significant association between a mother's occupation and her awareness level regarding ARI, while other variables did not show statistical significance. The majority of the mothers (88.0%) preferred to consult a qualified allopathic doctor for their child's ARI. Those who did not seek healthcare services for their child's illness believed that the disease was self-limiting, while others tried traditional medicines at home before seeking healthcare services (Koranath & Nair, 2024).

1.3 Need for the Study

ARIs are common respiratory diseases among under-five children in the world. ARIs are responsible for 15% of all deaths of children aged less than 5 years globally (WHO, 2020). Such an infection is manifested by a cough accompanied by short rapid breathing which may be associated with death especially when there are other comorbidities (Johnson et. al, 2013) although, a significant decline has been achieved over the past two decades (Roth et. al, 2018). The main infectious agents of ARIs are viruses (Choi et al., 2018). The viruses like influenza virus (IV), parainfluenza viruses (PIV), ADVs and coronaviruses (CVs) were all mainly responsible for Acute Lower Respiratory Infections (ALRIs) (Lukšić et al., 2013).

Globally Lower respiratory tract infections (LRTIs) are the leading causes of morbidity and mortality among children under five years old (Naghavi et al., 2017; Troeger et al., 2018; WHO, 2020). It caused 652, 572 deaths in children younger than 5 years worldwide in 2016 (Naghavi et al., 2017; Troeger et. al, 2018). In particular, pneumonia is recognized as the single largest cause of childhood deaths globally which accounted for 13% to 16% of overall deaths in 2015 (The Million Death Study Collaborators, 2010; Vashishtha 2010). Mortality due to ARIs varies significantly across the regions (GBD, 2017). ARI also account for up to 50% of visits of children to health facilities globally (West et. al, 1999). These are responsible for approximately 70% of childhood morbidities in developing countries (Selvaraj, et. al, 2014).

A study conducted to assess the prevalence of ALRIs among children under five years from 28 sub-Saharan African countries revealed that the overall prevalence of ARI for all the countries was 25.3% (Seidu et. al, 2019).

ARI is the major cause of mortality among children aged less than 5 years, especially in low-income (Walker et. al, 2013) and developing countries (Frese et. al, 2011) like India (Selvaraj et., al, 2014; WHO. 1998). It is estimated that Bangladesh, India, Indonesia, and Nepal together account for 40% of the global ARI mortality (Kumar et al., 2015). Every year a child experiences 5 episodes of ARI (Ghosh, 2021; Anand, 1994). In India, ARI accounts for 30-50% of visits to health facilities and 20-40% of hospital admissions (Vashishtha, 2010). Besides these, ARI is also the cause of economic loss to both families as well as society (Romieu et al.,2002; Ramaekers et al., 2017; Kurskaya et al., 2018).

Interestingly infants living in overcrowded surroundings and those who are sub optimally breastfed are more likely to suffer from ARI-related illnesses (Mathew et. al, 2011; Dhimal et. al, 2010).

Despite various efforts by International and National agencies to control and prevent childhood diseases like diarrhoea, pneumonia and ARI, still a large number of children from varied backgrounds are suffering from these preventable diseases that eventually lead to unprecedented levels of child mortality and morbidity in developing countries, including India (Sara, 1985; Bbaale, 2011; Van Esterik, 2002; Bang & Tiwari, 2011; Tiwari et al., 2016).

Child health is one of the major components of the Sustainable Development Goals (SDGs). This is also important in India to achieve the target given the current global health efforts–the United Nation's Sustainable Development Goals (SDG-3.2: ending preventable deaths of new-borns and under-five children by 2030) (**SDG**), and WHO and UNICEF lead a global strategy to prevent pneumonia and diarrhoea deaths by 2025 throughout the Global Action Plan for Pneumonia and Diarrhoea (**GAPPD**). The country has already set its goal to achieve the SDGs target to reduce under-five child mortality by 25/1000 live births in 2030 (SDGs) which is 50/1000 live births as per the National Family Health survey (IIPS, 2017; SDG). Notably, the prevalence of ARIs increased 2.7 percent to 2.8 percent between the year 2016 to 2019 (IIPS, 207; IIPS, 2021)

1.4 Identify the Research Gaps

The evidence indicates that children are more affected by ARIs than adults for several reasons. Children breathe more rapidly, have a higher metabolic rate, and their immune systems are not fully developed, leading to a higher incidence of respiratory infections than adults (European Respiratory Society, 2019; Anteneh & Hassen, 2020). So the present study has considered the prevalence of ARI among under-five children in India.

The distribution of acute respiratory infection (ARI) episodes across different districts of India yet to be fully explored. The achievement of the child mortality target in the Sustainable Development Goals (SDGs) also depends on changes taking place in India, as India accounts for a significant portion of global live births and neonatal mortality. Therefore, it is essential to understand the prevalence and determinants of ARI at overall as well as regional level. Additionally, previous studies did not explore the spatial clustering of ARI and its covariates among children using district-level data from NFHS-IV and NFHS-V. National burden estimates may not capture the regional variations across India's diverse territory.

To find out the determinants of ARI among children, there is a need to evaluate mothers' awareness of knowledge, attitudes, and practices related to acute respiratory tract infections (ARI). This evaluation is more relevant for developing countries. Very few studies have aimed to gather baseline data to understand the same. The present study has assessed mothers' knowledge, attitudes, and practices related to acute respiratory tract infections in children under five.

In almost all societies, the primary responsibility of caring for a child fall to the mother. Therefore, mothers' knowledge, attitudes, and health practices directly affect the child's health and survival. Most cases of morbidity from acute respiratory diseases can be effectively managed at home. Comprehensive health education on the causes, prevention, and management of these diseases has the potential to establish better communication between health services and society. This can help families identify early signs of acute respiratory diseases in children and encourage appropriate and timely care-seeking behaviours.

Previous studies have shown that the household environment plays a crucial role in developing childhood ARI. We have included some environmental variables that are not covered in NFHS data. Therefore, primary data will help us to identify the impact of responsible variables on ARI among children in rural West Bengal.

Accordingly, this study has aimed to investigate the prevalence and factors associated with ARI among under-five children in districts of India along with hot-spot analysis. Comprehending and effectively quantifying the various risk factors associated with ARI in infants and young children is of paramount importance for the healthcare sector and policymakers in India. This understanding is essential for crafting targeted and evidence-based policies at the district level. By leveraging this information, policymakers and advocates can play a pivotal role in implementing interventions aimed at reducing child morbidity and mortality due to ARI, ultimately contributing to improved public health outcomes in India.

1.5 Research Questions

Based on the literature review and identification of research gaps, we have formulated a set of research questions:

RQ:1 Are there disparities in the prevalence of ARI among children across India's states/union territories and districts?

RQ: 2 Are there any spatial clustering existing across the districts of India regarding the prevalence of childhood ARI? If so, what is the value of the Moran's index?

RQ: 3 Is there any spatial association between ARI and the covariates?

RQ: 4 What are the possible risk factors associated with ARI in India, especially in rural West Bengal?

RQ: 5 What proportion of children under five years with symptoms of acute respiratory infection (ARI) in India receive treatment from a health facility?

RQ: 6 What are the socio-demographic and economic determinants influencing treatment-seeking behavior for ARI among caregivers of under-five children in India?

RQ: 7 What are the determinants of health-seeking behaviour in India and rural West Bengal?

RQ: 8 What are mothers' knowledge, attitudes, and practices regarding their children's ARI?

RQ: 9 Is there any relationship between a mother's KAP level and ARI?"

RQ: 10 What environmental factors are responsible for ARI in rural West Bengal?

1.6 Research Objectives

The study aims to investigate the geographical variation and prevalence of ARIs and its associated contextual risk factors. These factors include environmental conditions and mothers' knowledge related to ARIs in rural West Bengal and across India as a whole. The specific objectives are as follows:

1. To assess the prevalence and identify the patterns of spatial clustering of ARI in children under five years of age in India. [***Based on Secondary Data***]
2. To investigate the contextual risks associated with ARI in India and rural West Bengal. [***Based on Primary & Secondary Data***]
3. To Identify the factors associated with the treatment-seeking behaviour for ARI in India. [***Based on Secondary Data***]
4. To assess the economic Burden and health-seeking behaviours of families dealing with ARI in rural West Bengal. [***Based on Primary Data***]
5. To understand the knowledge, attitudes, and practices (KAP) regarding acute respiratory infection among mothers of children under five in rural West Bengal. [***Based on Primary Data***]

1.7 Hypothesis

The study will test the following hypotheses based on the research questions emerging in our research.

Null Hypothesis 1 (H0): There are no significant disparities in the prevalence of ARI among children across India's states/union territories and districts.

Null Hypothesis 2 (H0): There is no significant spatial clustering of ARI prevalence across the districts of India.

Null Hypothesis 3 (H0): There is no significant spatial association between ARI prevalence and the covariates.

Null Hypothesis 4 (H0): There are no significant risk factors associated with ARI in India, including rural West Bengal.

Null Hypothesis 5 (H0): There are no significant determinants influencing health-seeking behaviour for ARI in India and rural West Bengal.

Null Hypothesis 6 (H0): Mothers' knowledge, attitudes, and practices regarding ARI in their children do not significantly differ.

Null Hypothesis 7 (H0): There is no significant relationship between a mother's KAP level and the prevalence of ARI in her children.

Null Hypothesis 8 (H0): Environmental factors do not significantly contribute to the prevalence of ARI in rural West Bengal.

1.8 Organisation of Thesis

Chapter 1: Introduction, Review of Literature, and Objectives

Chapter 2: Data Source and Methodology

Chapter 3: Results

- *Chapter 3.1:* Prevalence and spatial clustering of ARI among children (0-59 months) in India
- *Chapter 3.2:* Factors associated with ARI in India and rural West Bengal.
- *Chapter 3.3:* Determinants of treatment-seeking behaviour for ARI in India.
- *Chapter 3.4:* The economic Burden and health-seeking behaviours in West Bengal
- *Chapter 3.5:* Mother's knowledge, attitudes, and practices (KAP) regarding ARI of their children in rural West Bengal

Chapter 4: Discussion and Conclusion

1.9 Conceptual Framework

In Figure 1.6, we can see the conceptual framework that has been developed for the current study. This framework is based on an extensive review of existing literature, which indicates that factors such as the household environment, socio-economic characteristics, maternal characteristics, and children's characteristics are directly linked to the prevalence of ARI among children under the age of five. Additionally, it has been observed that maternal and socio-economic status play a crucial role in determining whether treatment is sought for the illness. Moreover, it is important to note that a mother's knowledge, attitude, and practices also significantly impact treatment-seeking behaviour, thereby potentially reducing the prevalence of ARI. Furthermore, the knowledge, attitudes, and practices of mothers are influenced by their own maternal and socio-economic characteristics.

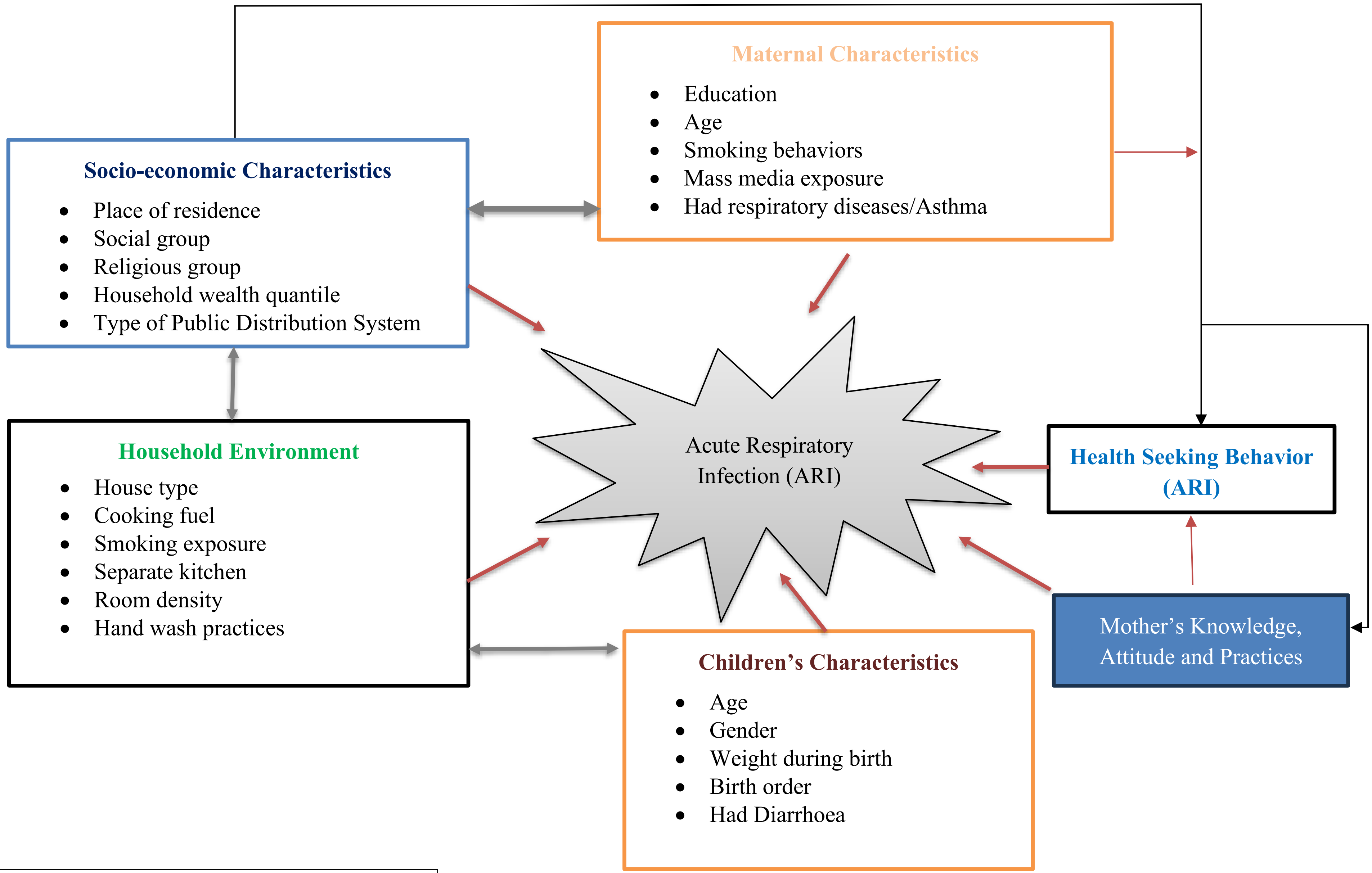


Figure 1.6: Conceptual Framework

CHAPTER 2

Data Source and Methodology

2.1 Introduction

This section provides a comprehensive elucidation of the key components of the study. It includes a thorough exposition of the data sources employed, offering insights into their selection and utilization and a detailed explanation of the methodology used in the research. Additionally, it underscores the foundational role of this chapter in setting the stage for subsequent analyses, highlighting the significance of the research objectives, the chosen data sources, and the systematic approach adopted in the study. We will be splitting this section into two parts: Data Source and Methodology.

Data Source: This section will cover the type of data source used and the reasons for selecting it. It will include details such as the data type, study area, sampling frame, sample size, and the data collection tools and procedures.

Methodology: In this section, we will outline the method used in the study and will explain why we have chosen this method. We will also identify the output and outcome variables and will describe how we have calculated them. Finally, we will specify the statistical techniques for achieving our study objective.

2.2 Data Source

The present study has utilized both primary and secondary sources of data. The National Family Health Survey, a high-level dataset, has been used as a secondary source of data to fulfill our study objectives.

Secondary Source of Data

2.2.1 National Family Health Survey

The National Family Health Survey (NFHS) is a comprehensive survey that is carried out in a representative sample of households throughout India. It has been conducted five times since it began in 1992-93. This survey provides state and national data on a variety of topics including fertility, infant and child mortality, family planning practices, maternal and child health, reproductive health, nutrition, anemia, and the utilization and quality of health and family planning services.

The NFHS has two primary goals. First, it aims to provide essential data on health and family welfare for policy and program purposes. Second, it aims to provide information on emerging health and family welfare issues. The Ministry of Health and Family Welfare, Government of India, has selected the International Institute for Population Sciences (IIPS) in Mumbai as the nodal agency that is responsible for coordinating and providing technical guidance for the survey. The IIPS has collaborated with several Field Organizations (FO) for survey implementation, with each FO responsible for conducting survey activities in one or more states covered by the NFHS.

During the first and second rounds of the National Family Health Survey (NFHS-I and II), data was exclusively available at the state level for India. However, the fourth and fifth rounds (NFHS-IV and V) expanded the scope to include data for all states/union territories, covering 640 and 707 districts across the country, respectively.

Sampling Design of NFHS:

In NFHS-V, a stratified, two-stage sampling approach has been developed. The district is divided between an urban area and a rural area. The sample frame's Primary Sampling Units (PSU) were chosen using data from the Census of 2011. The 2011 census served as the basis for the sample frame utilised to select the PSUs. PSUs were villages in rural regions and Census Enumeration Blocks (CEBs) in urban areas. The PSU nearest to them had connections to no more than 40 residential PSUs. Using the probability proportional to size (PPS) technique, villages were randomly selected from the sample frame inside each rural stratum. To produce six nearly equal substrata in each stratum, the three substrata—each based on the expected number of households in each village—were crossed with the two substrata—each based on the proportion of the population that belonged to scheduled castes and scheduled tribes (SCs/STs). PSUs were sorted in each explicit sample stratum based on the percentage of women who were literate at the age of six or older. The PSUs comprising the final sample were selected using PPS systematic sampling. The CEB data for urban areas was given by the Office of the Registrar General and Census Commissioner, New Delhi. Sorting the percentage of the SC/ST population in each CEB allowed for the methodical selection of sample CEBs.

Before the survey, a complete listing of households was conducted in each selected area. PSUs with a minimum of 300 households were segmented into groups of around 100-150 households each, and Two segments were chosen at random for the survey using systematic sampling. In the second stage, households were randomly selected using systematic sampling in each chosen rural and urban cluster.

Sample Size for NFHS-III (2015-16):

The Third round of The National Family Health Survey was conducted in 2005-06. A total of **48,679** under-five children who were alive during the interview and had been born to the women interviewed in the five years before the survey.

Sample Size for NFHS-IV (2015-16):

The fourth round of The National Family Health Survey was conducted in 2015-16. A sample consisting of 28 586 PSUs (130 from metropolitan slums, 8 397 from urban and 20 059 from rural areas) was selected in this stage. These PSUs (or segments for large PSU) were considered clusters in the second stage sampling. During field visits, 616,346 households were occupied. Ultimately, 601,509 households were successfully interviewed, resulting in a response rate of 98%. From these households, 699,686 ever-married women between the ages of 15 and 49 were interviewed.

The total number of children was 2,49,967 children's mothers interviewed, who were live born in the last five years (n=230,870). Among them, 11,022 dead children were excluded, including children who lived elsewhere or who did not live with their mothers (N=11,022). Finally, a total of **2,38,945** under-five children who were alive during the interview and had been born to the women interviewed in the five years before the survey (Figure 2.1)

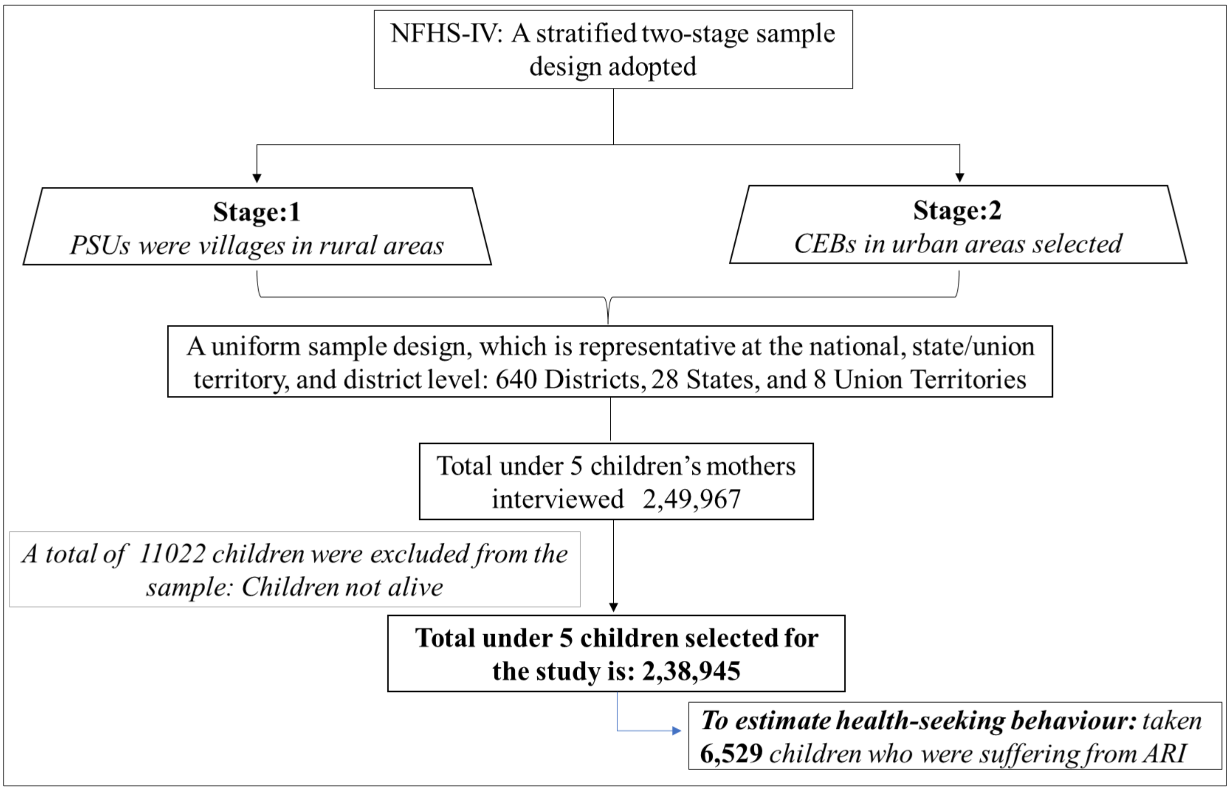


Figure 2.1: Child Inclusion Flowchart: NFHS-IV (2015-16)

Sample Size for NFHS-V (2019-21):

The survey's fourth round took place in 2015-16. This stage involved selecting a sample of 28,586 PSUs, with 130 from metropolitan slums, 8,397 from urban areas, and 20,059 from rural areas. These PSUs were treated as clusters during the second stage sampling. During field visits, 616,346 households were visited, and 601,509 households were successfully interviewed, resulting in a 98% response rate. From these households, 699,686 ever-married women aged 15 to 49 were interviewed.

The total number of children was 230,870 children's mothers interviewed, who were live born in the last five years (n=230,870). Among them, 8637 dead children were excluded, excluding children who lived elsewhere or who did not live with their mothers (N=8637). Finally, a total of 2,22,233 under-five children who were alive during the interview and had been born to the women interviewed in the five years before the survey (Figure 2.2)

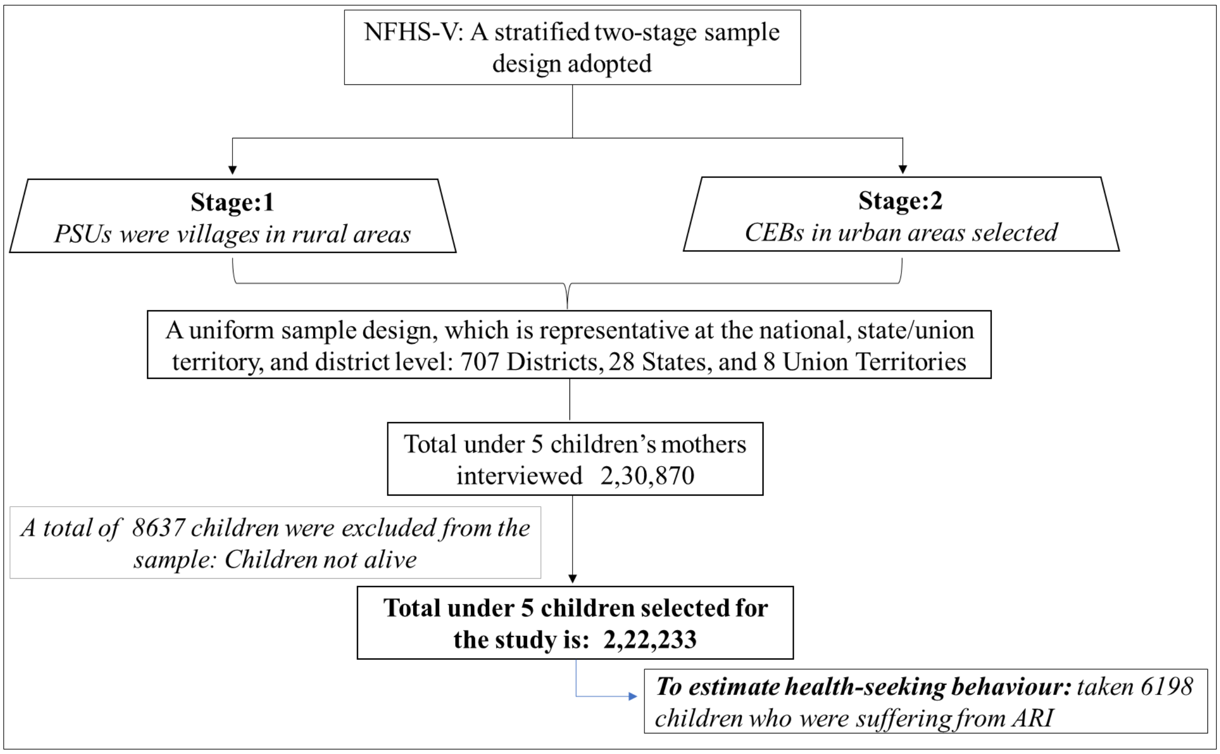


Figure 2.2: Child Inclusion Flowchart: NFHS-V (2019-21)

2.2.2 Particulate Matter (PM2.5) Data Source

We used global annual surface PM2.5 estimates for 2020 provided by the Atmospheric Composition Analysis Group at Washington University. These estimates originated from measurements of aerosol optical depth (AOD) from various satellite products, including NASA MODIS C6.1, MISR v23, MAIAC C6, and SeaWiFS satellite data. The data was then merged and analyzed in relation to surface PM2.5 levels and AOD using geographically weighted regression (GWR) (Adhikary et al., 2024; Van et al., 2021). The resulting estimates were assessed at a resolution of 0.01° × 0.01° (approximately 1 km × 1 km) for the exposure assessment. The dataset can be accessed publicly at the following website: https://sites.wustl.edu/acag/datasets/surface-pm2-5/

We utilized geographical data from the 2019–2021 Standard DHS dataset for India, which contained geocode information, to assess PM2.5 levels in India for 2020. The mean PM2.5 level was computed from each cluster in the dataset and was utilized as the main exposure variable (Adhikary et al., 2024; Van et al., 2021). Our research uncovered significant differences in PM2.5 levels among various clusters in India.

Primary Source of Data

Our study collected primary data from rural West Bengal to fulfill our research objectives. This data will play a crucial role in uncovering additional key factors that affect the occurrence of ARI in children within this region. Furthermore, the data provides deeper insights into mothers' awareness, attitudes, and behaviours concerning ARI and how it affects their children. It also looks into the disease's economic impact and examines families' health-seeking behaviours, including the strategies they employ to prevent such infections.

Need for Primary Data

The NFHS data didn't include information about certain predictor variables such as mothers' knowledge, perception, and economic burden related to the illness. Therefore, primary data was needed to evaluate the knowledge and economic impact of ARI among children. Additionally, environmental factors in many households can contribute to developing ARI in children. For example, a study in Ethiopia found that having pets and livestock (Hassen et al., 2020;) and the location of food preparation or cooking (Geremew et al., 2020) are associated with the risk of ARI. Furthermore, households located near Rice/Muri mills also increase the risk of ARI (Ghosh et al., 2014). Additionally, questions related to the alternative lighting source, cooking frequency, and children's availability during cooking are also included in our primary data collection. Since these variables were not included in the NFHS, we collected primary data based on rural West Bengal to address those gaps.

2.3 Study Area

2.3.1 Selection of the Study Area

Recent research highlighted that bidi consumption is highly prevalent in the states of West Bengal, Himachal Pradesh, Haryana, Uttarakhand, and Madhya Pradesh so most of the hotspot districts for ARI hotspot located in those states (Balasubramani et al., 2022). Tobacco consumption and smoking behaviours, increase indoor air pollution, which is an important risk factor for ARI (Balasubramani et al., 2022; Mueller et al., 2011). The high population density of West Bengal (>800 person per Km^2) increased the risk of ARI (Balasubramani et al., 2022; Mueller et al., 2011).

West Bengal, India's fourth most populous state, has the third highest rural population state after Uttar Pradesh and Bihar. ARI is the most frequent health concern in West Bengal, followed by undernutrition, pallor, worm infestation, skin disease, and diarrhea (Paramanik et al., 2015). According to the Household Survey (DLHS-III, 2007-08), West Bengal reported the highest prevalence of ARI among children (25%) (Prakash, 2014; DLHS-III, 2007-08), highlighting its significance for consideration. A comprehensive understanding of ARI is crucial in reducing the risk of morbidity and mortality in children under five years old (Farhad et al., 2014; Chan et al., 2012). The NFHS-IV data indicates fluctuations in the prevalence of ARI and treatment-seeking behaviour (NFHS-IV, 2015-16). Moreover, the health-seeking behaviour for rural West Bengal (72%) lags behind the urban part (76%) and the state overall (74%) (NFHS-IV). Purba Bardhaman district in West Bengal has been chosen as the new district. According to the NFHS-V data, the prevalence of ARI among children under five in Purba Bardhaman (5%) surpasses the national average (2.8%) and it is the second-highest prevalence in districts from West Bengal. As a new district, there are opportunities to explore research topics. Lastly, a random "taluka" (administrative subdivision) was selected from the listed 23 talukas of Purba Bardhaman district. The specific block selected is named 'Monteswar.'

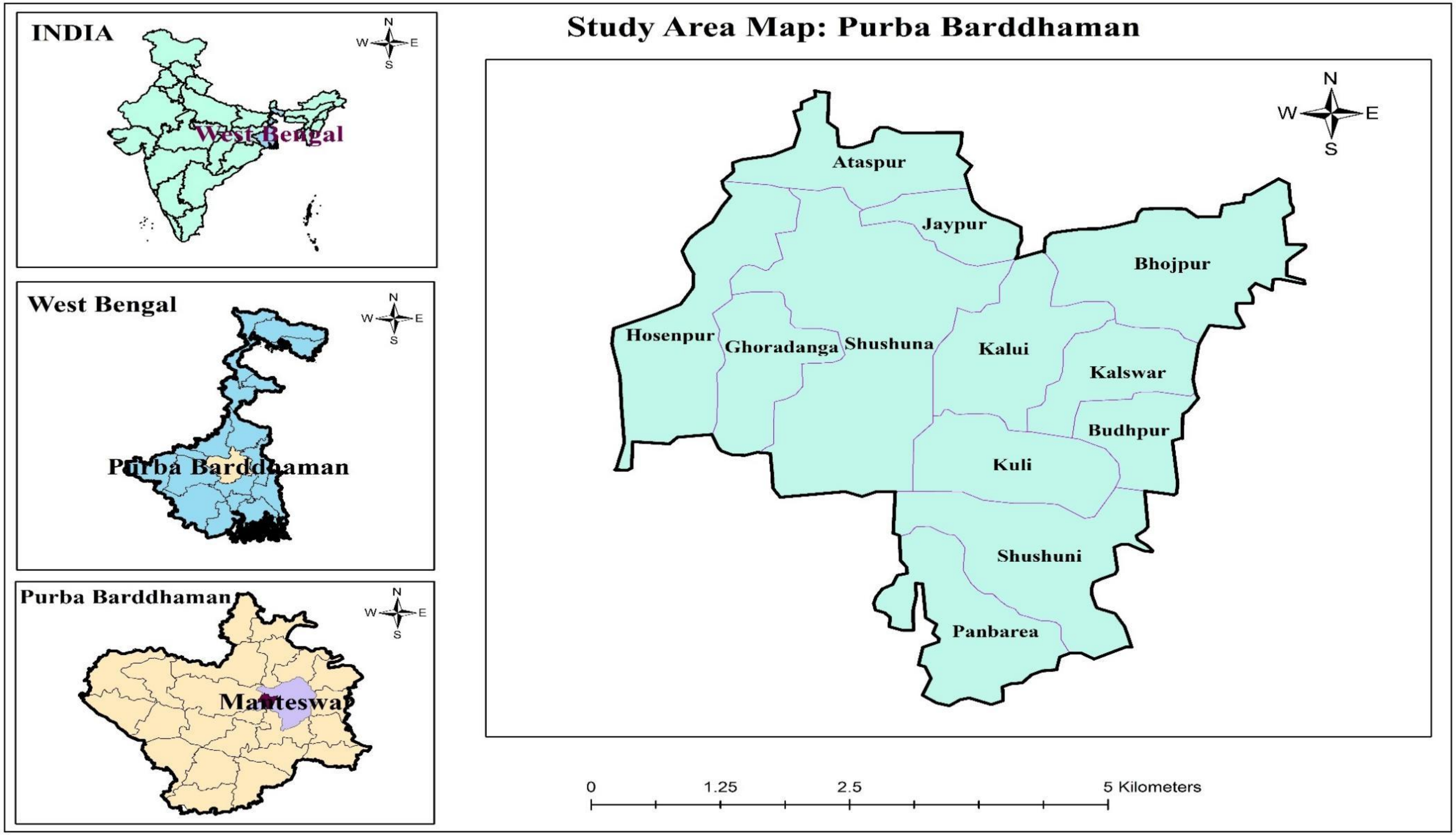


Figure 2.3: Study area for Purba Bardhaman Districts, West Bengal

2.4 About West Bengal

2.4.1 Socio-Demographic Profile of West Bengal

The socio-demographic profile of West Bengal state has been included in ***Table 2.1***. The information is based on data from a large-scale survey called the Demographic Health Survey in India.

In the household characteristics of the State, access to improved drinking water is good, but sanitation and clean fuel usage still need improvement. Additionally, many households are financially vulnerable due to limited health insurance coverage. In terms of socio-demographic status, there is a balanced sex ratio and high institutional birth rates. However, there are persistent gender gap in literacy and internet usage. While mortality rates are concerning, there is a positive trend toward improvement, for which high vaccination coverage might be an important reason. Regarding children's characteristics, there are high levels of stunting, wasting, underweight, and anemia, indicating critical issues of malnutrition and poor health. Although healthcare-seeking behaviour for conditions like diarrhea and ARI are reasonable, immediate attention is required for widespread anemia and malnutrition.

The comparison between NFHS-IV (2015–16) and NFHS-V (2019–21) reveals a mixed trend in West Bengal's health and socio-demographic indicators. Significant improvements were observed in basic household amenities: access to improved drinking water rose from 94.6% to 97.5 percent, improved sanitation facilities increased from 50.9% to 68%, and the use of clean cooking fuel improved from 27.8 percent to 40.2 percent. Female literacy increased from 70.9 percent to 76.1 percent, and the sex ratio improved from 1,011 to 1,049 females per 1,000 males. Positive progress was also seen in health outcomes, with reductions in neonatal, infant, and under-five mortality rates, and a notable rise in institutional births from 75.2% to 91.7%. However, some indicators showed deterioration. Health insurance coverage declined from 33.4 percent to 29.3 percent, and full immunization among children dropped slightly from 92.5 percent to 90.8 percent. Child nutrition indicators worsened, with increases in stunting (32.5% to 33.8%), underweight children (31.6% to 32.2%), and anaemia in children (54.2% to 69%). Additionally, the prevalence of diarrhoea increased, and fewer children with respiratory infections were taken to health facilities. These findings suggest that while infrastructure and service access have improved, child health and nutrition remain areas of concern requiring focused policy intervention.

Table 2.1: Socio-demographic profile of West Bengal (2019-21)

Indicators	NFHS-IV (2015-1-6)	NFHS-V (2019-21)
A. Household Characteristics		
Households using improved drinking-water (%)	94.6	97.5
households that use an improved sanitation facility (%)	50.9	68
Households using clean cooking fuel (%)	27.8	40.2
Health insurance coverage (%)	33.4	29.3
B. Socio-Demographic Characteristics		
Sex ratio of the total population (females per 1,000 males)	1,011	1,049
Literate women (%)	70.9	76.1
Literate men (%)	81.1	81.6
Use of Internet among women (%)	na	25.5
Use of internet among men (%)	na	46.7
Neonatal mortality rate (NNMR)	22.0	15.5
Infant mortality rate (IMR)	28	22
Under-five mortality rate (U5MR)	32	25.4
Institutional births (%)	75.2	91.7
C. Child Characteristics (*Children under 5 years)*		
Children aged 12-23 months fully vaccinated	92.5	90.8
Prevalence of diarrhoea (%)	5.9	6.5
Prevalence of acute respiratory infection (ARI)	3.3	2.8
Children with ARI taken to a health facility or health provider (%)	73.5	71.3
Prevalence of stunted (height-for-age) (%)	32.5	33.8
Prevalence of wasted (weight-for-height) (%)	20.3	20.3
Prevalence of underweight (weight-for-age) (%)	31.6	32.2
Children who are anaemic aged 6-59 months (<11.0 g/dl) (%)	54.2	69

Source: *National Family Health Survey (NFHS-IV, 2015-16 &NFHS-V, 2019-21)*

2.4.2 Birth Death and Infant Mortality Rate of West Bengal

The Sample Registration System (SRS) provides annual estimates of birth, death, and mortality rates in India, including across its State/UTs. According to the latest SRS data from 2022, West Bengal has lower birth, death, and infant mortality rates than the national averages (Table 2.2).

Table 2.2: Birth, Date and Infant mortality rate in West Bengal, India in 2022

Component	India	West Bengal
Births Rate (per 1000 population)	19.5	14.6
Death Rate (per 1000 population)	6	5.5
Infant Mortality Rate (per 1000 live births)	28	19

Source: Sample Registration System (2022). Available from: *https://censusindia.gov.in/census.website/data/SRSB*

2.4.3 Human Development Index

The 2023-24 Human Development Report (HDR) titled 'Breaking the Gridlock: Reimagining Cooperation in a Polarised World' reveals that India is ranked 134 on the global Human Development Index (HDI) (HDR, 2024). Switzerland has been ranked number one. India's HDI score has shown improvement from 2011-12 to 2017-18, and this progress has been observed in most States/Union Territories (UTs). For instance, Goa, Delhi, and Chandigarh have been classified in the very high HDI category in 2017-18. However, several States/UTs including Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Dadra & Nagar Haveli, Daman & Diu, Gujarat, Jammu & Kashmir, Jharkhand, Lakshadweep, Madhya Pradesh, Manipur, Nagaland, Odisha, Rajasthan, Tripura, Uttar Pradesh, and West Bengal were still classified in the medium HDI category in 2017-18. The HDI rank of West Bengal decreased from 25 (HDI score of 0.635) in 2012 to 24 (HDI score of 0.674) in 2018 (Gendering Human Development).

2.4.4 Morbidity Profile among Children in West Bengal

According to National Family Health Survey (NFHS), in West Bengal the prevalence of ARI has reduced from 3.3% in NFHS-4 (20015-16) to 2.8% in NFHS-5 (2019-20). In the case of diarrhoea it has increased from 5.9% to 6.5% at the same time. Similarly, malnutrition status (Stunting, wasting, and underweight) also showing the increasing trend from NFHS-4 to NFHS-5 (IIPS, 2017; IIPS, 2021).

2.4.5 Morbidity Profile among Children in Different Districts of West Bengal

Table 2.3 describes the prevalence of various morbid conditions among children in different districts of West Bengal. In Purba Bardhaman (study district), the prevalence of diarrhea is 3.3%, which is lower than the prevalence in the rest of West Bengal (6.5%). However, the prevalence of ARI (acute respiratory infections) is higher in Purba Bardhaman compared to the prevalence in West Bengal and India. Furthermore, this district has the second highest prevalence of ARI in West Bengal, following Haora district.

Table 2.3: Prevalence of different types of morbidity among children (0-59 months) in West Bengal in 2021

Districts Name	Diarrhoea	ARI	Stunted	Wasted	Underweight
Bankura	12.7	4.3	30.3	26	38.8
Birbhum	9.5	4.7	37	25.5	41.8
Dakshin Dinajpur	2.7	2.1	31.9	22.8	30.2
Darjeeling	6.6	3.1	34.3	20.6	31.6
Haora	6.6	5.6	27.5	21.3	27.3
Hugli	11.2	0.8	28.9	20	33.4
Jalpaiguri	4.3	2.1	28.9	18.3	25.4
Koch Bihar	4.5	2.5	28.7	16.8	22.5
Kolkata	5.6	2.6	29.6	29.3	32.9
Maldah	5.5	2.3	40.5	20	35.3
Murshidabad	7.8	2.4	39.8	16.3	32.4
Nadia	5.9	3.3	26.1	17.6	25.1
North Twenty-Four Parganas	2	2	32.4	13.3	23.6
Paschim Bardhaman	8.8	2	39.7	25.5	41
Paschim Medinipur	6.3	1.4	31.1	30.3	40
Purba Bardhaman	**3.3**	**5**	**32.7**	**21.1**	**31.6**
Purba Medinipur	8.9	3.8	25.8	15.5	30.6
Puruliya	9	4	36.9	29.4	46.3
South Twenty-Four Parganas	4.5	1.6	36.7	21.2	32.2
Uttar Dinajpur	7.9	4.3	44.8	16	32
West Bengal	**6.5**	**2.8**	**33.8**	**20.3**	**32.2**

Source: *National Family Health Survey-V (NFHS-V, 2019-21); ARI: Acute Respiratory Infection*

2.4.6 Public Health Facilities in West Bengal:

Distribution of Public Health Facilities in West Bengal:

The figure (**Figure 2.4**) describes the availability of public health facilities in West Bengal. Around 10,357 SCs are available in West Bengal. On the other hand, a total of 1,369 PHCs 348 CHCs, 60 sub-division hospitals and 18 district hospitals are available. The CHCs are designed to provide some specialist services under the NHM. Additionally, 24 medical colleges are available to provide higher level of services.

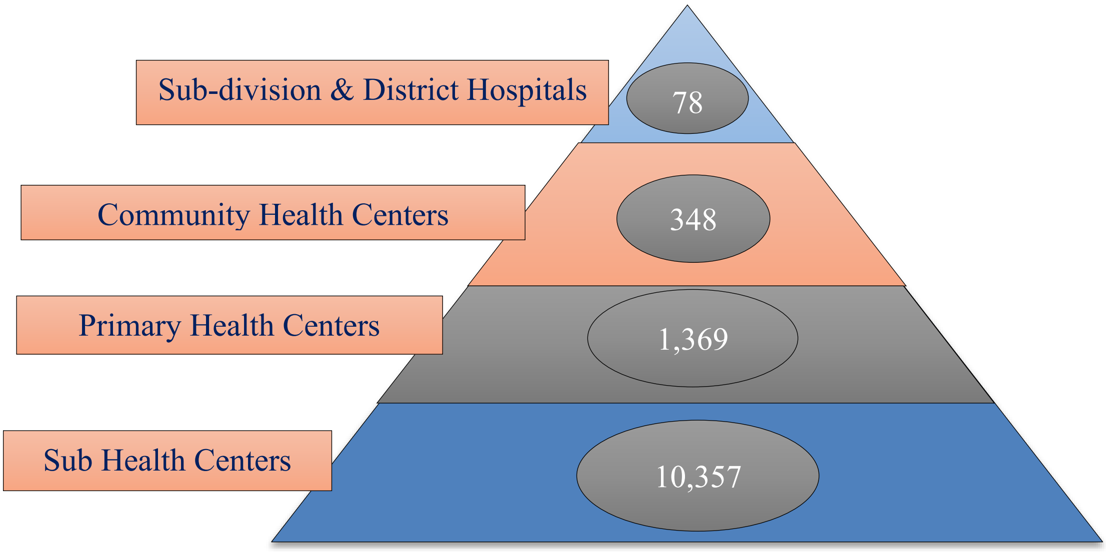


Figure 2.4: Distribution of Public Health Facilities in West Bengal

Distribution of Public Health Facilities in across the districts of West Bengal: The table below represents the distribution of public health facilities across the districts in West Bengal. In terms of Primary Health Centres (PHCs), North Twenty-Four Parganas has the highest number with 149 PHCs, while Kalimpong has the lowest at just 6. For Community Health Centres (CHCs), South Twenty-Four Parganas leads with 30 CHCs, whereas Kolkata has none. When it comes to Sub-District Hospitals (SDHs), North Twenty-Four Parganas again tops the list with 10, while districts like Kolkata, Jhargram, and Kalimpong have none. Regarding District Hospitals (DHs), Darjeeling and Purba Medinipur have the highest count with 2 each, while several districts including Koch Bihar, Maldah, Murshidabad, Paschim Medinipur, Purba Bardhaman, Puruliya, and Uttar Dinajpur have no district hospital at all (Table 2.4). These disparities highlight the uneven distribution of healthcare infrastructure across the state.

Table 2.4: ***Distribution of Public Health Facilities across the districts of West Bengal, India***

Districts	SHCs	PHCs	CHCs	SDH	DH
Alipurduar	236	14	7	1	1
Bankura	564	73	22	1	1
Birbhum	484	62	19	1	1
Dakshin Dinajpur	248	22	8	1	1
Darjeeling	181	28	9	1	2

Districts	SHCs	PHCs	CHCs	SDH	DH
Haora	448	74	15	7	1
Hugli	660	89	18	4	1
Jalpaiguri	301	27	7	1	1
Jhargram	219	26	8	0	1
Kalimpong	49	6	3	0	1
Koch Bihar	406	38	12	4	0
Kolkata	0	144	0	0	0
Maldah	511	40	16	1	0
Murshidabad	832	83	27	4	0
Nadia	469	64	17	5	1
North Twenty-Four Parganas	742	149	22	10	2
Paschim Bardhaman	173	61	9	1	1
Paschim Medinipur	639	68	21	2	0
Purba Bardhaman	592	83	25	2	0
Purba Medinipur	706	59	24	4	2
Puruliya	485	55	20	1	0
South Twenty-Four Parganas	1068	80	30	7	1
Uttar Dinajpur	344	24	9	2	0
West Bengal	**10357**	**1369**	**348**	**60**	**18**

Health Facility Functionality Against Requirements in West Bengal:

As per the Rural Health Statistics (RHS) 2017-18, the state-wise details of shortfall of public healthcare facilities viz, Sub Health Centres (SHCs), Primary Health Centres (PHCs) & Community Health Centres (CHCs), availability of Sub District Hospitals & District Hospitals and vacancy position of doctors at PHCs and CHCs are given below (Table 2.5).

In West Bengal, there is a clear inequality in the availability of health facilities. For Sub-Health Centres (SHCs), only 10,357 are available, far fewer than the required 13,083, resulting in a shortfall of 2,726. Similarly, Primary Health Centres (PHCs) are significantly underprovided, with just 913 available out of the needed 2,153, creating a shortfall of 1,240. For Community Health Centres (CHCs), there are 348 available, while 538 are required, leading to a shortfall of 190. These disparities in availability highlight the urgent need to address the gaps in healthcare infrastructure across the state.

Table 2.5: Shortfall of Health Centres (As per 2011 Census Population) in West Bengal

Type of Health Facility	Required	In Position	Shortfall
SHC	13083	10357	2726
PHCs	2153	913	1240
CHCs	538	348	190

Source: PIB, GoI (2020) [https://pib.gov.in/PressReleasePage.aspx?PRID=1595208]

***Distribution of Human Resources in West Bengal*:**

The distribution of Hunam Resources in health care facilities has been described in table 2.6. Interesting to see in the CHCs 25 paediatricians are available to provide service on child health care in the state.

Table 2.6: Distribution of Human Resources in West Bengal

<table>
<tr><th>Staff Designation</th><th>Rural</th><th>Urban</th></tr>
<tr><td>A. Sub Health Centres</td><td></td><td></td></tr>
<tr><td>Health Worker (Male & Female)</td><td>19619</td><td></td></tr>
<tr><td>B. Primary Health Centres</td><td></td><td></td></tr>
<tr><td>Health Worker (Female)</td><td>0</td><td>733</td></tr>
<tr><td>Doctors/Medical Officer</td><td>1247</td><td>560</td></tr>
<tr><td>Pharmacists</td><td>805</td><td>319</td></tr>
<tr><td>Lab Technicians</td><td>195</td><td>403</td></tr>
<tr><td>Staff Nurse</td><td>1822</td><td>407</td></tr>
<tr><td>C. Community Health Centres</td><td></td><td></td></tr>
<tr><td>GDMOs/Medical Officer</td><td>1538</td><td>5</td></tr>
<tr><td>Surgeons</td><td>0</td><td rowspan="4"></td></tr>
<tr><td>Obstetricians & Gynaecologist</td><td>49</td></tr>
<tr><td>Physician</td><td>0</td></tr>
<tr><td>Paediatricians</td><td>25</td></tr>
<tr><td>Radiologist</td><td>163</td><td>0</td></tr>
<tr><td>Pharmacist</td><td>572</td><td>2</td></tr>
<tr><td>Lab Technician</td><td>704</td><td>1</td></tr>
<tr><td>Nursing Staff</td><td>3809</td><td>7</td></tr>
<tr><td>D. Sub-Division Hospital</td><td></td><td></td></tr>
<tr><td>Doctors & Specialist</td><td colspan="2">2243</td></tr>
<tr><td>Paramedical Staff</td><td colspan="2">7950</td></tr>
<tr><td>E. District Hospital</td><td></td><td></td></tr>
<tr><td>Doctors & Specialist</td><td colspan="2">743</td></tr>
<tr><td>Paramedical Staff</td><td colspan="2">3627</td></tr>
</table>

Source: *Health Management Information System:* https://www.hmis.mohfw.gov.in/ (Health Dynamics in India, 2022-23)

Distribution of Public Health Facilities in Purba Bardhman District:

The figure (***Figure 2.5***) describes the availability of public health facilities in the districts of Purba Bardhhaman. Around 821 SCs are available in rural areas. On the other hand, a total of 83 PHCs are available of which 74 are in rural areas whereas 9 PHCs are in urban areas. There are 25 CHCs available in the rural part. The CHCs are designed to provide some specialist services under the NHM. There are 2 sub-divisional hospitals located in the districts although no district Hospital is available. Only 1 Medical College is available.

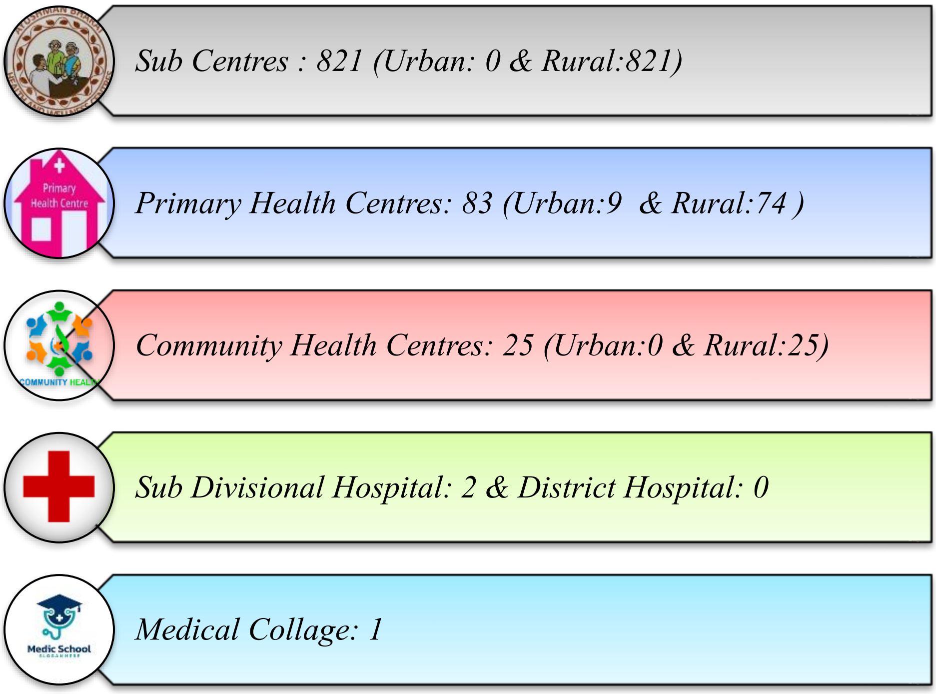


Figure 2.5: Public Health Facilities in Purba Bardhman District of West Bengal

2.4.7 Profile of the Selected Districts

The name Bardhamana originates from a distortion of the Sanskrit word Vardhamana, translated to "The increasing or prosperous" in English. Situated in the Burdwan Division, the Purba Bardhaman district is strategically located between the latitudes of 23°53′ N and 22°56′ N and longitudes of 88°25′ E and 87°56′ E. Spanning an area of 5432.69 square kilometres, it boasted a population of 4,835,532 as per the 2011 Census of India. Following a bifurcation in 2017, the district's population was comprised of 2,469,310 males (51%) and 2,366,222 females (49%), with approximately 726,345 individuals (15.02%) residing in urban regions (Census 2011). Bardhaman (Purba and Paschim) is also famously known as the rice bowl of Bengal, highlighting its agricultural significance. The other socio-demographic characteristic has been mentioned below in ***Table 2.7***:

Table 2.7: Socio-demographic profile of Purba Bardhaman (2019-21)

Indicators	NFHS-V (2019-21)
A. Household Characteristics	
Households using improved drinking-water (%)	99.1
households that use an improved sanitation facility (%)	64.2
Households using clean cooking fuel (%)	32.1
Health insurance coverage (%)	37.2
B. Socio-Demographic Characteristics	
Sex ratio of the total population (females per 1,000 males)	1,067
Literate women (%)	73.2
Institutional births (%)	97.2
C. Child Characteristics (Children under 5 years)	
Children aged 12-23 months fully vaccinated	90.8
Prevalence of diarrhoea (%)	3.3
Prevalence of acute respiratory infection (ARI)	5
Children with ARI taken to a health facility or health provider (%)	56.6
Prevalence of stunted (height-for-age) (%)	32.7
Prevalence of wasted (weight-for-height) (%)	21.1
Prevalence of underweight (weight-for-age) (%)	31.6
Children who are anaemic aged 6-59 months (<11.0 g/dl) (%)	71.5

Source: *National Family Health Survey-V (NFHS-V, 2019-21)*

In Purba Bardhaman district, nearly everyone has access to improved drinking water. However, there are still issues with sanitation and clean cooking fuel, which can impact people's health. Additionally, many families do not have health insurance, making them vulnerable to financial difficulties during medical emergencies. In terms of socio-demographic characteristics, the region has a good gender balance, and a good numbers of institutional birth.. Nonetheless, there is a disparity in literacy levels between men and women that requires attention. When it comes to child characteristics, many children suffer from malnutrition, with high rates of stunting, wasting, and anemia. While a considerable number of children receive vaccinations, more efforts are needed to improve their overall health and access to healthcare, particularly for respiratory infections.

2.4.8 Profile of the Selected Block and Villages

The table (***Table 2.8***) provides demographic and social data for selected villages in the Manteswar block. The total population across these villages varies, with Shushuna having the highest population (3,722) and Kalswar the lowest (590). The population of children aged 0-6 years is significant, ranging from 6.2 percent in Budhpur to 12.3 percent in Kuli, with an average of 11.3% for the entire block. Female literacy rates show considerable variation, with Budhpur having the highest at 98.73 percent, while Kalswar has the lowest at 54.48 percent. Overall, the block has an average female literacy rate of 67.9 percent, indicating moderate educational attainment with variations in literacy levels among the villages.

Table 2.8: Profile of the selected villages from the block in the study area

Sl. No	***Village***	***AWCs***	**HHs**	***Total Population***	***(0-6) years population (%)***	***Female literacy (%)***
1	Shushuni	3	580	2590	10.8	57.84
2	Ataspur	2	203	787	7.8	78.59
3	Hosenpur	2	170	796	8.9	80.64
4	Ghoradanga	2	308	1406	11.6	67.59
5	Shushuna	4	842	3722	10.9	65.46
6	Jaypur	2	183	740	12.2	62.92
7	Panbarea	2	370	1800	11.9	69.45
8	Kalui	2	460	1949	11.3	66.90
9	Kuli	2	271	1172	12.3	58.14
10	Budhpur	1	161	690	6.2	98.73
11	Kalswar	1	141	590	11.2	54.48
12	Bhojpur	3	686	2914	12.1	61.54
Manteswar (Block)			54082	237398	11.3	67.9

Source: *Census India, 2011*

2.5 Sampling

2.5.1 Sampling Design

In the 2011 Census, the Monteswar block was reported to consist of 144 villages. Out of these, we excluded 20 villages as they have fewer than 100 households each. From the remaining pool, one village was randomly chosen as the starting point. Based on this initial selection, an additional 11 villages located in its vicinity were chosen, bringing the total to 12 selected villages. This selection strategy aimed at clustering the villages to reduce costs and time associated with the study. To facilitate the identification of under-five children within these villages, we compiled a list of Anganwadi Centers (AWCs) present in each. From this list, we chose the AWCs with the highest enrollment in each of the 12 villages, resulting in a total of 12 AWCs being selected. The distribution of the total estimated sample size was then calculated using the Probability Proportionate to Size method across the chosen AWCs, based on their enrollment figures. Finally, the children were selected through a process of simple random sampling without replacement. This methodical approach ensured a structured and efficient sampling process.

2.5.2 Sample Size Calculation

We estimated the sample size for the study in Purba Bardhman by considering the prevalence of ARI. The total calculated sample for the study is 288. Considering a 10 percent non-response rate, we will collect 302 samples for the study. We had to exclude six samples because they refused to answer. So, finally, we have 296 samples for the final analysis.

Formula:

$$\text{Sample Size (N)} = \frac{z^2\ x\ p(1-p)}{\varepsilon^2}$$

$$N = \frac{3.86^2\ x\ 0.05(1-0.05)}{0.05^2}$$

$$N = 288$$

Final Sample Size =288+14 (by taking 5% non-response rate)

=302

Whereas,

N is the population size
Z is the z-score
p̂ is the estimated prevalence of the study area (5%)
ε is the margin of error (5%)

2.5.3 Estimated Sample Size from the Selected Villages and AWCs

Table 2.9 represents the estimated sample size from the selected village and AWCs. The table contains data on child enrolment (0-6 years) in Anganwadi Centers (AWCs) across 12 villages. The combined child enrollment for all villages is 633, with each village contributing a varying proportion to the total. A sample size calculation suggests an estimated 302 samples from the selected 12 villages. The specific sample sizes for each village are outlined in the table, ranging from 14 in Budhpur to 44 in Bhojpur, reflecting proportional child enrolments.

Table 2.9: Estimated sample Size from the selected Villages and AWCs

Sl. No	*Name of the Village*	*Selected AWC Name*	*Child Enrolment (0-6 Years)*	*Proportion*	*Sample Size*
1	Shushuni	Susunia F P School	64	0.1	31
2	Ataspur	Atashpur Muslimparal AWC	80	0.13	38
3	Hosenpur	Hassainpur AWC	40	0.06	19
4	Ghoradanga	Ghoradanga Dharabahik Shikha Kendra AWC	53	0.08	25
5	Shushuna	Tara Susuna AWC	46	0.07	22
6	Jaypur	Jaypur F P School AWC	47	0.07	22
7	Panbarea	Panbaria Masjidtala	69	0.11	33
8	Kalui	Kalui AWC	37	0.06	18
9	Kuli	Kuli AWC	37	0.06	18
10	Budhpur	Budpur F P School	30	0.05	14
11	Kalswar	Kalswar F P School	37	0.06	18
12	Bhojpur	Vojpur 1 No F P School	93	0.15	44
Total			**633**	**1**	**302**

Source: *Authors' calculation*

2.5.4 Response Rate

The table displays data on the sample size, obtained sample, and response rate from various Anganwadi Centers (AWCs) in different villages (Table 2.10). Overall, the response rate is 98 percent, indicating a highly successful survey effort with minimal non-response issues. The majority of the villages achieved complete or near-complete participation, which enhances the reliability of the collected data. Some responses from 3 villages were excluded from the sample due to incomplete information.

Table 2.10: Response Rate from the selected village and AWCs

Sl. No	*Name of the Village*	*Selected AWC Name*	*Estimated Sample Size (N)*	*Obtained Sample (N)*	*Response Rate (%)*
1	Shushuni	Susunia F P School	31	31	100.0
2	Ataspur	Atashpur Muslimparal AWC	38	37	97.4
3	Hosenpur	Hassainpur AWC	19	19	100.0
4	Ghoradanga	Ghoradanga Dharabahik Shikha Kendra AWC	25	24	96.0
5	Shushuna	Tara Susuna AWC	22	22	100.0
6	Jaypur	Jaypur F P School AWC	22	22	100.0
7	Panbarea	Panbaria Masjidtala	33	33	100.0

Sl. No	*Name of the Village*	*Selected AWC Name*	*Estimated Sample Size (N)*	*Obtained Sample (N)*	*Response Rate (%)*
8	Kalui	Kalui AWC	18	14	77.8
9	Kuli	Kuli AWC	18	18	100.0
10	Budhpur	Budpur F P School	14	14	100.0
11	Kalswar	Kalswar F P School	18	18	100.0
12	Bhojpur	Vojpur 1 No F P School	44	44	100.0
Total			**302**	**296**	**98.0**

Source: *Authors' calculation*

2.6 Data Collection

2.6.1 Study Participants

To fulfil the objectives of this research, we have decided to examine the responses provided by mothers to their children aged less than 5. In instances where mothers have more than two children within this specified age group, we have select the resources pertaining to the youngest child. This method was adopted to reduce the recall was adopted to maintain the accuracy of the data.

2.6.2 Data Collection Tool

We have collected the primary data with the help of a structured questionnaire (See ***Annexure: II)***. The questionnaire schedule includes household, maternal and child characteristics. It also includes questions related to knowledge, Attitude, and practices among mothers for their children. Furthermore, treatment cost and health-seeking behaviour were also captured for the children who had ARI before the two weeks of the survey. A consent has been taken from the every selected respondent before the data collection (See ***Annexure: I***). The Census and Survey Processing System (CSPro) data entry software is used to collect household locations and enter the survey data. We have divided our tools into five different sections:

A. **Section I:** Socio-Demographic
B. **Section II:** Household Living Condition
C. **Section III:** Maternal characteristics
D. **Section IV:** Children Characteristics
E. **Section V:** Mother’s Knowledge, Attitude & Practices

A. *Socio-demographic section:* This part contains general questions about religion, caste, ration card, family size, family type, household annual income, and family history of ARI illness.
B. *Household living condition section:* In this part, we asked questions about the household and living environment, including the nearby landmarks (such as paved road, poultry farm, or rice mill), house type, availability of electricity, smoking habits of household members, main source of cooking fuel, location and environment for cooking, presence of a separate kitchen and ventilation, frequency of cooking, presence of children during cooking, water source and sanitation facilities, and household members' contact with pets or domestic animals.
   The highlighted indicators are new ones we used in the current survey, which were not used in the NFHS survey.
C. *Maternal Characteristics section:* This includes information on the mother's age, education, occupation, total number of children, place of delivery for the last child, type of delivery, birth weight of the child, early initiation of breastfeeding, any illnesses in the previous 12 days, and exposure to mass media (such as reading newspapers, listening to the radio, or watching TV).
D. *Child characteristics section:* This part covers the child's age, height, weight, nutritional status, immunization status, occurrences of diarrhea in the last 12 days, frequency of diarrhea episodes, common child illnesses (fever, cough, difficulty breathing, etc.), and questions related to ARI and its frequency.
E. *Mother's Knowledge, Attitude, & Practices section:* In this section, we asked mothers about their knowledge, attitudes, and practices related to their children's ARI. For more details, please refer to annexure II.

2.6.3 Data Collection Experience

Process of data collection and Period: The institution verified the study tool and approved the data collection. Before initiating the field visits, we approached the gram panchayat level officer of the selected. We also visited the selected Anganwadi Centers (AWCs) from the village and collected the list of the children. We hired two investigators to streamline and facilitate the data collection process. Understanding the importance of preparedness, we provided these investigators with a comprehensive training program encompassing both online and offline modules to equip them with the necessary skills and knowledge.We started our data collection journey on August 10, 2022. Within three months, we completed all the data collection on October 12. A consent was obtained from the children's mother.

Data Collection Approval: Permission for data collection was granted by the university's authority of the Gokhale Institute of Politics and Economics (GIPE) after reviewing the questionnaires on 1st August (Annexure III).

Target Population: We have decided to examine the responses provided by mothers to their children aged less than 5. If mothers have more than two children within this specified age group, we have to select the resources from the youngest child only, to reduce the recall bais and maintain the accuracy of the data.

Gathering the information: We have collected the primary data with the help of a structured questionnaire. The questionnaire schedule includes household, maternal and child characteristics. It also includes questions related to knowledge, Attitude, and practices among mothers for their children. Furthermore, treatment cost and health-seeking behaviour were also captured for the children who had ARI before the two weeks of the survey. A consent has been taken from every selected respondent before the data collection.

Challenges and experience during the field visit: Some of the good experiences and some challenges have been described that we faced during our field visit. These are:

- As we converted our tool in local language (Bengali) so we didn't face any language barrier problem.
- The AWCs and villagers are very cooperative and help me a lot to collect the information. Some of the respondents come forward and show on interest what we are doing in the field.
- Some of the villagers help me to get the children help us to get the children from the listed children.
- The villages located in remote areas delays in reaching some households.
- Some of the AWCs denay to give children information. But after explaining the purpose and confidentiality they give the details.
- One AWCs were replaced as the AWCs teacher not given approval for the survey so we have selected second highest enrolment AWCs from Bhajpur village.
- Some of the household dropped in the middle of the survey. So, we have excluded then as non-response.

Team and Coordination: We have hired three investigator and trained them about every question listed in the questionnaire schedule. A total of two offline training has been given to them in the last week of July. The investigators were graduate students and local in the area. Collaboration with local community leaders also played a crucial role in the smooth execution of the study. They provided valuable insights into the cultural dynamics of the villages and helped establish trust between the field team and the participants.

Technological Support: An application has been created to get the household location. CSPro data entry software was installed to their smart phone.

Data Quality and monitoring: To maintain the reliability and validity and good quality of data every day monitoring and follow-up from the investigator were done. In around 8 percent of respondents, schedules were revised after revisiting the household.

Impact on research: This primary data provided valuable insights into the risk factors, economic burden of ARI, and the factors influencing health-seeking behaviour and mothers' knowledge attuited and practices in rural West Bengal. It will significantly contribute to the policy recommendations arising from rural West Bengal.

2.7 Data Analysis Software

To analyze the data effectively, we employed a range of software to meet the specific requirements. This included the use of STATA 16, ArcGIS 10.8, GeoDa, and CsPro.

2.7.1 STATA

STATA is a robust statistical software package for various purposes, including data management, statistical analysis, and graphical representation. It is a popular choice among researchers across multiple domains, such as economics, sociology, political science, biostatistics, and epidemiology. The software has key features such as advanced data management capabilities, extensive statistical analysis tools, sophisticated graphical representation options, versatile programming functionalities, and a supportive user community.

2.7.2 ArcGIS

ArcGIS is an all-encompassing geographic information system (GIS) developed by Esri. Its functionalities extend to creating, managing, analyzing, and visualizing spatial data, making it an essential tool in urban planning, environmental science, natural resource management, and public health. With robust features like mapping, spatial analysis, data management, and visualization, ArcGIS effectively supports geospatial workflows across various disciplines.

2.7.3 GeoDa

GeoDa, developed by the Center for Spatial Data Science at the University of Chicago, is an open-source software package for spatial data analysis. It specializes in exploratory spatial data analysis (ESDA) and spatial econometrics, offering key features such as comprehensive data visualization and in-depth spatial statistics tools.

2.7.4 CsPro

CsPro, short for Census and Survey Processing System, is a software package the U.S. Census Bureau designed for data collection, processing, and analysis. It is widely used for large-scale surveys and census-related activities. The software's key features include robust data entry and efficient data processing capabilities.

2.2 Methodology

For Objective 1:

To show the prevalence and identify the spatial clustering of ARI in India's children under five years of age we have employed the methodology below:

Measurement of variables:

2.2.1 Computation of Prevalence of Acute Respiratory Infection (ARI)

Prevalence of ARI is defined as the "number of under 5 children suffering with symptoms of ARI at any time in the 2 weeks preceding the survey out of the total number of living children less than 5 years of age" (NFHS). According to the NFHS definition ARI consists of a cough accompanied by:

a. Short, rapid breathing that is chest-related, and/or
b. Difficult breathing that is chest related.

Prevalence of ARI

$$= \frac{\begin{array}{c} Number\ of\ children\ under\ age\ 5\ with\ symptoms\ of\ ARI \\ at\ any\ time\ in\ the\ 2\ weeks\ preceding\ the\ survey \end{array}}{Number\ of\ living\ children\ under\ age\ 5} \times 100$$

2.2.2 Computation of Absolute Change:

Absolute change has been computed to measure the spatial temporal changes in the prevalence of ARI between 2016-2021. It is the simple difference in the indicator between two different s periods of time. An absolute change refers to the actual increase or decrease from a reference value to a new value and is synonymous with the term "difference." Mathematically, it is calculated as the new value minus the reference value (Absolute change = new value − reference value).

$$\mathbf{AC=T_2-T_1}$$

Whereas,
AC*=Absolute change*
$\boldsymbol{T_1}$*= Prevalence of ARI among under five children in the year T1 (2016)*
$\boldsymbol{T_2}$*= Prevalence of ARI among under five children in the year T2 (2021)*

2.2.3 Spatial clustering analysis

Spatial Analysis:
Spatial analysis refers to "a general ability to manipulate spatial data into different forms and extract additional meaning as a result" (Singh et al., 2017). Specifically, spatial analysis comprises a body of techniques "requiring access to both the locations and the attributes of objects" (Monica et al., 2009). Spatial statistics measure geographic differences in geographical factors and can detect breaches of the independence assumptions necessary for many epidemiological statistics. They also gauge the ways in which populations, their attributes, covariates, and risk factors differ in geographical areas. Geographical Information Systems (GIS) have a significant impact on healthcare, the surveillance of infectious diseases, and the monitoring of the spatial-temporal changes of disease vectors (Fletcher-Lartey and Caprarelli, 2016). GIS enables researchers to analyze the connections between spatial and temporal trends, risks, environmental factors, and health at all levels. Using GIS for spatial representation of health issues aids in faster conclusions and better decisions for public health planning (Ghosh et al., 2020).

2.2.4 Spatial Autocorrelation

The technique of spatial autocorrelation analysis are utilized to identify patterns of spatial clusters (Ghosh et al., 2020). We used two methods to analyze the data. The first method is

Moran's I, which provides a general indication of the spatial autocorrelation of a dataset. Another one is the local indicator of spatial association (LISA), which identifies spatial clusters or outliers for each location in a dataset.

The present study aims to investigate the geographical patterns and spatial clustering of ARI among children under five years of age across the 707 districts in India, using spatial analysis software such as ArcGIS 10.8 and GeoDa 1.18. To achieve this goal, the study employs Exploratory Spatial Data Analysis (ESDA) which helps to identify the clustering, spatial autocorrelation, and spatial heterogeneity in the prevalence of ARI among children. The study also uses Geographical Information System (GIS) and spatial statistical techniques to describe and represent the spatial distribution of ARI, to detect hot-spot and cold-spot areas, and to suggest spatial regimes or other forms of spatial heterogeneity. This approach is useful in previous studies (Ghosh et al., 2020) for understanding the distribution of health outcomes across geographical areas.

2.2.5 Moran's I

Measuring the overall clustering of a dataset across all districts can be done using global spatial autocorrelation, which quantifies the degree of spatial autocorrelation, and is often measured using Moran's I (***Figure 2.6***). Moran's I statistics is a summary measure of spatial autocorrelation that evaluates the extent to which data points are random or perfectly clustered and similar to their spatial neighbours (Anselin, 1995; Anselin, 2009; Bivand et al., 2022).

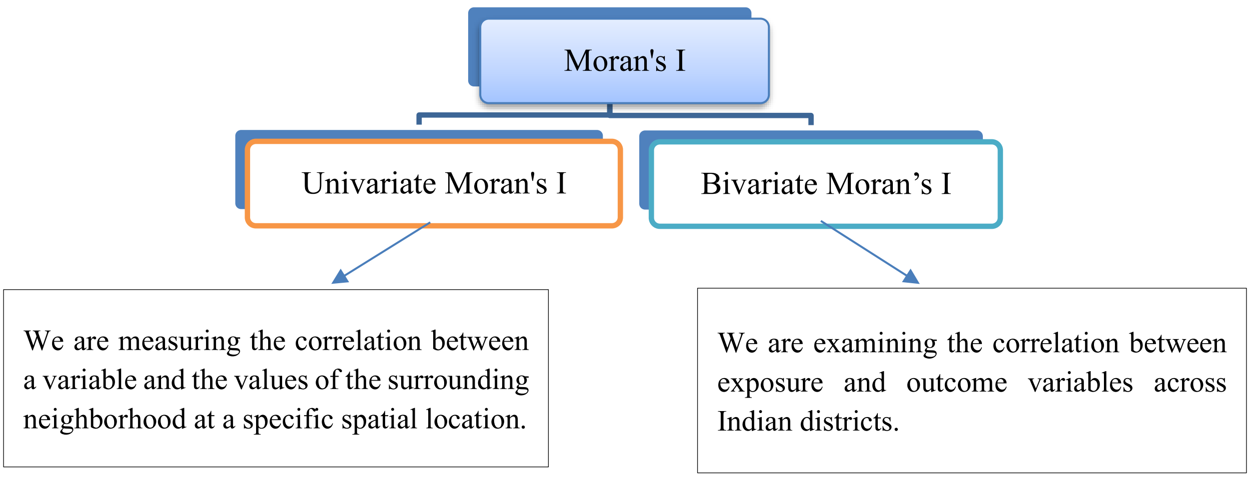
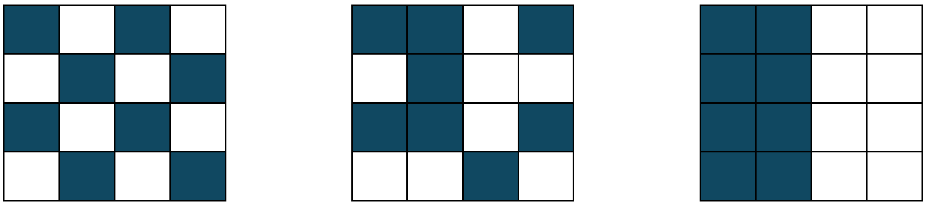


Figure 2.6: Types of Moran's I

To measure spatial autocorrelation it calculates a correlation coefficient that indicates the overall spatial autocorrelation of the dataset by measuring how similar an object is to its surrounding objects. The value of Moran's- I range from −1 to +1 (Anselin, 1995; Anselin, 2009; Ghosh et al., 2020; Bivand et al., 2022).



(A)Perfect Dispersion (B)Perfect Randomness (C)Perfect Clustering

Figure 2.7: Spatial Autocorrelation

- -1 represents the ideal clustering of dissimilar values. Negative (positive) values indicate a negative (positive) spatial autocorrelation, meaning that closely located points are more dissimilar (Figure 2.7-A).
- 0 indicates no autocorrelation, reflecting perfect randomness (Figure 2.7-B).
- +1 is described as a perfect clustering of similar values. Positive autocorrelation implies that points with similar attribute values are closely distributed in space (Figure 2.7-C).

2.2.6 Global and Local Moran's Index and Contiguity Weights:

Local and Global Moran's I is a local spatial autocorrelation statistic based on the Moran's I statistic. It was developed by Anselin(1995) as a local indicator of spatial association or LISA statistic. Anselin defines LISA statistics as having the following two properties:

- The LISA for each observation indicates the extent of significant spatial clustering of similar values around that observation; and
- The sum of LISAs for all observations is proportional to a global indicator of spatial association.

Contiguity Weights: Contiguity means that two spatial units share a common border of non-zero length. Operationally, we can further distinguish between a rook and a queen criterion of contiguity, in analogy to the moves allowed for the such-named pieces on a chess board.

Rook Contiguity: In Rook Contiguity, two areas are neighbors only if they share a common border (edge). It's more restrictive than Queen Contiguity, similar to the rook in chess, which only moves horizontally or vertically.

Bishop Contiguity: Bishop Contiguity defines neighbors only if they share a corner (vertex), not a full edge. This is the most limited of the three standard contiguity types and is less commonly used. It's similar to the bishop in chess, which moves diagonally.

Linear Contiguity: Linear Contiguity looks at spatial units that are directly connected in a linear sequence, like along a road, river, or corridor. It's often used in transport or network analysis rather than general geographic contiguity.

Double Linear Contiguity: This expands on linear contiguity by also including the neighbors of linear neighbors—essentially two steps away along a line. It adds a broader context to linear relationships.

Double Rook Contiguity: This includes both the immediate rook neighbors and their rook neighbors (i.e., neighbors of neighbors). It increases the range of spatial interaction and smooths the influence over a larger area.

Queen Contiguity: The Queen Contiguity matrix considers two areas as neighbors if they share either a border (edge) or a corner (vertex). This is the most inclusive type of contiguity. It's named after the queen in chess, which can move in all directions—horizontally, vertically, and diagonally. This method captures more spatial connections and is commonly used in GIS for accurate spatial pattern detection. Here, neighbors are defined based on physical distance rather than shared borders or corners. Units within a specified distance threshold (e.g., 10 km) are considered neighbors. This method is flexible and often used when geographic or Euclidean distance is more meaningful than administrative boundaries.

The computation of spatial autocorrelation requires the construction of matrix known as spatial weight matrix (W). For the construction of matrix, we define neighbourhood by assigning spatial contiguous weights (queen's weight) that include all common points. We use Moran's I Index and Local Indicators of Spatial Autocorrelation (LISA) to measure the extent of autocorrelation among the neighbourhood districts. The LISA values consent the computation of its similarity with its neighbour districts and also test the level of significance for each location.

We have used Queen's Contiguity Matrix in the study for some specific reason, which are explained below:

- The Queen's Contiguity Matrix is used in GMI and LMI analysis because it provides a more complete way of defining neighbors. It considers both shared edges and shared corners between spatial units, unlike the Rook's matrix which only includes shared edges. This means it captures more connections between areas, which helps to better understand how values are related in space.

- Using the Queen's matrix improves the ability to detect spatial patterns, especially local clusters and outliers. This is very helpful when using Local Moran's I (LMI), as it can show where high or low values are grouped together or stand out from their surroundings.
- The Queen's matrix works well in areas with irregularly shaped regions, like cities or rural districts, because it includes more flexible definitions of neighborhood. This helps make sure important spatial relationships are not missed in the analysis.
- The Queen's Contiguity Matrix is widely used in previous studies, so using it allows for easier comparison with other research. It also supports more accurate results in both Global Moran's I and Local Moran's I by including all meaningful spatial connections.

Accordingly, applying the Queen's Contiguity Matrix in this research is well-justified. It supports more accurate results in both Global Moran's I (GMI) and Local Moran's I (LMI) and ensures that the spatial analysis reflects the true nature of geographic connections.

2.2.7 Local Indicators of Spatial Autocorrelation (LISA)

Local Indicators of Spatial Autocorrelation (LISA) measures the extent of autocorrelation among the neighbourhood districts. The LISA values consent the computation of its similarity with its neighbour districts and test the level of significance for each location. LISA map portrays results in three scenarios-

- **Hot Spots**
  - High-high: High values with similar neighbours.
- **Cold Spots:**
  - Low-low: Low values with similar neighbours.
- **Spatial Outliers**
  - Low-high: Low values but with higher values of neighbours.
  - High-low: High values but with low-value neighbours.
  - no significant local autocorrelation

The univariate and bivariate Moran's I index measurements and spatial regression models were performed to assess the distribution of Acute Respiratory Infection among children in India.

Univariate Moran's I: A Univariate Moran's I analyzes the spatial autocorrelation of neighbouring values around a particular spatial location, which indicates how much spatial non-stationery and clustering is present in data. The formula used to calculate the Moran's I index is as follows:

$$\text{Univariate Moran's I} = \frac{n}{So} \times \frac{\sum_i \sum_j W_{ij}(x_i - \overline{X})[x_j - \overline{X}]}{\sum_i [x_i - \overline{X}]}$$

Whereas

x= *is* the variable of interest

$\overline{X} = is\ the\ mean\ of\ x$

$n = is\ the\ number\ of\ spatial\ unit$

W_{ij} = is *the standardized weight matrix between observation i and j with zeroes on the diagonal*

$So = is\ the\ aggregate\ of\ all\ spatial\ weights$

$i.e\ So = \sum_i \sum_j W_{ij}$

Bivariate Moran's I: Bivariate Moran's I looks at the local correlation between the outcome variable and particular region characteristics (Anselin, 2013; Bivand et al., 2022).

$$\text{Bivariate Moran's I} = \frac{n}{So} \times \frac{\sum_i \sum_j W_{ij}(x_i - \overline{X})[y_i - \overline{Y}]}{\sum_i [y_i - \overline{Y}]}$$

Whereas

X and y: are the variables of interest

$\overline{X} = is\ the\ mean\ of\ x$

$\overline{Y} = is\ the\ mean\ of\ y$

$n = is\ the\ number\ of\ spatial\ units$

W_{ij} = is *the standardized weight matrix between observation i and j with zeroes on the diagonal*

$So = is\ the\ aggregate\ of\ all\ spatial\ weights$

$i.e\ So = \sum_i \sum_j W_{ij}$

Univariate LISA: Univariate LISA is a method used to measure the spatial correlation of neighborhood values around a particular location (Bivand et al., 2022). This technique can help determine the spatial randomness and clustering level in the data. The formula for calculating the Univariate LISA $[I_i]$ measure is as follows:

$$\textbf{Univariate LISA}: \boldsymbol{I_i = \frac{n.(x_i - \overline{X})}{\sum_i [x_i - \overline{X}]^2} \sum_i \sum_j W_{ij}(x_i - \overline{X})}$$

Bivariate LISA: Bivariate LISA was estimated to analyze the association between certain district characteristics and ARI prevalence. The bivariate LISA is presented below:

$$\textbf{Bivariate LISA}: I_i = \frac{n.(x_i - \overline{X})}{\sum_i [y_i - \overline{Y}]^2} \sum_i \sum_j W_{ij}(y_i - \overline{Y})$$

The spatial weights are only non-zero when two units, i and j, are neighbors (Anselin, 1995; Anselin et al., 2009**)**. Otherwise, it remains zero. As described by Anselin in 1995 and 2010, this method uses Queen Contiguity weights to represent whether spatial units share a boundary. If we denote the set of boundary points of unit I as the band (i), then we can define the Queen Contiguity Weight as follows:

$$W_{ij} = \begin{cases} 1, bnd\ (i)\ \cap bnd\ (j) \neq \emptyset \\ 0, bnd\ (i)\ \cap bnd\ (j) \neq \emptyset \end{cases}$$

It is possible for spatial units to share only one boundary point, such as a shared corner point on a grid of spatial units. However, a stronger condition is to require that some positive portion of their boundary be shared.

2.2.8 Spatial Regression Model

To establish the relationship between ARI prevalence and contextual correlates, we have applied and compared regression models: Ordinary Least Square (OLS), Spatial Error Model (SEM) (Anselin, 1995) and Spatial Lag Model (SLM) (Anselin, 1995; Anselin, 2013**),** and using Geoda.

We used the spatial ordinary least square (OLS) regression model to determine the presence of autocorrelation in the error term. The OLS model confirmed the presence of spatial autocorrelation in the error term for the dependent variable. Therefore, we proceeded to estimate the SLM and SEM (Anselin,1995; Anselin,2013**)**. The SLM assumes that observations of the outcome variable are influenced by neighbouring areas, while the SEM accounts for the impact of variables that are not incorporated in the regression model but still affect the outcome variable. The SLM does not consider the spatial dependence of the error term, while the SEM does. The basic equation for OLS is expressed as follows:

$$\boldsymbol{Y} = \alpha + \beta X + \varepsilon$$

Whereas

$Y = is\ the\ outcome\ variable$

$X = is\ the\ vactor\ of\ predictor\ variable$

$\alpha = is\ the\ model\ intercept$
$\beta = is\ the\ corresponding\ coefficient\ vector$

The spatial lag model (SLM): The spatial lag model (SLM) suggests that neighbouring units are spatially dependent and lag behind each other. (Anselin, 2013; Bivand et al., 2022**)**. A spatial lag model is a mathematical formula that is often used in spatial analysis. It can be written in the following format:

$$\boldsymbol{Y_i} = \delta \sum_{j \neq 1} W_{ij} Y_j + \beta X_j + \varepsilon_j$$

Whereas
$Y_i = Denotes\ the\ ARI\ prevalence\ for\ the\ i\ th\ district$
$\delta = spatial\ autoregressive\ coefficient$
$W_{ij} = spetial\ weight\ of\ proximity\ between\ district\ i\ and\ j$
$Y_j = is\ the\ ARI\ prevalence\ in\ the\ j\ th\ district$
$\beta = denotes\ the\ coefficient$
$X_j = is\ the\ predictor\ variable$
$\varepsilon_j =$ is the residual

The spatial error model (SEM): On the other hand, the analysis considers the contribution of variables that were omitted from the model but may have a significant impact (Bivand et al., 2022). The following is the expression for a Spatial Error Model (SEM):

$$\boldsymbol{Y_i} = \beta X_j + \lambda \sum_{j \neq 1} W_{ij} Y_j\, \varepsilon_j + \varepsilon_i$$

Whereas
$Y_i = Denotes\ the\ ARI\ prevalence\ for\ the\ i\ th\ district$
$\lambda = spatial\ autoregressive\ coefficient$
$W_{ij} = spetial\ weight\ of\ proximity\ between\ district\ i\ and\ j$
$Y_j = is\ the\ ARI\ prevalence\ in\ the\ j\ th\ district$
$\beta = denotes\ the\ coefficient$
$X_j = is\ the\ predictor\ variable$
$\varepsilon_i =$ is the residual

Akaike Information Criterion (AIC): The Akaike Information Criterion (AIC) is a widely used measure for model selection in statistics. It helps to compare different statistical models and determine which one best fits the data while balancing goodness of fit and model complexity. AIC is commonly used to select the best model from a set of candidate models. It helps in identifying the model that provides the best balance between fit and complexity. A lower AIC value indicates a better model fit. Among a set of candidate models, the model with the lowest AIC is preferred.

Lambda (λ): Lag coefficient (λ) measures the degree of spatial autocorrelation in the error terms. A positive value indicates that errors are positively correlated across space, meaning that if one location has a high error term, nearby locations are likely to have high error terms as well. The magnitude of λ indicates the strength of this spatial dependence. Larger values suggest stronger spatial autocorrelation. By incorporating λ, spatial error models can better handle the complexities of spatial data, leading to more robust and meaningful results. The coefficient adjusts the error structure to account for spatial dependencies, leading to more accurate model estimates and inferences.

Rho (ρ): ρ measures the strength and direction of spatial dependence in the dependent variable. A positive value indicates that high values of the dependent variable at one location are associated with high values at nearby locations, while a negative value indicates the opposite. The magnitude of ρ indicates the strength of this spatial dependence. Larger values suggest stronger spatial feedback effects. The spatial lag model includes ρρ to account for the spatial autocorrelation in the dependent variable. This helps in producing more accurate and reliable estimates.

Methodology for Objective 2:

[To investigate the contextual risks associated with ARI in India and rural West Bengal]

In this objective, we utilized bivariate analysis and the chi-square test to examine the association between ARI and various factors such as household environment, socio-economic characteristics, and maternal and childhood characteristics in India and rural West Bengal. The measurements and parameters of the variables used in our analysis are explained in detail below:

Measurement of variables:

2.2.8 Outcome Variables

Acute Respiratory Infection (ARI): In the NFHS survey, mothers were asked if their children under the age of five had experienced a cough in the two weeks before the survey. This type of cough is characterized by quick, shallow breaths and chest discomfort. If the response was "yes," the corresponding variable was marked as 1, indicating the presence of Acute Respiratory Infection (ARI). If the response was "no," it was labeled as 0, indicating no ARI.

2.2.9 Explanatory Variables

Based on the existing literature we had selected the output variables. The study included factors such as household environment, socioeconomic traits, maternal attributes, and child characteristics. The detailed computation of the independent variables from the NFHS data is mentioned below (***Table 2.11***).

Table 2.11: Description of the independent variable based on NFHS-IV and NFHS-V in India

Variables	Description of the Variable
	A. **Household Environment**
Type of House	House type categories as (1) Kaccha House: Dwellings constructed using mud, thatch, or other inferior materials. (2) Semi pucca House: Residences utilizing a combination of low-quality and high-quality materials. (3) Pucca House: Homes constructed entirely with high-quality materials, including the floor, roof, and exterior walls.
Type of fuel used for cooking	Cooking fuel categories as (1) Unclean Fuel (kerosene, coal, lignite, charcoal, wood, straw/shrubs/grass, agricultural crop, animal dung, and other); and (2) Clean fuel /no food cooked at home (electricity, LPG, biogas, no food cooked in house)
Smoke exposure in the household	Household's smoking exposure recorded as (0) No (Never); and (1) Yes (Daily/weekly; Monthly/less than once a month)
Separate kitchen	Availability of a separate kitchen is coded as (0) for a household without a separate kitchen, and (1) for a household with a separate kitchen.

Variables	Description of the Variable
Household crowding	Household crowding is classified as follows: (1) Not crowded (<= 3 persons sleep in a room); (2) Crowded (> 3 persons sleep in a room); and (3) No room for sleep.
Place of handwashing in household	Handwashing in households is categorized as (0) if not observed and (1) if observed.
Season of interview	The season of the interview was considered and was classified as (1) Winter Season (October-January); (2) Summer Season (February-May); and (3) Rainy Season (June-September)
	B. **Socio-Economic Characteristics**
Place of Residence	Place of residence has two categories: (1) urban and (2) rural
Social Group	The Indian constitution of 1949 identified specific groups within the Republic of India as deserving special administrative and welfare assistance. While these groups were named, they were not explicitly defined. SC/ST refers to two historically disadvantaged groups acknowledged in the Indian constitution and referred to as depressed classes. OBC denotes socially and educationally disadvantaged classes separate from the SC/ST groups. Social groups are categorized into four groups: Scheduled Caste (SC) (1), Scheduled Tribe (ST) (2), Other Backward Classes (OBC) (3), 'Others' (4)
Religion Group	Religion is categorized into two groups: (1) Hindu, (2) Non-Hindu (including Muslim, Christian, Sikh, Buddhist, neo-Buddhist, Jain, Jewish, and others).
Wealth Quintile	The wealth index is a measure of a household's wealth based on the possessions and facilities they have. It reflects their socio-economic status, with each household receiving a score based on the goods they own. To calculate this score, 33 different assets and housing features were considered using Principal Component Analysis. The resulting score is then divided into five equal

Variables	Description of the Variable
	categories: (1) poorest, (2) poorer, (3) middle, (4) richer, and (5) richest, each representing 20% of the population.
	C. **Maternal Characteristics**
Mother's education	There are four categories that classify the education level of women: 'no education' (0), 'primary' (1), 'secondary' (2), and 'higher' (3).
Mother's age	The age categories for women are: (1) 15-19 years; (2) 20-29 years; (3) 30-39 years; (4) 40-49 years.
Mother smoking exposure	Mother's smoking behaviour is recorded as follows: (1) if she smokes bidis and cigarettes regularly, and (2) for never smokers.
Mother exposure to mass media	In the NFHS IV and V survey, women were asked three questions: (a) their frequency of reading newspapers/magazines, (b) their frequency of watching television, and (c) their frequency of listening to the radio. The response options included 'almost every day', 'at least once a week', 'less than once a week', and 'not at all'. Based on these responses, a composite index is calculated and categorized into four groups: 'no' (0) if the respondent is not exposed to any form of mass media, 'low' (1) if the respondent is exposed to one form of mass media, 'medium' (2) if the respondent is exposed to two forms of mass media, and 'high' (3) if the respondent is exposed to all three forms of mass media.
Mother had respiratory diseases/asthma	Chronic respiratory disease in women, including asthma, is classified as: (0) No, and (1) Yes."
	D. **Children Characteristics**
Age of Child (Months)	The age of the child at the time of survey is recorded in completed months as follows: (1) 0-11 months; (2) 12-23 months; (3) 24-35 months; (4) 36-47 months; and (5) 48-59 months.

Variables	Description of the Variable
Sex of the child	The sex of the child was used as original (1) male (2) female
Child Nutrition Status	Children whose weight-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are classified as underweight. Children whose weight-for-age Z-score is below minus three standard deviations (-3 SD) from the median are considered severely underweight
Whether the child had diarrhoea	It was inquired whether her child/ children had experienced diarrhoeal illnesses before the final two weeks of the survey. The answer was documented as (0) negative and (1) affirmative.
Child's birth order	The original birth order of the child was categorized into two groups: (1) less than 3, and (2) 3 or more.
	E. **Others**
Regions in India	The NFHS classifies the regions in the following manner: Chandigarh, Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttarakhand, and Ladakh make up the Northern region. The Eastern region consists of Bihar, Jharkhand, Odisha, and West Bengal. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura form the North-Eastern region. The Central region includes Chhattisgarh, Madhya Pradesh, and Uttar Pradesh. Dadra & Nagar Haveli, Daman & Diu, Goa, Gujarat, and Maharashtra comprise the Western region. Lastly, Andaman & Nicobar Islands, Andhra Pradesh, Karnataka, Kerala, Lakshadweep, Puducherry, Tamil Nadu, and Telangana make up the Southern region.

Source: NFHS Data

Moreover explanatory variables collected through primary data to identify the risk factors associated with ARI in rural West Bengal are presented belowin **table 2.12**.

Table 2.12: Description of the independent variable based on the primary data in rural West Bengal

Background Characteristics	Description of the Variable
	A. **Household Environment**
Type of House	The type of house is classified into three categories (1) Pucca; (2) Semi Pucca; and (3) Kachha
Located Pucca Road (within 1Km)	If a pucca road is located within a 1km range of the household, it is coded as (1) Yes; otherwise, it is coded as (2) No.
Poultry firm (within 1Km)	If a poultry firm is located within a 1km range of the household, it is coded as (1) Yes; otherwise, it is coded as (2) No.
Muri mill (within 1Km)	If a muri mill is located within a 1km range of the household, it is coded as (1) Yes; otherwise, it is coded as (2) No.
Rice Mill (within 1Km)	If a rice mill is located within a 1km range of the household, it is coded as (1) Yes; otherwise, it is coded as (2) No.
Contact with pet/domestic animals	Household members' contact with pet/domestic animals should be coded as (0) for No and (1) for Yes.
Source of Alternative light during unavailability of electricity	Source of Alternative light during unavailability of electricity classified as (1) Kerosene lamp; (2) Emergency light
Smoking anyone in the Household	Household smoking exposure should be recorded as (0) for No and (1) for Yes.
Family History of Respiratory Illness	History of respiratory illness in the household is coded as (1) for yes and (2) for no
Main source of cooking fuel	Main source of cooking fuel categorized into three categories: (1) Firewood, Kerosene, Coal, and Charcoal; (2) Cow dung cakes; and (3) LPG/Natural Gas Pipeline.
Place of cooking	Place of cooking is classified as: (1) household cook in a separate kitchen, (2) cooking inside the house but not in a

Background Characteristics	Description of the Variable
	separate kitchen, and (3) cooking in the open or outside the house.
Frequency of cooking in a day	Frequency of cooking in a day is coded as (1) Once; (2) Twice; or (3) More (more than two times).
Presence of child during cooking	Presence of a child during cooking is classified as: (0) Not present, (1) Sometimes, or (2) Most of the time.
B. **Socio-economic Characteristics**	
Religion	Religion is categorized into two groups: (1) Hindu, (2) Muslim
Social Category (Caste)	Social group cataroize as (1) SC/ST; (2) OBC; (3) General (excluding SC, ST & OBC)
PDS/Ration card type	Public Distribution System (PDS)/ Ration cards is categorized as (1) APL and (2) BPL.
Type of family	Type of family categorized into three categories: (1) Joint family, (2) Nuclear family, and (3) Extended family.
Family Income (Per Years)	Family income per year categorized into three groups: (1) < Rs. 50,000; (2) Rs. 50,000 to 75,000; (3) > Rs. 75,000.
C. **Mother's Characteristics**	
Mother's Age	The age of women has four categories: '< 20 years' (1), '20 - 24 years' (2), '25 - 29 years' (3), '> 29 years' (4)
Mother’s Education	The education level of women is classified into four categories: (0) primary (1) secondary (2) higher secondary and above
Total number of children	Total number of children coded as (1) One Children; (2) Two Children; and (3) More than two children
Mother respiratory illness in last 2 weeks	if the mother Suffering from respiratory illness in last 2 weeks recode as (1) Yes and (2) No

Background Characteristics	Description of the Variable
Mass media exposure	If mothers have had exposure to mass media (Radio/TV/Newspaper) coded as (1) Yes otherwise (2) No.
D. **Children Characteristics**	
Child age (in months)	The age of the child at the time of the survey is noted in completed months as follows: (1) 0-11 months; (2) 12-23 months; (3) 24-35 months; (4) 36-47 months; and (5) 48-59 months.
Sex of the child	The sex of the child was used as original (1) male (2) female
Child weight during birth/birth weight of child	Birth weight categorized as per the WHO guidelines. A birth weight less than 2500 gm is coded as (1) Low Birth Weight, and a birth weight greater than 2500 gm is coded as (2) Normal birth weight.
Child had diarrohea (in the last 2 weeks)	It was asked whether the child/children had experienced diarrheal illnesses before the final two weeks of the survey. The response was recorded as (0) for no and (1) for yes.
Diarrohea Episode (in last 1 year)	Diarrohea episodes are recorded as: (1) No Episode, (2) Single Episode, or (3) Two or More Episodes.

Source: Primary Data

2.2.10 Computation of Household Environmental Vulnerability Index (HEVI)

The HEVI uses the Dimension Index (DI), which has a value between 0 and 1.A higher value indicates higher vulnerability (Mallick, 2021; Ghosh et al., 2021). The index is used to assess household environmental conditions. In the primary data, six questions related to the household environment were asked (see ***Table 2.13***). We recorded all the questions as 0 or 1 based on vulnerability. An average score is calculated from the questions, resulting in a value between 0 and 1 (*Cronbach's alpha=0.63*). A score of 0 represents the lowest vulnerability, while 1 indicates a higher vulnerability in the household. The overall score is divided into four quartiles: 0.0-0.25 for low HEVI, 0.26-0.50 for medium HEVI, 0.51-0.75 for high HEVI, and >0.75 for very high HEVI.

Table 2.13: Computation of Household Environmental Vulnerability Index

Q. No	Tittle	Recode	Score (Min/Max)
1	Availability of Pucca road near the house (within 1 Km)	Yes=1; No=0	0/4
2	Availability of Poultry firm near the house (within 1 Km)	Yes=1; No=0	
3	Availability of Muri mill near the house (within 1 Km)	Yes=1; No=0	
4	Availability of Rice mill near the house (within 1 Km)	Yes=1; No=0	
5	House Type	Kuchha and semi Pucca= 1, Pucca=0	0/1
6	Alternative option use for lighting when electricity not available	Kerosene lamp=1; Emergency Light =0	0/1
7	Anyone household smoke inside the house (Cigarettes/Beedi)	Yes=1; No=0	0/1
8	Source of the main cooking fuel use for cooking	Firewood/ Kerosene/ Coal and charcoal/Cow dung cakes=1, LPG/Natural Gas Pipe/Electricity=0	0/1
9	Place of Cooking	Cooking in open/ outside house/Cooking inside house, but not in kitchen=1; Cooking in separate kitchen=0	0/1

Statistical Analysis:

2.2.11 Chi-Square Test

To demonstrate the prevalence of ARI and their association with other background characteristics, we conducted a bivariate analysis using a chi-square test. This analysis helped identify the variables that are significantly associated with the prevalence of childhood ARI in India and rural West Bengal. Below are the details of the chi-square test.

The chi-square test is a statistical method aimed at comparing observed outcomes with what was expected theoretically. Its purpose is to ascertain if differences between the actual and expected data arise merely by chance or point to an existing relationship among the variables analyzed. This makes the chi-square test a powerful tool for exploring the link between two categorical variables. To evaluate the distribution hypothesis of a categorical variable, one must utilize the chi-square test or an equivalent nonparametric method. Categorical variables, which are classified into types like animals or countries, are either nominal or ordinal in nature. Since they are limited to certain specific values, they do not follow a normal distribution as continuous variables. The Chi-Square Test of Independence is a feature available in the Crosstabs process.

$$X^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

2.2.12 Logistic Regression Approaches

To examine the determinants of treatment-seeking behavior among under-five children in India, both multivariable logistic regression and multilevel logistic regression models were employed.

Multivariable Logistic Regression: Multivariable logistic regression is used when the outcome variable is binary (e.g., whether treatment was sought: Yes/No) and the interest lies in assessing the independent effects of multiple explanatory variables simultaneously. This method adjusts for potential confounding by including several predictors in the model, allowing estimation of the association of each variable with the outcome while holding others constant. In this study, individual- and household-level socio-demographic and economic characteristics (e.g., child's age, sex, mother's education, household wealth, place of residence) were included in the model to identify significant determinants of treatment-seeking behavior.

Multilevel Logistic Regression: Given the hierarchical structure of NFHS data, where children are nested within households, and households within clusters (primary sampling units), a standard logistic regression may underestimate standard errors due to intra-cluster correlation. To account for this clustering and unobserved heterogeneity at higher levels, multilevel logistic regression was applied. This approach incorporates random effects, thereby allowing the model to capture both individual-level determinants and contextual influences (e.g., community or regional variations). By doing so, it provides more robust and unbiased estimates while reflecting the true data structure.

Rationale for Using Both Models: While multivariable logistic regression highlights the net effect of individual- and household-level factors, multilevel logistic regression additionally accounts for clustering effects in NFHS data and helps assess the extent of variation attributable to higher-level factors. Together, these approaches strengthen the validity of findings regarding determinants of treatment-seeking behavior among under-five children in India.

2.2.13 Multilevel Logistics Regression Model

Multilevel modelling, also known as hierarchical linear modelling or mixed-effects modelling, is a statistical technique used to analyze data with a hierarchical or nested structure. It considers the grouping or clustering of data points within multiple levels. This approach allows for examining variation at different levels of the hierarchy, capturing both within-group and between-group variability. Multilevel modelling is particularly valuable when standard linear regression assumptions are violated due to the presence of correlated data points or when the focus is on understanding how group-level factors influence individual-level outcomes.

We used contingency table analysis and multilevel logistic regression to understand the factors associated with ARI among Indian children under five.

Multilevel models allow for hierarchical and clustered data, which, if ignored, could generate improper standard errors for the coefficients of the predictor variables and error terms. NFHS datasets, due to the sampling procedures used, have a hierarchical structure with women and men nested within the household, which is nested in a PSU or village followed by districts and states (Yadav & Nilima, 2021).

This data structure generates a dataset where observations are not entirely independent because they come from the same household or primary sampling unit (PSU). This goes against the assumption of independent observations in simple regression analysis. Multilevel models can accommodate such datasets and provide standard error adjustments for clustered observations. Another reason for using multilevel logistic regression in this study is to estimate the impact of contextual, village, or community-level variables on childhood ARI prevalence. These variables do not vary from person to person within a single community, creating a clustering effect that can only be addressed by fitting a multilevel regression model (Yadav & Nilima, 2021). A four-level logit model can be expressed as follows:

$$\textbf{logit}\,\pi_{ijkl} = \beta_0 + \mathrm{BX}'ijkl + (u0l + v0kl + w0kl)$$

whereas,

i, j, k and l are the level one (individual)
level 2 (village or PSU)

level 3 (district) and level 4 (state) or community units, respectively

π_{ij} is the probability of suffering from ARI, for the i^{th} children in the j^{th}, k^{th} and l^{th} PSUs, districts and state level.

We applied multilevel logistic regression analysis, incorporating district-level analysis using STATA 14 software. Before applying multilevel models, it is always good to look at the extent to which the outcome of interest varies at a higher level. We have developed a logistic model (not displayed) that results in the Hosmer–Lemeshow chi-square test being non-significant (p = 0.678), indicating that the model is suitable for logistic regression. Further, after taking the district's construction of a multilevel logistic model, it gives a significant intra-cluster correlation coefficient (ICC), which suggests that a multilevel model is appropriate and best fit for our study (Ghosh et al., 2023). The Intra-class correlation (ICC) is also calculated which is formulated as:

$$\boldsymbol{ICC = \frac{\sigma_j^2}{\sigma_j^2 + 3.29}}$$

where σ_j^2 represents the districts level variance.

The results of multilevel logistic regression are presented in the terms of odds ratios. Statistical analysis is performed on Stata 14 SE (Stata Corporation, College Station, Texas, USA) [47].

2.2.14 Multivariable Logistics Regression Model

The study used descriptive statistics and bivariate analysis, including the Chi-square test, to obtain initial results. Multivariable logistic regression models were used to identify the factors associated with ARI among children under five years of age in rural West Bengal.

The mathematical expression of the logistic regression analysis is:

$$\boldsymbol{logit(P) = [ln\, P/(1-P)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots + \beta_k X_k}$$

Let P be the probability of an event (suffering from ARI), which is influenced by a set of predictor variables with coefficients β0, β1, β2, and so on (βk) and predictor variables X1, X2, and so on (Xk). The ratio of P to (1-P) represents the odds, and the log of this ratio is the logit of P. We used dichotomous logit to estimate the dependent variables and considered significant levels of 1%, 5%, and 10% for all statistical tests. All analyses were performed using STATA version 14.

2.2.15 Concentration Index

In developing nations, there are significant disparities in health outcomes between the wealthy and the impoverished (Wagstaff, 2000). These discrepancies diminish the potential of impoverished individuals to contribute to the economy by limiting their ability to lead a fulfilling life. Health possesses inherent value, so inequalities in health directly impact the well-being and happiness of the less privileged. Research on inequalities in health status between the poor and the rich should not only focus on measuring their extent, but should also strive to pinpoint the most marginalized population subgroups. Identifying these groups enables the identification of the factors contributing to inequalities, such as age, gender, and education, which are recognized as influential determinants of health disparities in low and middle-income countries.

Properties of concentration index:

The concentration index is calculated as double the area between the concentration curve and the line of equality, known as the 45-degree line. When there is no socioeconomic-related inequality, the concentration index is zero. It is conventionally considered negative when the curve is above the line of equality, indicating a disproportionate concentration of the health variable among the poor, and positive when it lies below the line of equality.If the health variable represents a negative aspect such as ill health, a negative concentration index implies that ill health is more concentrated among the poor. The concentration index is computed using a formula that defines it in terms of double the (weighted) covariance of the child health indicators and individual relative rank in terms of economic status, divided by the variable mean.

$$C = \frac{2}{\mu}\sum_{i=1}^{n} cov_w\,(Y_i; R_i)$$

Whereas,

$\boldsymbol{Y_i}$= The child health indicator of the ith individual (i.e Childhood ARI)

$\boldsymbol{R_i}$= The fractional rank of the ith individual (for weighted data) in terms of the index of household economic status.

μ= The unconditional mean of ARI of the sample

$\boldsymbol{cov_w}$ = The weighted covariance.

The index is limited to values between -1 and +1. It's important to note that the concentration index is based solely on the relationship between the health variable and the ranking of the living standards variable, and not on the variation in the living standards variable itself. Changes in inequality may not necessarily impact the concentration index measure of income-related health inequality.

The concentration index consolidates information from the concentration curve, but it can only do so by making value judgments about the importance of inequality at different points in the distribution. As a result, the concentration index loses some of the information present in the concentration curve. Its value can be zero either because the concentration curve aligns with the 45-degree line throughout, or because it intersects the line and the (weighted) areas above and below the line cancel each other out. It's crucial to differentiate between these cases, so the summary index should be evaluated alongside the concentration curve. The sign of the concentration index indicates the relationship between the health variable and the position in the living standards distribution, and its magnitude demonstrates the strength of the relationship and the variability in the health variable. With these methodological advancements in mind, the aims of this chapter are twofold: first, to utilize the concentration index mentioned above to quantify the socioeconomic distribution of the prevalence rate of ARI by quantifying the contribution attributable to the place of residence and the States/UTs in India.

Methodology for Objective 3:

[To Identify the factors associated with the treatment-seeking behaviour for ARI in India]

In this objective, we utilized bivariate analysis and the chi-square test to examine the association between ARI and treatment seeking behaviour with the various factors such as socio-economic and maternal characteristics in India. The measurements and parameters of the variables used in our analysis are explained in detail below:

Measurement of Variables:

2.2.16 Computation Treatment-seeking Behaviour of ARI

Regarding treatment-seeking behaviour, the outcome variable was assigned a value of 1 if the individual sought treatment from a health facility or provider, and a value of 0 if they did not. It's important to note that seeking help from traditional healers, friends, or relatives is not included in this categorization (IIPS, 2021; NFHS-V, 2019-21; Varghese and Muhammad, 2023).

2.2.17 Explanatory Variables

The selected explanatory variables have been used to determine the factors associated with treatment-seeking behaviour among children suffering from ARI in India (**Table 2.14**).

Table 2.14: Variable included in treatment-seeking behaviour for the children suffering from ARI based on NFHS-IV and NFHS-V in India

Background characteristics	Description of the Variable
Place of Resident	Place of residence has two categories: (1) urban and (2) rural
Household Wealth Index	Wealth index classified into five category (1) poorest, (2) poorer, (3) middle, (4) richer, and (5) richest (detailed given in table 2.8)
Gender of the Head of the Household	The gender of the Head of the Household has two categories: (1) male and (2) female
Household Size	The number of household members categorizes in to two parts ≤ 4 Members as (1) and 5 and more members as (2)
Religious group	Hindu and non-Hindu
Social Group	Its divided in to Scheduled Caste (SC) (1), Scheduled Tribe (ST) (2), Other Backward Classes (OBC) (3), 'Others' (4) [already mentioned in table 2.9]
Distance to health facility	Distance to health facility has two categories (1) No/not a big problem and (2) Big problem
Having to take transport	Having to take transport has two categories (1) No/not a big problem and (2) a big problem
Mother's literacy	Mother's literacy recodes in to two categories (1) as literate and (2) as illiterate

Background characteristics	Description of the Variable
Mass Media Exposure	If mothers have had exposure to mass media (radio/TV/newspaper), it is coded as (1) Yes; otherwise, it is coded as (2) No.
Children ever born to women	Children ever born to women are recoded as (1) one child; (2) two children and (3) more than two children.
Age of the child	The age of the child at the time of survey is recorded in completed months as follows: (1) 0-11 months; (2) 12-23 months; (3) 24-35 months; (4) 36-47 months; and (5) 48-59 months.
Sex of the Child	The sex of the child was used as original (1) male (2) female
Region in India	Religion is categorized into two groups: (1) Hindu, (2) non-Hindu (including Muslim, Christian, Sikh, Buddhist, neo-Buddhist, Jain, Jewish, and others).
EAG and non-EAG state	Eight states—Rajasthan, Uttar Pradesh, Uttarakhand, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, and Odisha—are designated as (1) Empowered Action Group (EAG) states, while the remaining states are designated as (2) non-EAG states.

Statistical Analysis:

2.2.18 Multivariable Logistics Regression Model

The study used descriptive statistics and bivariate analysis, including the Chi-square test, to obtain initial results. Multivariable logistic regression models were used to identify the factors associated with treatment seeking behavioure on ARI among children in India in 2016 and 2021.

The mathematical expression of the logistic regression analysis is:

$$logit(P) = [ln\, P/(1-P)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots + \beta_k X_k$$

Let P be the probability of an event occurrence of seeking treatment (suffering from ARI), which is influenced by a set of predictor variables with coefficients β0, β1, β2, and so on (βk) and predictor variables X1, X2, and so on (Xk). The ratio of P to (1-P) represents the odds, and the log of this ratio is the logit of P. We used dichotomous logit to estimate the dependent variables and considered significant levels of 1%, 5%, and 10% for all statistical tests. All analyses were performed using STATA version 14.

Methodology for Objective 4:

To assess the economic Burden and health-seeking behaviours of families dealing with ARI in rural West Bengal, we have used the following methodology.

2.2.19 Description of the Variable for Economic Burden and Health-seeking Behaviours

In this section, we have analysed the economic Burden and health-seeking behaviours of families dealing with ARI in rural West Bengal. The description of the variable for the section is given below (***Table 2.15***):

Table 2.15: Economic Burden and health-seeking behaviours in rural west Bengal, India

Description	Details
Household Expenditure on Child's Health for ARI	Total cost incurred in Rs, excluding transportation costs
Duration of ARI:	Duration of ARI categorized into: 3 days, 4 days, 5 or more days
Seeking advice for treatment for ARI	Whether advice or treatment was sought: Yes/No
Place for seek advice or treatment	Location of treatment: Public or Private healthcare facility
Began to seek advice or treatment after the illness	Initiation of treatment: Immediate (same day or next day) or Delayed (from next day onwards)
The drugs of the illness after the treatment	Whether drugs were prescribed: Yes/No
Consumption of drugs after the treatment initiation	When the drugs were consumed: Same day, Next day, or after two days

2.2.20 Statistical Analysis:

The study used descriptive statistics and bivariate analysis, including the Chi-square test, to obtain initial results. We used descriptive statistics to obtain the treatment cost for the individual family. The mean standard deviation value is given as the overall treatment cost for the individual family when the children suffer from ARI in rural West Bengal. Similarly, univariate analysis and bivariate analysis with a chi-square test were applied to show the status of treatment-seeking and the association between the treatment-seeking variable.

Methodology for Objective 5:

[To understand the knowledge, attitudes, and practices (KAP) regarding acute respiratory infection among mothers of children under five in rural West Bengal]

In this study, our objective was to understand the knowledge, attitudes, and practices (KAP) concerning acute respiratory infection (ARI) among mothers of children in rural West Bengal. To achieve this, we employed univariate and bivariate analysis techniques, including using a chi-square test. In addition to this, we employed a logistic regression model to assess the association between ARI prevalence and the KAP of mothers in rural West Bengal. The measurements and parameters of the variables used in our analysis are explained in detail below:

Measurement of Variables:

2.2.21 Computation of Knowledge, Attitude, and Practices

During the survey, we administered a series of questions to assess the knowledge, attitude, and practices (KAP) of the participating mothers (**Table 2.16**). For the knowledge section, we posed 8 questions and scored 1 for a correct response and 0 for an incorrect response, resulting in a total score out of 8. The attitude section comprised 5 questions, and we employed a scoring system of 0 for "very serious," 1 for "serious," and 2 for "not serious." As for the practices section, we asked 6 questions and assigned a score of 1 for demonstrating good practices and 0 otherwise, with a maximum score of 6.

We converted the scores for knowledge, attitude, and practices into percentages. Subsequently, we classified scores below 50% as poor, scores between 50% and 70% as average, and scores above 70% as good for knowledge, attitude, and practices. Furthermore, we combined all three components to create an overall KAP score using the same categorization.

Table 2.16: Computation of KAP Score

Sl. No	**Questions regarding Knowledge**	**Recode Score**
1	The illnesses (ARI) caused by:	We score 1 for every correct answer and 0 for every incorrect answer.
2	What are the symptoms of ARI?	
3	What do you think, how does a child get an infection of respiratory diseases?	
3	Clean Air	
4	Smoky Air	
5	Eating old or rotten food	
6	Cooking inside with fire	
7	Cooking outside	
8	What are the complications of ARI?	
Sl. No	**Questions regarding Attitude**	
9	Do you consider ARI as a Serious Illness?	Mother's attitudes categorized as "Not Serious" are scored as 0, while those categorized as "Serious" as 1, and “Very Serious" are scored as 2.
10	How important do you think it is for your child to breath clean air?	
11	How serious do you think it is if your child is having difficulty in breathing, they have a sever cough, or have problem with their chest?	
12	How serious do you think it is if your child has a runny or blocked nose?	
13	How important you consider building immunity of your child against ARI?	
Sl. No	**Questions regarding Practices**	
14	What is the frequency of air ventilation of your home in winter season?	Daily=1; else =0
15	From where you seek treatment of your children during ARI illness?	Homeopathy & Medical Care=1; Home Treatment and Medicine shop =0
16	Do you maintain eating utensils or drinking containers separately for children?	Yes=1 & No=0
17	Do you maintain distancing from your child when you are suffering from cold and cough?	Yes=1 & No=0
18	Duration of desensitizing/cleaning room during child illness	Every Day=1; Else=0
19	When do you visit the doctor after the symptoms of our child	Urgently=1 and else=0

Sl. No	Questions regarding Knowledge	Recode Score
Reliability Test	***The highest Score*** 29 and ***lowest Score*** 0. ***No of Items*** =19; ***No of Observation***= 296; ***Cronbach's Alpha***= 0.672	<50% Score as Poor; 51%-70% as "Average" and >70 as good

Statistical Analysis:

2.2.22 Multivariable Logistic Regression

The study used descriptive statistics and bivariate analysis, including the Chi-square test, to obtain initial results. Multivariable logistic regression models were used to show the association between ARI prevalence in children in rural West Bengal with the mother's knowledge, attitudes, and practices among children in 2021.

The mathematical expression of the logistic regression analysis is:

$$\boldsymbol{logit(P)} = [\boldsymbol{ln\,P/(1-P)}] = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 X_1} + \boldsymbol{\beta_2 X_2} + \ldots\ldots\ldots\ldots + \boldsymbol{\beta_k X_k}$$

Let P be the probability of an event (suffering from ARI), which is influenced by a set of predictor variables with coefficients β0, β1, β2, and so on (βk) and predictor variables X1, X2, and so on (Xk). The ratio of P to (1-P) represents the odds, and the log of this ratio is the logit of P. We used dichotomous logit to estimate the dependent variables and considered significant levels of 1%, 5%, and 10% for all statistical tests. All analyses were performed using STATA version 14.

In conclusion, the research study has used both secondary and primary data and different statistical techniques to analyze the data.

CHAPTER 3: Results

3.1 Spatial Prevalence and Spatial-Clustering of ARI in Children in India

Introduction

ARI remains a leading cause of morbidity and mortality among children under five years of age globally, with India bearing a significant burden of this public health issue. Despite various interventions, the prevalence and patterns of ARI continue to pose challenges for health systems across the country. Understanding the distribution and determinants of ARI is crucial for effective policy formulation and implementation of targeted health interventions.

This study aims to comprehensively analyze ARI's prevalence and spatial distribution among children under five years of age in India. The broad objective is to elucidate the prevalence and identify any spatial clustering of ARI among children within the districts in India. To achieve this, the study focuses on the following specific (sub) objectives:

- To show the prevalence of ARI among children in India from 2005-2021.
- To show the prevalence with geographical variation of ARI in India in 2016-2021
- To examine the spatio-temporal changes of ARI prevalence in India from 2016-2021.
- To detect the spatial clustering of ARI prevalence in India.

Prevalence of ARI in India (2005-2021): This objective seeks to provide a detailed analysis of the prevalence of ARI among children in India over 16 years from 2005 to 2021. By examining this extended timeframe, we aim to identify long-term trends and shifts in ARI prevalence.

Geographical Variation of ARI (2016-2021): Building on the first objective, this study segment narrows the focus to 2016-2021. It aims to illustrate the prevalence of ARI with an emphasis on geographical variation, highlighting regional disparities and potential areas requiring targeted interventions.

Spatio-Temporal Changes of ARI (2016-2021): This objective delves into the spatio-temporal dynamics of ARI prevalence within the same five-year period. By examining changes over time and across regions, state/UTs, and districts, we seek to understand the patterns and potential factors driving these changes.

Spatial Clustering of ARI Prevalence: The final objective is to detect and analyze spatial clustering of ARI prevalence across India. Identifying clusters will help to recognize areas with unusually high or low prevalence, providing insights into potential environmental, socio-economic, and healthcare-related factors influencing ARI distribution.

Through these objectives, the study aspires to contribute valuable knowledge to the field of public health, offering insights that can inform strategic planning and resource allocation to combat ARI effectively. By mapping and analyzing ARI's prevalence and spatial patterns, this research aims to support evidence-based interventions that can reduce the burden of ARI among children in India, ultimately improving child health outcomes nationwide.

Data Source and Methodology

The study used data from the last three rounds of the NFHS. We used STATA 14, ArcGIS 10.8, and GeoDA software to analyse the data and identify spatial clustering. The methodology chapter (Page No.) provides a detailed methodology.

3.1.1 Prevalence of ARI among children in India

Prevalence of ARI among children in India from 2005-2021:

Figure 3.1 represents the prevalence of ARI among children in India from NFHS-III (2005-06) to NFHS-IV (2019-21). Over the study period, the prevalence of ARI has decreased from 5.8 percent to 2.8 percent. The children living in rural residences reported a higher prevalence of ARI as compared to urban residences in the entire three rounds. However, there is a slight increase in the prevalence in rural residences from NFHS-IV (2.9%) to NFHS-V (3.0%).

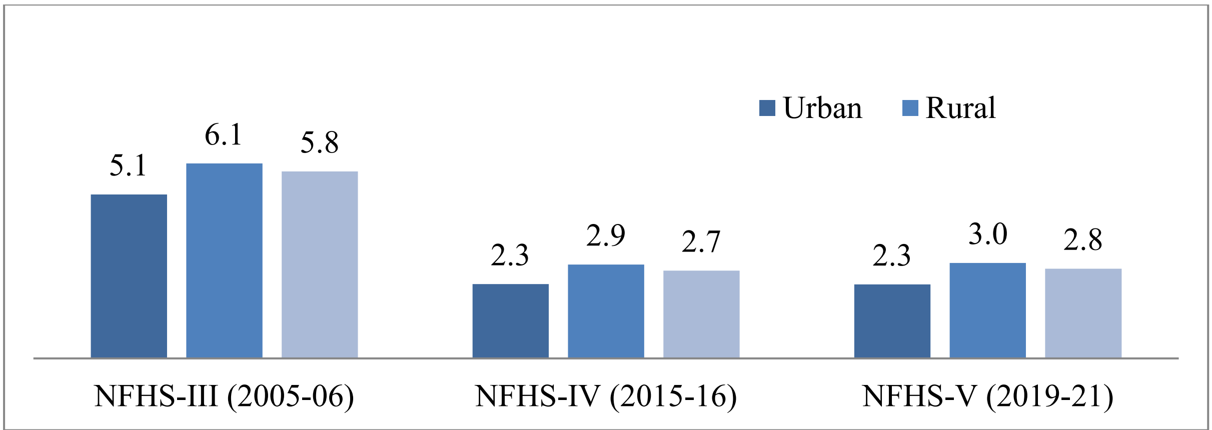


Figure 3.1: Prevalence of ARI among children (0-5 years) in India from NFHS-III (2005-06) to NFHS-V (2019-21)

Prevalence of ARI among children across the regions in India from 2016-2021:

Regional analysis provides deeper insights, revealing prevalence rates of 2.8 percent, 2.9 percent, and 3.8 percent in India's eastern, northern, and central regions, respectively, exceeding the national average in 2016 (***Figure 3.2***). On the other hand, the northeast, eastern, and central regions show a prevalence more than the national average (i.e. 2.8%) in 2021.

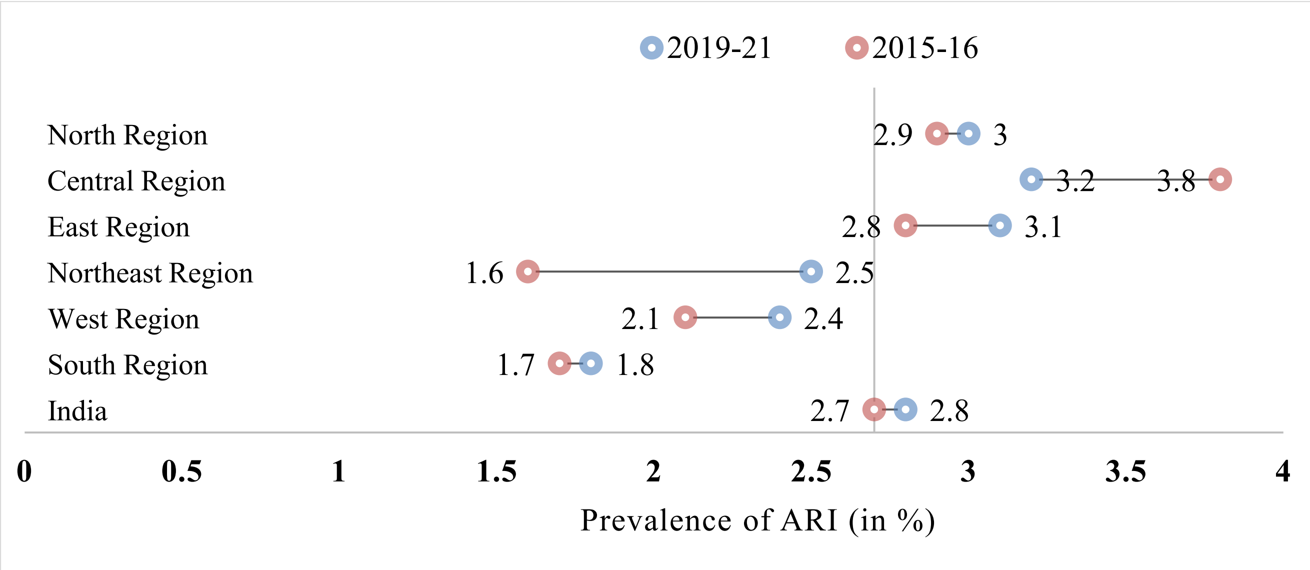


Figure 3.2: Forest plot showing inequalities across the regions in India suffering from ARI in 2016 and 2021

3.1.2 Prevalence with Geographical Variation of ARI in India in 2016-2021

Prevalence with geographical variance of ARI among 0–5-year-old children in India (2005-6): The table below describes the prevalence of ARI among children across the states in India in 2005-06 (Table 3.1). The prevalence is highest in the eastern (7.89%) region followed by the northeastern (6.95%) and central (6.12%) regions, whereas the southern (2.4%) region reported the lowest prevalence of ARI in India. Coming to the state-level variation ARI prevalence is highest in Tripura (14.15%) followed by West Bengal (13%) and Jammu & Kashmir (7.62%) respectively. On the other hand, Himachal Pradesh shows the lowest prevalence of ARI. The incidence of ARI in rural India was highest in Delhi (14.58%) followed by Tripura and West Bengal (13.58%). On the other hand in the urban residence the prevalence is highest in Tripura (12.4%) followed by Arunachal Pradesh (11.59%) and West Bengal (10.83%).

Table 3.1: Prevalence of ARI among children (0-5 years) across the state and UTs in India in NFHS-III (2005-06)

State	Urban	Rural	Total	Sample Size
North Region	5.47	6.15	5.96	6,331
Jammu & Kashmir	7.92	7.54	7.62	406
Himachal Pradesh	0.8	1.4	1.35	221
Punjab	6.22	7.27	6.89	978
Uttaranchal	3.58	4.52	4.3	366
Haryana	0.78	3.3	2.68	906
Delhi	5.55	14.58	6.35	459
Rajasthan	6.79	6.92	6.9	2995
Central Region	5.8	6.2	6.12	14,174
Uttar Pradesh	6.89	7.13	7.08	9892
Chhattisgarh	6.54	3.95	4.39	1014
Madhya Pradesh	2.74	4.04	3.74	3268
East Region	7.43	7.98	7.89	12,267
Bihar	6.37	6.89	6.83	5369
West Bengal	10.83	13.58	13	3624
Jharkhand	4.51	5.38	5.22	1601
Orissa	3.11	2.74	2.79	1672
Northeast Region	7.35	6.88	6.95	1,840
Sikkim	1.05	5.68	4.98	22
Arunachal Pradesh	11.59	5.05	6.75	57
Nagaland	4.37	4.15	4.2	84
Manipur	4.48	4.77	4.69	105
Mizoram	5.23	3.11	4.1	45
Tripura	12.4	14.47	14.15	141
Meghalaya	0.98	2.05	1.88	159
Assam	8.78	7.12	7.31	1228
Western Region	5.12	4.25	4.62	6,210
Gujarat	6.74	3.53	4.73	2269
Maharashtra	4.37	4.74	4.57	3891
Goa	3.89	3.31	3.63	49
South Region	2.2	2.52	2.4	7,858
Andhra Pradesh	2.02	2.02	2.02	2729
Karnataka	1.79	1.69	1.73	2367
Kerala	3.42	2.36	2.69	924
Tamil Nadu	2.39	4.73	3.67	1838
India	**5.1**	**6.1**	**5.8**	**48,679**

Prevalence with geographical variance of ARI among 0–5-year-old children in India (2015-16):

Table ***3.2*** represents the prevalence of ARI among children at the state/UT level in India (2015-16). The survey results indicate that approximately 2.7 percent of children under five in India experienced ARI in the two weeks preceding the survey. The geographical distribution reveals a disparity between rural and urban areas. Rural areas have a slightly lower prevalence rate of 2.3 percent compared to 2.9 percent in urban areas. Furthermore, the ARI prevalence has been reported to range from the lowest in Sikkim (0.30%) to the highest in Meghalaya (5.8%) in 2016. Interestingly, a significant portion of States/UTs, around 66 percent, report ARI prevalence rates exceeding the national average of 2.7%. ARI was most prevalent in Meghalaya (5.8%), followed by Jammu and Kashmir (5.44%), Uttar Pradesh (4.65%), Uttarakhand (4.63%), and Punjab (4.11%). The eastern (2.8%), northern (2.9%), and central (3.8%) regions show a prevalence of more than the national average.

Table 3.2: Prevalence of ARI among children (0-5 years) across the state and UTs in India in NFHS-IV (2015-16)

State/UTs	**Weighted Prevalence of ARI (in Percentage)**			
	Total	***Urban***	***Rural***	***Sample (N)***
A. North Region	**2.9**	**2.8**	**3.0**	**31, 622**
Chandigarh	2.8	2.9	0.0	142
Nct Of Delhi	2.4	2.4	0.6	2, 900
Haryana	3.2	3.3	3.1	5, 489
Himachal Pradesh	1.6	0.8	1.7	1, 076
Jammu & Kashmir	5.4	3.0	6.2	2, 126
Punjab	4.1	4.4	3.9	3, 980
Rajasthan	2.1	1.8	2.1	13, 984
Uttarakhand	4.6	4.1	4.9	1, 925
Ladakh	NA	NA	NA	NA
B. Central Region	**3.8**	**2.9**	**4.1**	**63, 451**
Chhattisgarh	2.2	2.3	2.2	5, 795
Madhya Pradesh	2.1	1.3	2.4	16, 107
Uttar Pradesh	4.7	3.7	4.9	41, 549
C. East Region	**2.8**	2.2	2.9	**60, 802**
Bihar	2.5	1.7	2.6	29, 782
Jharkhand	3.2	3.4	3.2	7, 084
Odisha	2.4	1.9	2.5	7, 849
West Bengal	3.3	2.3	3.7	16, 087

D. Northeast Region	**1.6**	**1.5**	**1.7**	**8, 446**
Arunachal Pradesh	2.1	1.2	2.4	207
Assam	1.0	0.5	1.1	5, 885
Manipur	1.7	1.8	1.7	475
Meghalaya	5.8	4.8	6.0	727
Mizoram	2.2	3.0	1.2	203
Nagaland	1.4	1.6	1.3	324
Sikkim	0.3	0.4	0.2	58
Tripura	2.6	2.1	2.8	566
E. West Region	**2.1**	**2.2**	**1.9**	**30, 903**
Dadra & Nagar Haveli and Daman & Diu	1.5	0.9	2.2	98
Goa	1.4	0.9	2.4	208
Gujarat	1.4	1.5	1.4	10, 319
Maharashtra	2.4	2.5	2.2	20, 279
F. South Region	**1.7**	**1.8**	**1.6**	**43, 721**
Andaman & Nicobar Islands	1.5	2.8	0.6	49
Andhra Pradesh	0.5	0.9	0.4	8, 647
Karnataka	1.2	1.0	1.3	10, 034
Kerala	0.8	0.6	1.0	4, 258
Lakshadweep	0.9	1.1	0.0	12
Puducherry	3.0	2.5	4.0	205
Tamil Nadu	2.8	2.7	2.9	13, 720
Telangana	2.0	2.1	2.0	6, 796
India	**2.7**	**2.3**	**2.9**	**2, 38, 945**

Prevalence with a geographical variance of ARI among 0–5-year-old children in India (2019-21):

Table (**Table 3.3**) represents the prevalence of childhood ARI across the State/UTs in India. The prevalence has slightly increased from 2.7 to 2.8 percent from 2016 to 2021. Children from rural (2.9%) India reported a higher prevalence of ARI as compared to urban (2.3%) children. Delhi (5.6%) shows the highest prevalence of ARI whereas Dadra & Nagar Haveli/Daman & Diu (0.3%) shows a low prevalence of ARI in 2021. Around 72 percent of States/UTs show more ARI prevalence among children than the national average (i.e, 2.8%). Childhood ARI prevalence is highly concentrated in Delhi (5.59), Ladak (5.31%) Puducherry (4.87%), Meghalaya (4.80%), Jammu & Kashmir (3.85%), and Uttar Pradesh (3.54%) in the year of

2021. The northeast, eastern, and central region show a prevalence more than the national average (i.e. 2.8%).

Table 3.3: Prevalence of ARI among children (0-5 years) across the state and UTs in India in NFHS-IV (2019-21)

State/UTs	**Weighted Prevalence of ARI (in Percentage)**			
	Total	Urban	Rural	Sample (N)
A. North Region	**3.0**	**3.2**	**2.9**	**29, 963**
Chandigarh	0.3	0.3	0.0	141
Nct Of Delhi	5.6	5.5	6.0	2, 868
Haryana	2.3	1.9	2.5	4, 256
Himachal Pradesh	1.5	4.0	1.1	934
Jammu & Kashmir	3.9	2.9	4.1	1, 611
Punjab	2.5	1.3	3.1	3, 949
Rajasthan	2.9	2.6	3.0	14, 430
Uttarakhand	2.3	2.9	1.9	1, 748
Ladakh	5.3	10.5	4.0	26
B. Central Region	**3.2**	**2.7**	**3.3**	**61, 096**
Chhattisgarh	1.5	1.5	1.5	4, 849
Madhya Pradesh	2.6	3.2	2.5	13, 271
Uttar Pradesh	3.5	2.7	3.8	42, 976
C. East Region	**3.1**	**2.4**	**3.3**	**57, 887**
Bihar	3.5	2.9	3.7	28, 959
Jharkhand	2.1	1.6	2.2	6, 678
Odisha	3.2	2.8	3.2	6, 906
West Bengal	2.8	2.1	3.1	15, 344
D. Northeast Region	**2.5**	**2.4**	**2.5**	**8, 115**
Arunachal Pradesh	2.1	2.5	2.1	170
Assam	2.5	2.5	2.5	5, 649
Manipur	1.8	2.4	1.4	437
Meghalaya	4.8	5.8	4.7	838
Mizoram	0.6	0.9	0.2	176
Nagaland	1.1	1.0	1.1	206
Sikkim	0.7	0.8	0.7	60
Tripura	1.3	0.8	1.5	579
E. West Region	**2.4**	**1.9**	**2.8**	**27, 916**
Dadra & Nagar Haveli and Daman & Diu	0.3	0.6	0.1	85
Goa	0.9	0.0	2.4	199

State/UTs	Weighted Prevalence of ARI (in Percentage)			
	Total	Urban	Rural	Sample (N)
Gujarat	1.0	0.9	1.1	9, 418
Maharashtra	3.2	2.4	3.8	18, 213
F. South Region	**1.8**	**1.6**	**1.9**	**37, 256**
Andaman & Nicobar Islands	1.7	0.0	3.2	39
Andhra Pradesh	2.4	2.1	2.4	7, 081
Karnataka	1.5	1.2	1.7	9, 881
Kerala	2.4	1.9	2.9	4, 502
Lakshadweep	1.4	2.0	0.0	10
Puducherry	4.9	6.4	1.6	145
Tamil Nadu	1.1	1.4	0.9	10, 610
Telangana	2.2	1.9	2.5	4, 988
India	**2.8**	**2.3**	**3.0**	**2, 22, 233**

Spatial Prevalence of ARI among children (0–5 years) across the districts in India (2015-16):

The map in Figure (**Fig: 3.3**) illustrates the spatial prevalence of Acute Respiratory Infection (ARI) across the 640 districts in India in the year 2015-16. The map indicates that approximately 39% of districts (248 out of 640) in India reported a prevalence of ARI higher than the national average of 2.7%. For 11% (74 districts), the prevalence ranged between 2% and 2.7%, while the remaining 50% of districts (318 districts) reported a prevalence of less than 2% in 2016.

Ramban (19.5%) and Kishtwar (16.6%) districts in Jammu & Kashmir exhibited the highest prevalence of ARI. The high prevalence districts are located in the central, western, eastern, southern, and northern parts of India, primarily in the states of Uttar Pradesh, Tamil Nadu, Maharashtra, Madhya Pradesh, Bihar, Uttarakhand, West Bengal, Odisha, and Jharkhand, Jammu & Kashmir, Chhattisgarh, and Arunachal Pradesh.

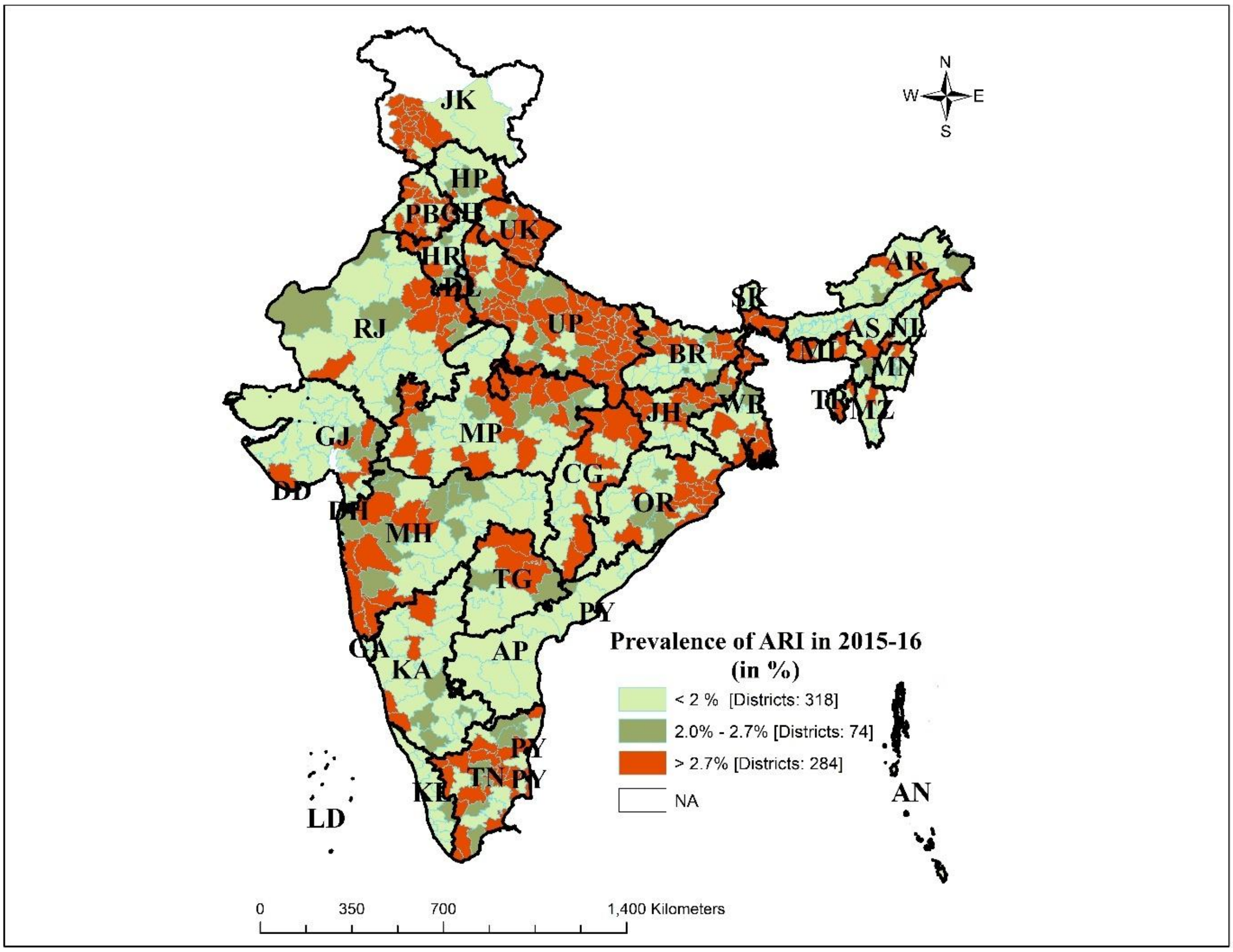


Figure 3.3: Prevalence of ARI among children (0–5 years) across the districts in India (2015-16)

Spatial Prevalence of ARI among children (0–5 years) across the districts in India (2019-21):

The map in Figure (**Fig: 3.4**) illustrates the spatial prevalence of Acute Respiratory Infection (ARI) across the 707 districts in India in the year 2019-21. The map indicates that approximately 36% of districts (254 out of 707) in India reported a prevalence of ARI higher than the national average of 2.8 percent. Moreover, for 15% (109 districts), the prevalence ranged between 2% and 2.8%, while the remaining 49% districts (344 districts) reported a prevalence of less than 2% in 2021.

Gonda (19.5%) and Bundi (16.6%) districts in Uttar Pradesh and Rajasthan exhibited the highest prevalence of ARI. These high prevalence districts are located primarily in the states of Uttar Pradesh, Bihar, Madhya Pradesh, Jammu & Kashmir, Chhattisgarh, Meghalaya, Delhi, Odisha, Rajasthan, Telangana, and Andhra Pradesh.

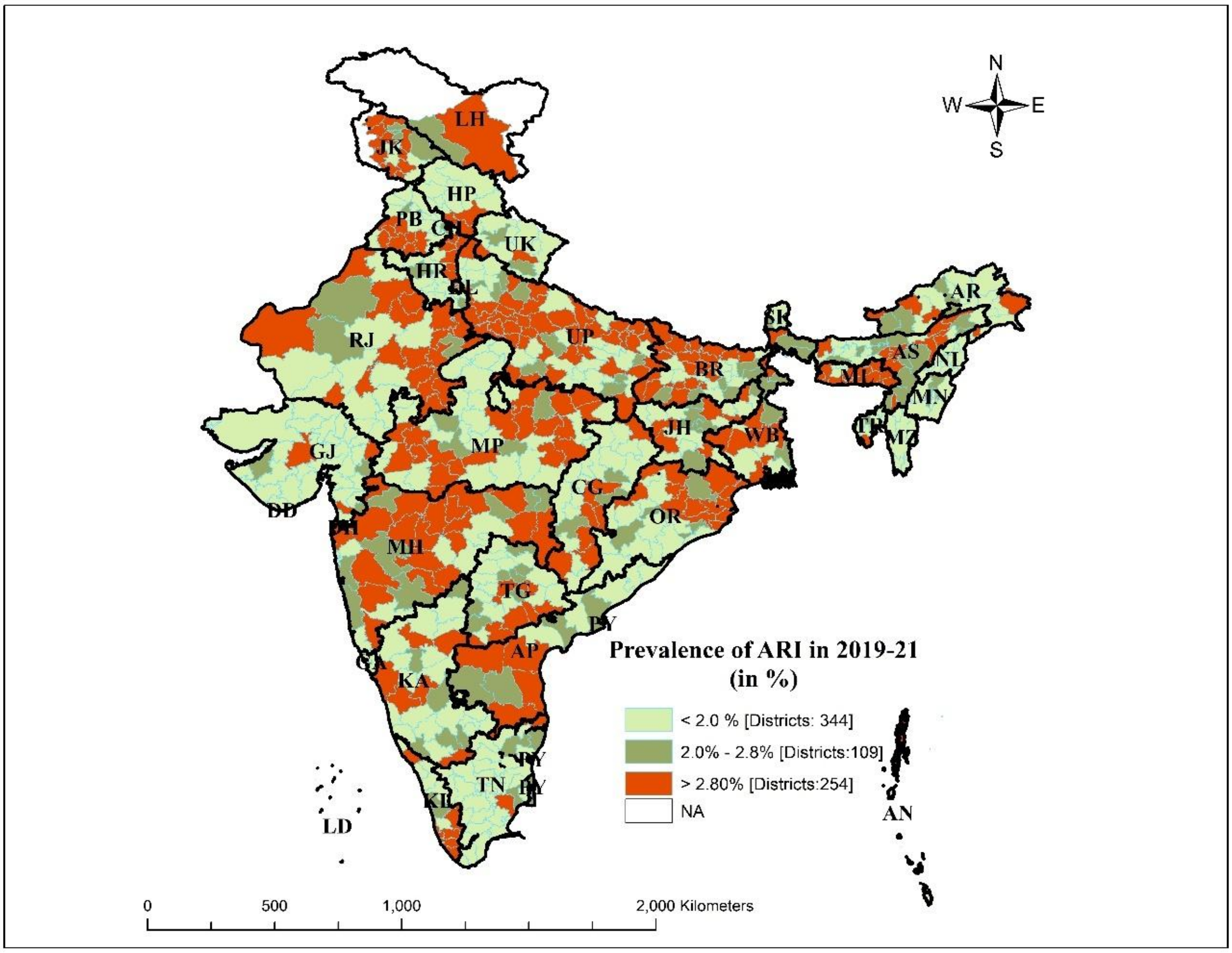


Figure 3.4: Prevalence of ARI among children (0–5 years) across the districts in India (2019-21)

3.1.3 Particulate Matter (PM2.5 μg/m3) Concentration and ARI Prevalence in India

Particulate Matter (PM2.5 μg/m3) in India*:* PM2.5 concentrations across states and union territories in India are represented in **Table 3.4**. The highest levels of PM2.5 are found in Delhi, followed by Uttar Pradesh, Haryana, Bihar, Punjab, Tripura, and West Bengal. Conversely, Lakshadweep, Arunachal Pradesh, Jammu & Kashmir, Ladakh, and Andaman & Nicobar Islands exhibit lower PM2.5 levels.

Table 3.4: Particulate Matter (PM2.5) concentration across States/UTs in India

State/UTs	Particulate Matter (PM2.5 μg/m3)
Andaman & Nicobar Islands	16.2
Andhra Pradesh	29.2
Arunachal Pradesh	12.9
Assam	32.2
Bihar	82.5

State/UTs	Particulate Matter (PM2.5 µg/m3)
Chandigarh	49.9
Chhattisgarh	51.5
Dadra & Nagar Haveli & Daman & Diu	30.2
Goa	28.9
Gujarat	46.2
Haryana	85.3
Himachal Pradesh	25.6
Jammu & Kashmir	15.4
Jharkhand	59.7
Karnataka	27.1
Kerala	16.4
Ladakh	15.4
Lakshadweep	0
Madhya Pradesh	54
Maharashtra	41.4
Manipur	29.2
Meghalaya	36.9
Mizoram	38.1
Nagaland	26.1
NCT of Delhi	115.8
Odisha	44.4
Puducherry	26.8
Punjab	69.9
Rajasthan	62.1
Sikkim	30.2
Tamil Nadu	25.6
Telangana	33.7
Tripura	63.7
Uttar Pradesh	89.7
Uttarakhand	31.1
West Bengal	62.4

Note: *Data Source:* https://sites.wustl.edu/acag/datasets/surface-pm2-5/

A district-level map indicates very high PM2.5 concentrations in the northern Indian plains, including Punjab, Haryana, Rajasthan, West Bengal, and parts of Chhattisgarh. Moderate levels are observed in Madhya Pradesh, Maharashtra, and Odisha, while relatively low levels are present in the southern, northern (Uttarakhand, Himachal Pradesh, Jammu and Kashmir, Ladakh), southern (Kerala, Karnataka, Andhra Pradesh, Telangana, and Tamil Nadu), and northeastern (Assam, Arunachal Pradesh, Meghalaya, and Nagaland) regions of India (**Figure 3.5**).

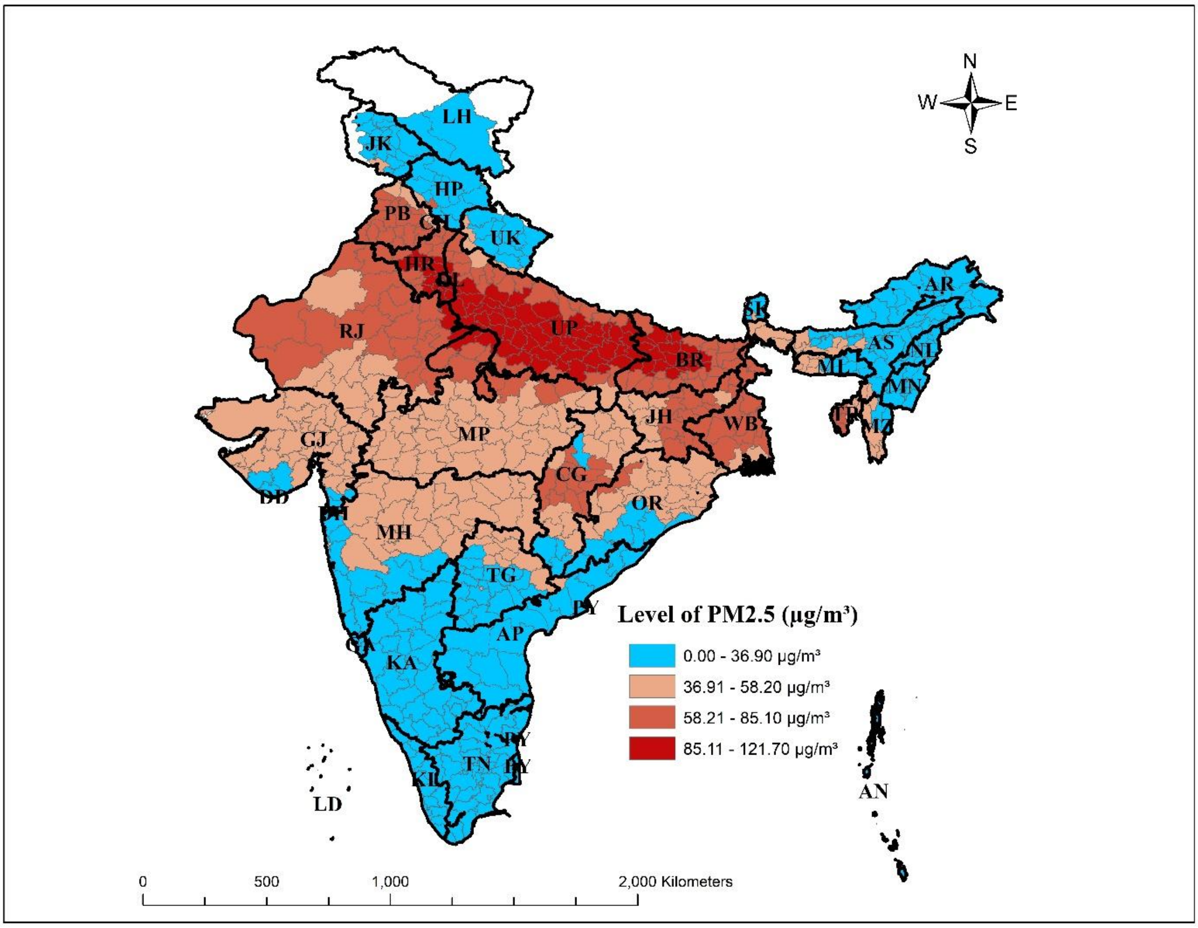


Figure 3.5: Particulate Matter (PM2.5 µg/m3) concentration across the districts in India

Particulate Matter (PM2.5 µg/m3) concentration and ARI prevalence:

The figure below represents the PM 2.5 (µg/m3) concentration and ARI prevalence across the districts in India, showing an association between ARI prevalence and PM 2.5 levels (**Figure 3.6**). The districts with higher PM 2.5 levels indicate a higher prevalence of ARI. Districts from Uttar Pradesh, Bihar, Punjab, Haryana, and West Bengal show a high prevalence of ARI and PM 2.5 levels. Additionally, most of the districts located in Northern, Eastern, Central, and Western India show a high prevalence of ARI and PM 2.5 levels.

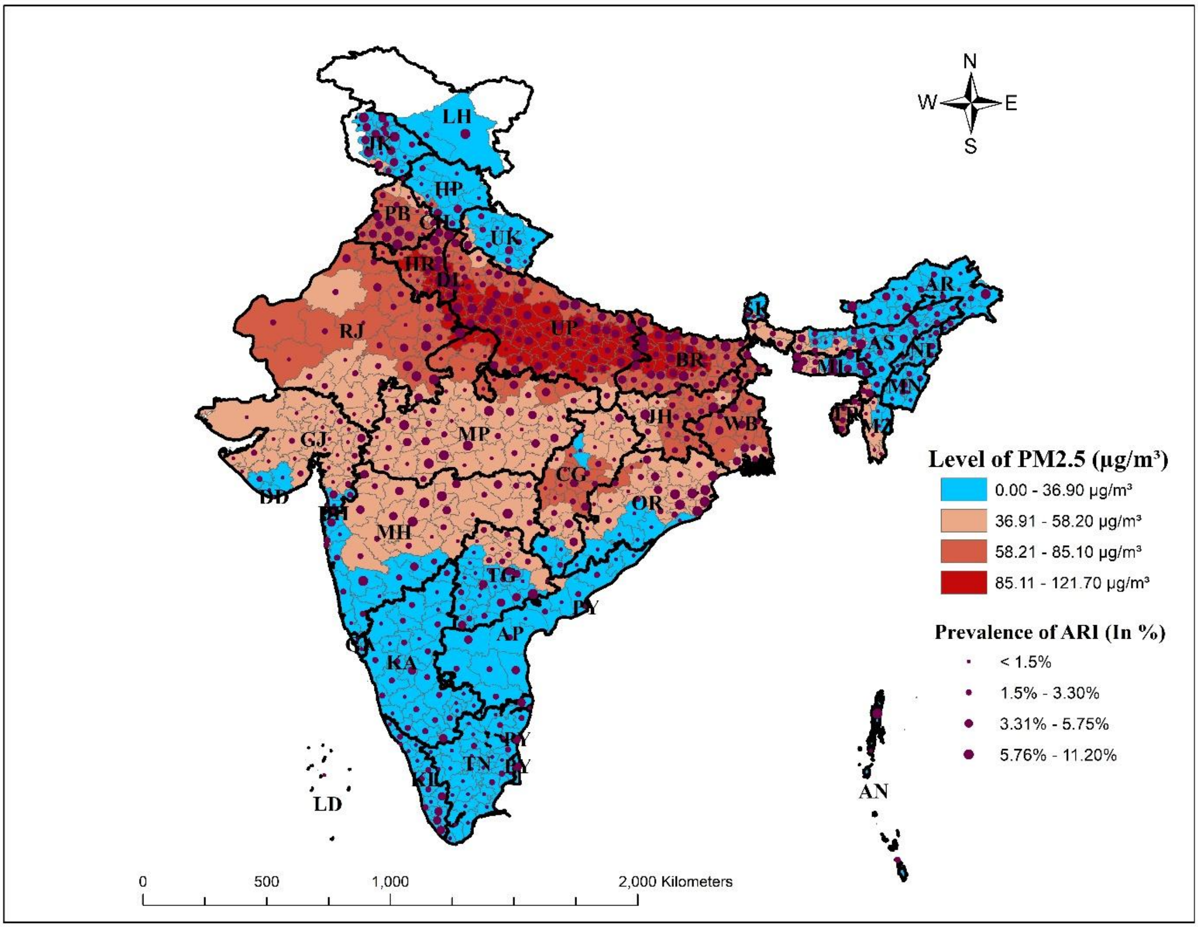


Figure 3.6: Particulate Matter (PM2.5 µg/m3) concentration and ARI prevalence across the districts in India

3.1.4 Spatio-temporal Changes of ARI Prevalence in India from 2016-2021

Spatial-temporal changes of ARI across regions in India (2016-2021):

With regards to temporal changes specific to certain regions, all regions in India except the central region have shown an increase in the prevalence of childhood ARI (**Figure: 3.7**). The northeast region displayed the highest increase in the prevalence of ARI, while the north region had the lowest increase in the prevalence. In terms of place of residence, northern, eastern, and northeastern regions showed an increasing trend, while east, northeast, west, and south rural regions also showed an increase in the prevalence of ARI from 2016 to 2021.

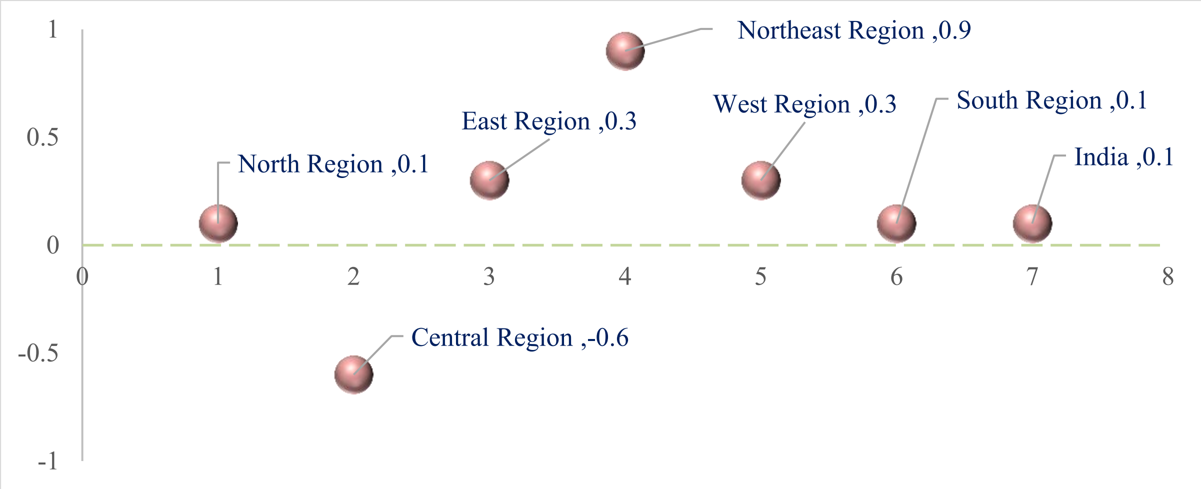


Figure 3.7: Spatial-temporal changes of ARI across regions in India from 2016 to 2021

Spatial-temporal changes of ARI among children across the State/UTs in India from 2016 to 2021:

The absolute change in the prevalence of ARI was computed to measure the difference between 2016 and 2021 (**Table: 3.5)**. Positive values denote an increase in prevalence, while negative values indicate a decrease, and zero denotes no change in the prevalence. The results show that there was a slight increase (0.1%) in the overall prevalence of ARI among children during this period. However, there was a wide variation in the change of prevalence across different regions. Delhi reported the highest increase in prevalence (3.2%) while Chandigarh showed the highest decrease (-2.5%). In rural areas, Delhi showed the highest increase (5.4%), while Uttarakhand showed the highest decrease (-2.9%). In urban areas, Puducherry reported the highest increase in prevalence (3.9%), while Punjab showed the highest decrease (-3.1%).

Table 3.5: Spatial-Temporal changes of ARI among children in India from 2016 to 2021

State/UTs	Absolute Change (in %)		
	Total	**Urban**	**Rural**
A. North Region	**0.07**	**0.36**	-0.05
Chandigarh	-2.49	-2.59	0.00
Nct Of Delhi	**3.22**	**3.13**	**5.36**
Haryana	-0.90	-1.48	-0.60
Himachal Pradesh	-0.17	**3.22**	-0.56
Jammu & Kashmir	-1.59	-0.10	-2.12
Punjab	-1.66	-3.09	-0.82
Rajasthan	**0.87**	**0.83**	**0.90**
Uttarakhand	-2.35	-1.26	-2.94
B. Central Region	-0.61	-0.17	-0.72

State/UTs	Absolute Change (in %)		
	Total	**Urban**	**Rural**
Chhattisgarh	-0.71	-0.84	-0.65
Madhya Pradesh	**0.50**	**1.86**	**0.05**
Uttar Pradesh	-1.11	-1.02	-1.11
C. East Region	**0.33**	**0.17**	**0.39**
Bihar	**1.01**	**1.17**	**1.04**
Jharkhand	-1.13	-1.85	-0.98
Odisha	**0.72**	**0.96**	**0.72**
West Bengal	-0.49	-0.21	-0.59
D. Northeast Region	**0.87**	**0.90**	**0.88**
Arunachal Pradesh	0.00	**1.30**	-0.31
Assam	**1.48**	**2.00**	**1.44**
Manipur	**0.05**	**0.59**	-0.23
Meghalaya	-1.00	**0.97**	-1.27
Mizoram	-1.58	-2.10	-0.99
Nagaland	-0.32	-0.61	-0.19
Sikkim	**0.42**	**0.40**	**0.46**
Tripura	-1.33	-1.31	-1.35
4. West Region	**0.38**	-0.29	**0.89**
Dadra & Nagar Haveli and Daman & Diu	-1.22	-0.29	-2.09
Goa	-0.51	-0.89	**0.03**
Gujarat	-0.42	-0.61	-0.27
Maharashtra	**0.81**	-0.14	**1.57**
5. South Region	**0.12**	-0.12	**0.27**
Andaman & Nicobar Islands	**0.19**	-2.77	**2.59**
Andhra Pradesh	**1.86**	**1.19**	**2.00**
Karnataka	**0.33**	**0.21**	**0.38**
Kerala	**1.59**	**1.37**	**1.84**
Lakshadweep	**0.47**	**0.88**	0.00
Puducherry	**1.92**	**3.86**	-2.43
Tamil Nadu	-1.69	-1.31	-1.98
Telangana	**0.21**	-0.15	**0.51**
India	**0.06**	0.00	**0.08**

Note: *Positive (+) changes Increase in prevalence; Negative (-) changes: decrease in prevalence. NA: Ladakh does not include in NFHS-IV (2015-16)*

Figure (**Fig: 3.8**) illustrates the changes in the prevalence of ARI among children across different states and union territories of India between 2016 to 2021. Approximately 18 states and union territories, including Chandigarh, Uttarakhand, Tamil Nadu, Punjab, Jammu & Kashmir, Mizoram, Tripura, Dadra & Nagar Haveli and Daman & Diu, Jharkhand, Uttar Pradesh, Meghalaya, Haryana, Chhattisgarh, Goa, West Bengal, Gujarat, Nagaland, and Himachal Pradesh, showed a decrease in the prevalence of ARI. On the other hand, 16 states and union territories, such as Manipur, Andaman & Nicobar Islands, Telangana, Karnataka, Sikkim, Lakshadweep, Madhya Pradesh, Odisha, Maharashtra, Rajasthan, Bihar, Assam, Kerala, Andhra Pradesh, and NCT of Delhi, recorded an increase in the prevalence rate of this condition (**Fig: 3.8**).

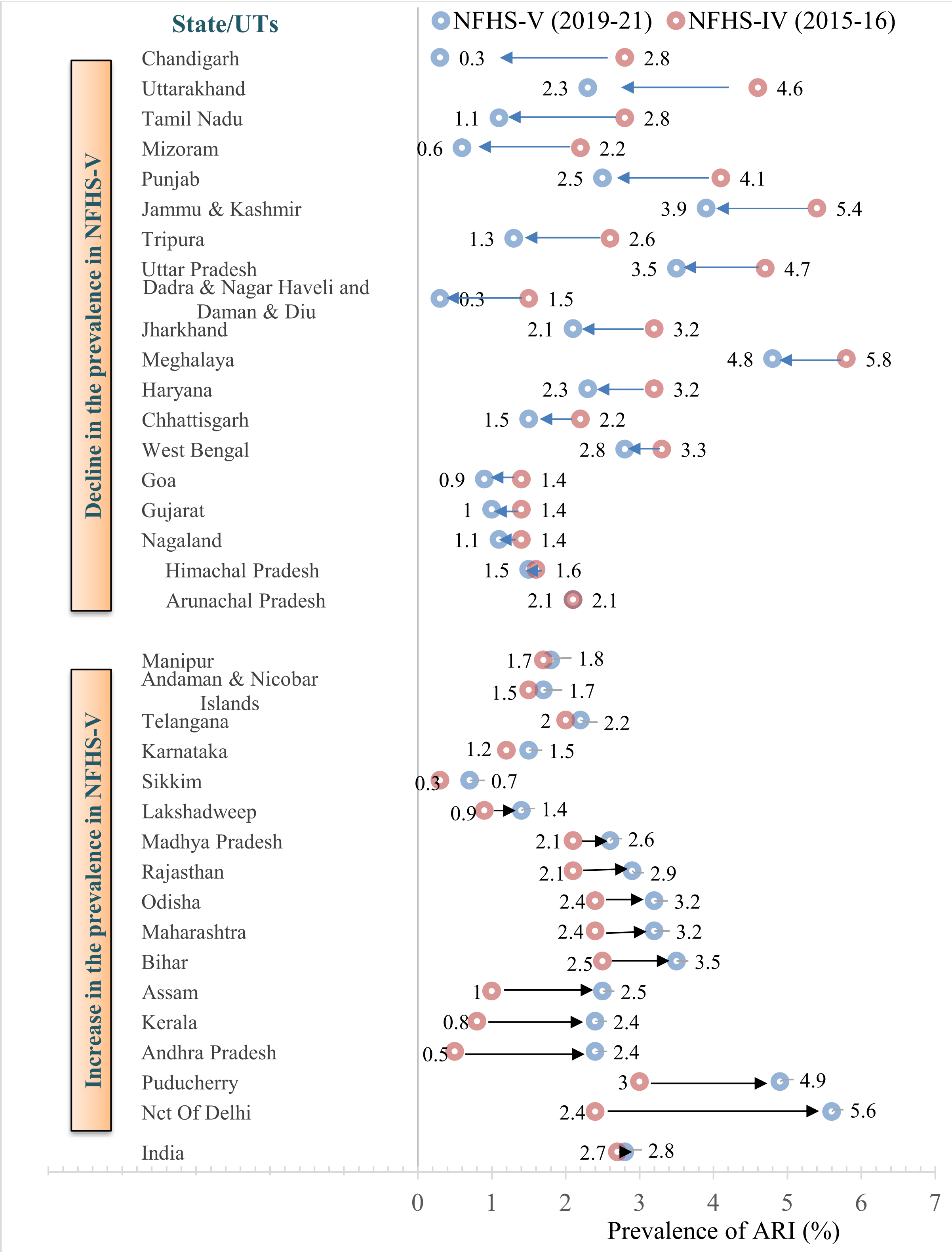


Figure 3.8: Spatial-Temporal changes of ARI among children across the state and UTs in India (2016-2021)

Spatial-temporal changes across the 640 districts in India:

The figure **3.9** represents the spatial-temporal changes across the 640 districts in India from 2016 to 2021. The figure represents the spatiotemporal changes across the 640 districts in India from 2016 to 2021. The map indicates a wide variation in the change of prevalence across different districts in India. Approximately 48% of districts (309 out of 640) in India reported a decrease in the prevalence of ARI, whereas 52% of districts showed an increase in the prevalence of ARI in India. Ramben district in Jammu and Kashmir reported the highest decrease in prevalence (-16.1%), while Bundi district in Rajasthan showed the highest increase (8%). Most of the districts with increasing prevalence belong to the states of Madhya Pradesh, Karnataka, Andhra Pradesh, Assam, Bihar, Gujarat, Maharashtra, Nagaland, Odisha, Rajasthan, Uttar Pradesh, and West Bengal. On the other hand three districts i.e Dhule (Maharastra), Jalaun (uttar Pradesh) and south district of Sikkim showed no change in the prevalence of ARI.

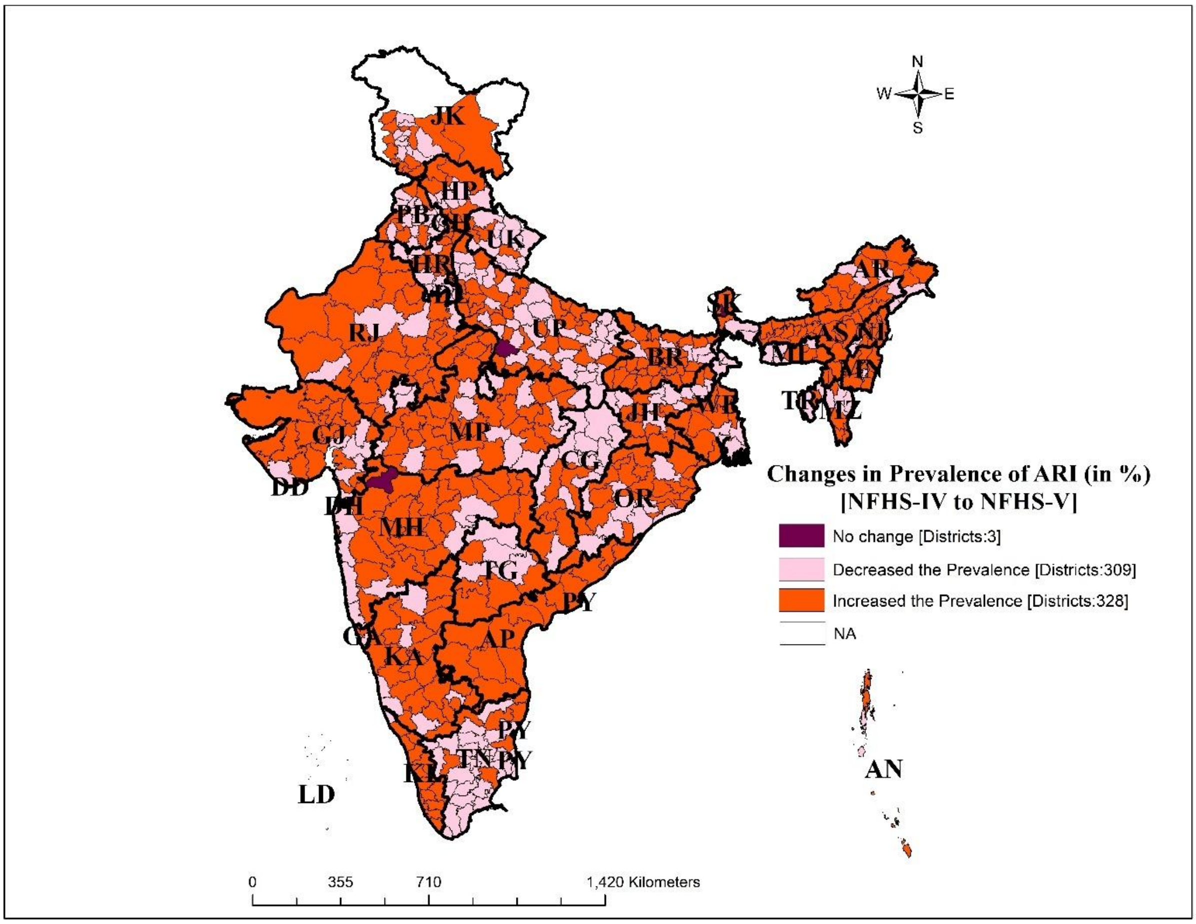


Figure 3.9: Spatio-temporal changes in the prevalence of ARI among children in India from 2016 to 2021

3.1.5 Spatial Clustering of ARI Prevalence in India in 2019-21

Spatial clustering in the prevalence of ARI among children in India (2019-21): The figure despite the LISA cluster map and significance map for ARI prevalence among children across districts in India, 2019–21 (NFHS-5). The results showed that out of 707 districts 58 districts are detected as hotspot areas [**Fig. 3.10 (A)**] with a Moran's Index value of 0.27. The most of the hot-spot districts are located in Uttar Pradesh, Maharashtra, Panjab, Jammu & Kashmir, Odisha and Assam. On the other hand, 66 districts are showing cold spot areas from Gujarat, Tamilnadan and Mizoram. The level of significance map represents around 152 districts have reported in clusters with ≤5% significance level [**Fig. 3.10 (B)**].

A. LISA cluster map ***B. LISA significance map***

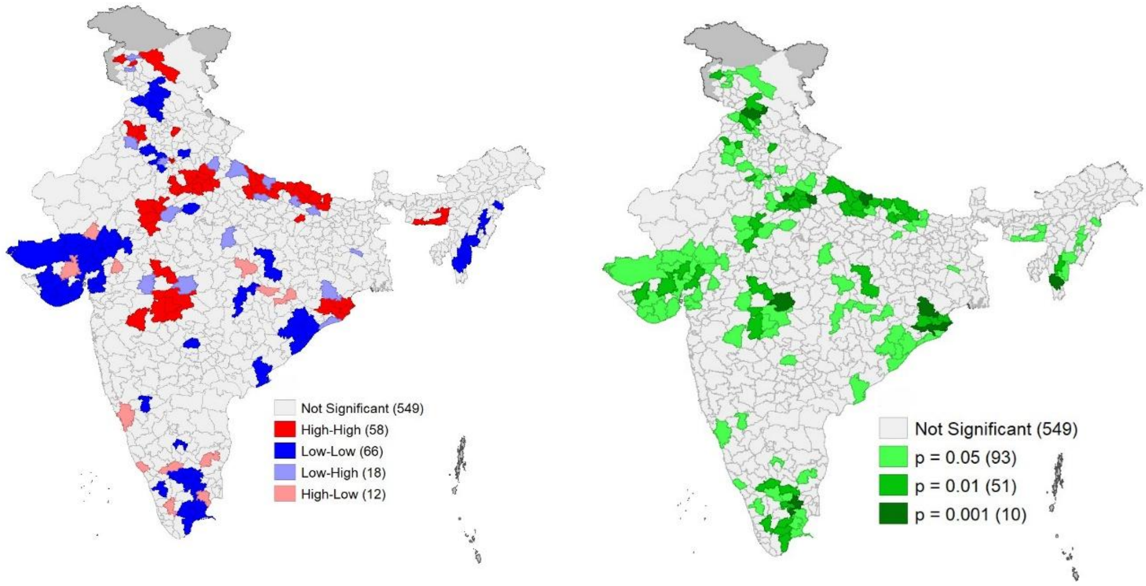


Figure 3.10: LISA cluster map and significance map for ARI prevalence among children in districts of India, 2019–21 (NFHS-V)

Univariate Moran's I: The table (**Table 3.6**)indicates that there is spatial autocorrelation between children who had ARI and those living in areas with high levels of Particulate Matter 2.5 (M'I=0.229), children with illiterate mothers (M'I=0.157), children who had diarrhoea 2 weeks before the survey (M'I=0.139), exposure to smoking in the household, low birth weight (M'I=0.068), and underweight children (M'I=0.052).

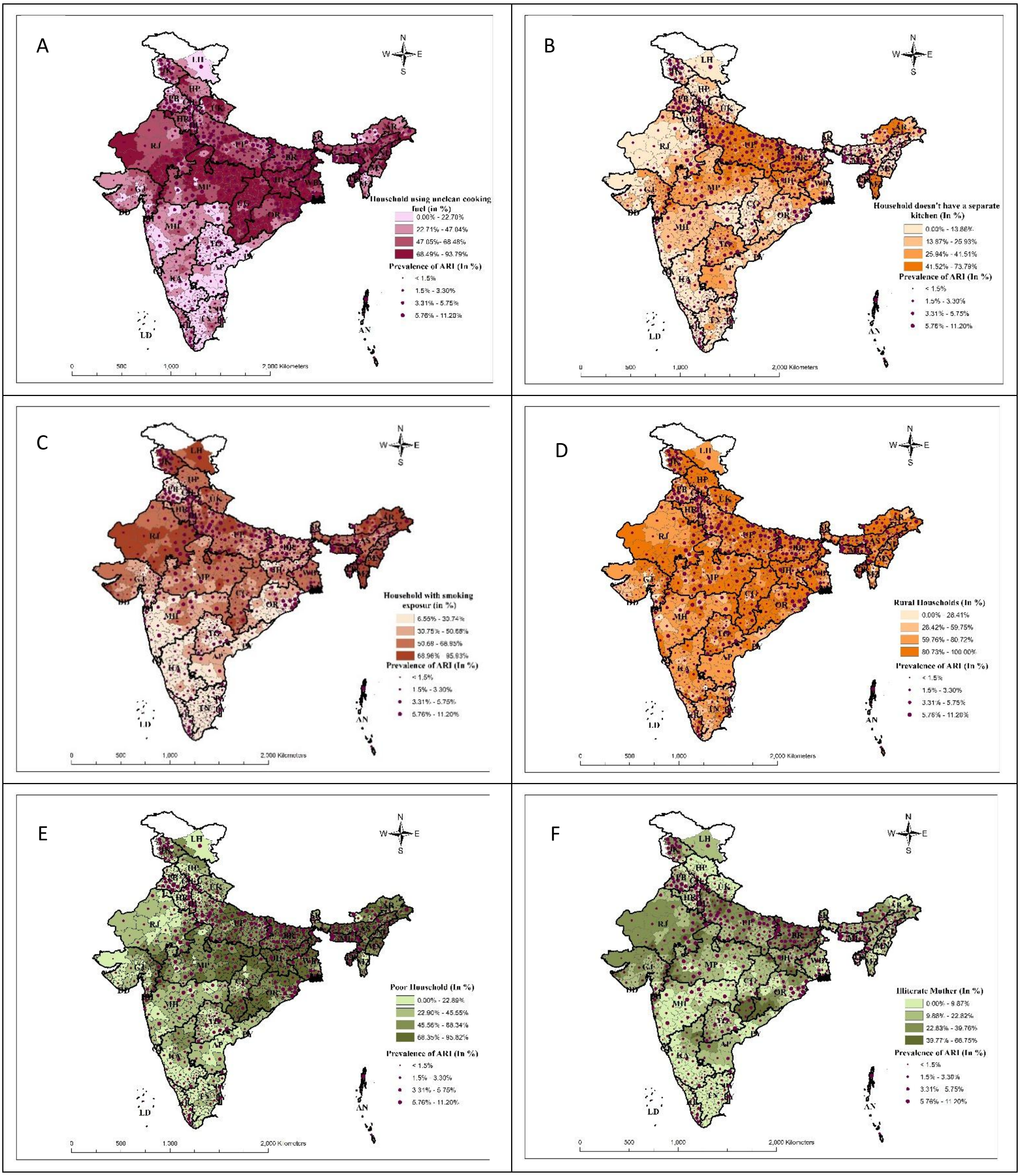
Bivariate Morans'I: Table 3.6 displays the values of bivariate Moran's I statistics in India. The results indicate that the highest univariate Moran's I among the predictors was the concentration of Particle Matters 2.5 (Moran's I=0.953, p <0.001), followed by smoking exposure in the household (Moran's I=0.81; p<0.001), mothers' smoking behaviour (Moran's I = 0.778, p-value = 0.001), and poor household (Moran's I=0.769; p<0.001).

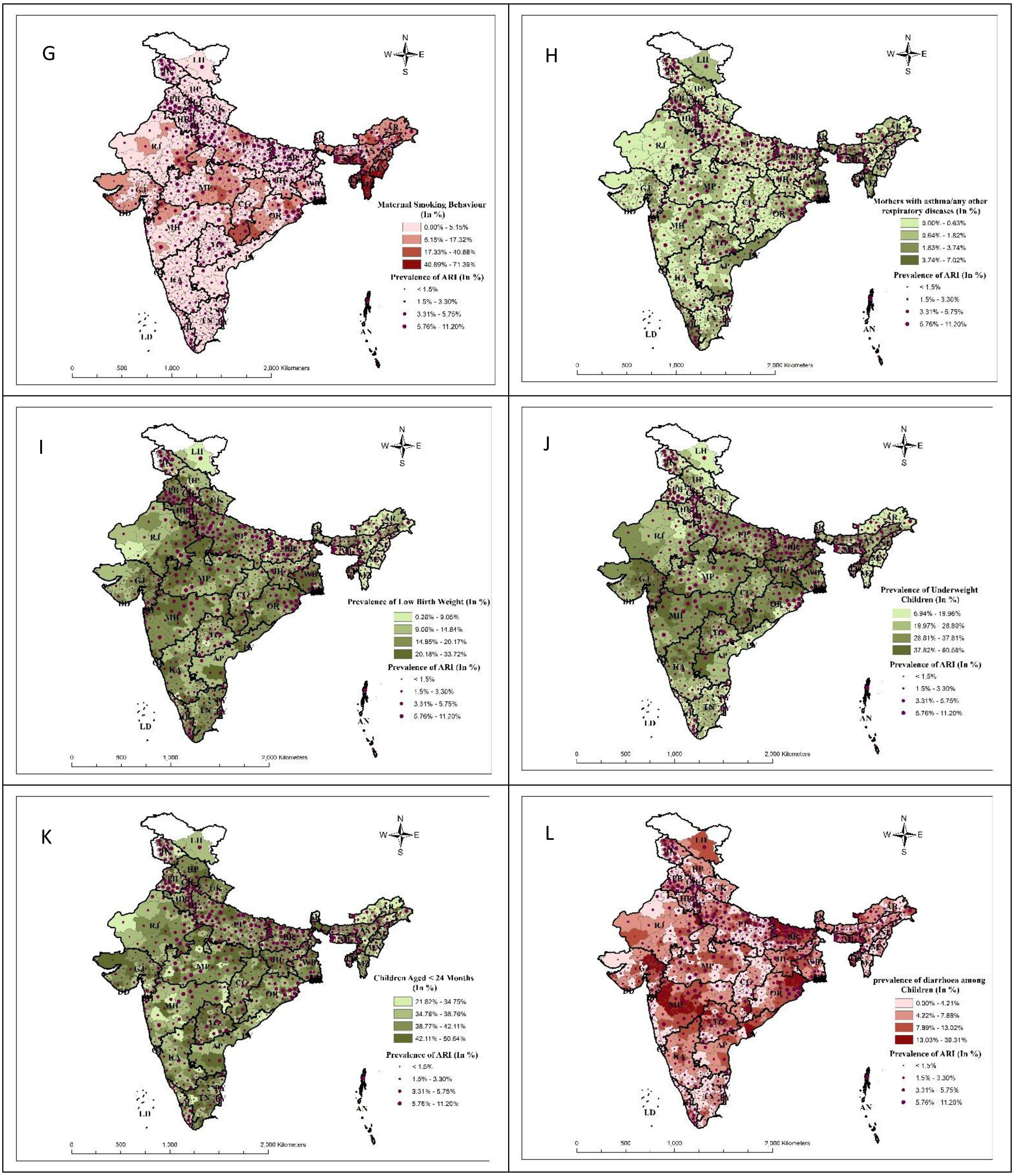
Table 3.6: Univariate and Bivariate Moran's I for ARI and predictors in India, 2019-21.

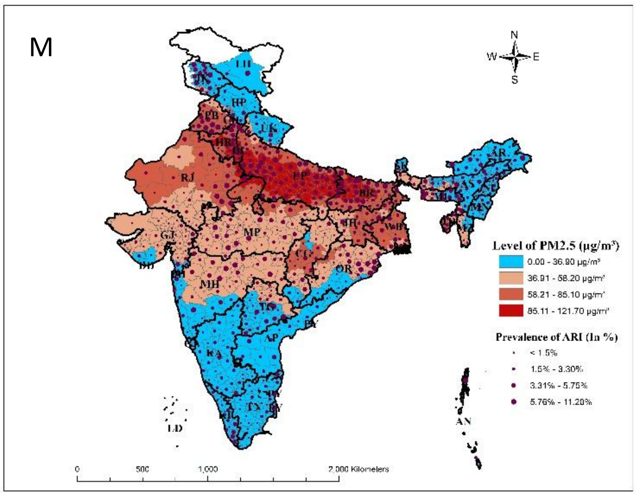
Predictors	U Moran's I	B Moran's I
ARI prevalence (%)	0.271*	NA
Households using unclean cooking fuel (%)	0.703*	0.070*
The household doesn't have a separate kitchen (%)	0.780*	0.146*
Smoking exposure in the household (%)	0.808*	0.097*
Rural household (%)	0.441*	0.042*
Poor household (%)	0.769*	0.088*
Illiterate mother (%)	0.680*	0.164*
Mothers smoke (%)	**0.778***	**-0.059***
mothers with asthma/respiratory infection (%)	0.287*	0.039*
Low Birth Weights (%)	0.563*	0.051*
Underweight children (%)	0.660*	0.035*
Children ages <24 months (%)	0.180*	-0.037*
The child had diarrhoea 2 weeks before the survey	0.405*	0.155*
Particle matters 2.5	0.953*	0.241*

Spatial association between ARI prevalence with the covariates across the 707 districts in India:

The spatial distribution of ARI and its related factors are illustrated in **figure 3.11**. This map provides essential information about the prevalence of ARI and other related factors within a single visual representation. The prevalence is categorized into four quantiles. The dots describe prevalence of ARI, while the color pattern represents the other related factors.


A
Household using unclean cooking fuel (in %)
0.00% - 22.70%
22.71% - 47.04%
47.05%- 68.48%
68.49% - 93.79%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
B
Household doesn't have a separate kitchen (In %)
0.00% - 13.86%
13.87% - 25.93%
25.94% - 41.51%
41.52% - 73.79%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
C
Household with smoking exposur (in %)
6.55% - 30.74%
30.75% - 50.68%
50.69 - 68.95%
68.96% 95.93%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
D
Rural Households (In %)
0.00% 28.41%
28.42% - 59.75%
59.76% - 80.72%
80.73% - 100.00%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
E
Poor Household (In %)
0.00% - 22.89%
22.90% - 45.55%
45.56% - 68.34%
68.35% - 95.82%
Prevalence of ARI (In %)
< 1.5%
1.5% 3.30%
3.31% - 5.75%
5.76% - 11.20%
F
Illiterate Mother (In %)
0.00% - 9.87%
9.88% - 22.82%
22.83% - 39.76%
39.77% - 66.75%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% 5.75%
5.76% - 11.20%
0 500 1,000 2,000 Kilometers


G
Maternal Smoking Behaviour (In %)
0.00% - 5.15%
5.15% - 17.32%
17.33% - 40.88%
40.89% - 71.39%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
2,000 Kilometers
H
Mothers with asthma/any other respiratory diseases (In %)
0.00% - 0.63%
0.64% - 1.82%
1.83% - 3.74%
3.74% - 7.02%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
2,000 Kilometers
I
Prevalence of Low Birth Weight (In %)
0.26% - 9.05%
9.06% - 14.84%
14.85% - 20.17%
20.18% - 33.72%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
2,000 Kilometers
J
Prevalence of Underweight Children (In %)
6.94% - 19.96%
19.97% - 28.80%
28.81% - 37.81%
37.82% - 60.58%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
2,000 Kilometers
K
Children Aged < 24 Months (In %)
21.82% - 34.75%
34.76% - 38.76%
38.77% - 42.11%
42.11% - 50.64%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
2,000 Kilometers
L
prevalence of diarrhoea among Children (In %)
0.00% - 4.21%
4.22% - 7.88%
7.89% - 13.02%
13.03% - 38.31%
Prevalence of ARI (In %)
< 1.5%
1.5% - 3.30%
3.31% - 5.75%
5.76% - 11.20%
2,000 Kilometers



Note: *(A)* Households using unclean cooking fuel
(B) The household doesn't have a separate kitchen
(C) Smoking exposure in the household
(D) Rural household
(E) Poor household
(F) Illiterate mother
(G) Mothers smoke
(H) Mothers with asthma/respiratory infection
(I) Low Birth Weights
(J) Underweight children
(K) Children ages <24 months
(L) The child had diarrhoea 2 weeks before the survey
(M) Particle matters 2.5

Figure 3.11: Spatial prevalence map with the prevalence of ARI and Its correlates

In another this section, we will discuss the spatial relationship between ARI and the covariates using bivariate and univariate LISA maps with the spatial regression model. Figure 3.1.11 represents univariate LISA Map (i.e. cluster and significance) maps for independent variables for the districts of India.

The Moran's I statistic was 0.70, suggesting a significant high spatial clustering dependence in the prevalence of using unclean cooking fuel in India [**Figure 3.12 (A)**]. A total of 169 districts from the central region (West Bengal, Odisha, Bihar, Jharkhand), some parts of the central region (Madhya Pradesh and Chhattisgarh), northern region (Rajasthan, and Uttarakhand), and northeastern region (Assam, Nagaland) formed the hot spots (high-high), while 161 districts from all southern states (Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, and Kerala), some parts of northern states (Jammu & Kashmir and Punjab), one northern state (Mizoram), and one western state (Maharashtra) were identified as the cold spots (low-low) for household using unclean cooking fuel (Moran's I = 0.70, p-value = 0.001) across India.

The univariate LISA cluster map of households without a separate kitchen (Moran's I = 0.78, p-value = 0.001) revealed 134 hotspots and 178 cold spots [**Figure 3.12 (B)**]. The majority of hotspots are situated in the eastern region (Jharkhand, Bihar), central region (Uttar Pradesh, Madhya Pradesh, and Chhattisgarh), and some parts of the northeastern region (Arunachal Pradesh). Cold spots, on the other hand, are located in the western states (Gujarat), northern states (Rajasthan, Jammu & Kashmir, Punjab, and Himachal Pradesh), southern states (sections of Kerala, Karnataka, and Tamil Nadu), and northeastern states (Sikkim, Assam, Meghalaya, and Mizoram).

In the case of household smoking exposure, a total of 168 hot spot districts were detected in India (Moran's I = 0.81, p-value < 0.001) [**Figure 3.12 (C)**]. Most of the hotspot districts were located in the northeastern states (parts of Assam, Arunachal Pradesh, Meghalaya, Manipur, Tripura, and Mizoram), western state (Gujarat), central region (Uttar Pradesh and Madhya Pradesh), and the northern region (Rajasthan) of India. Additionally, 174 "cold-spot" districts were identified in the southern (Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, and Odisha), northern (Punjab), and western (some from Maharashtra) regions of India.

The analysis of rural resident children using a Univariate LISA cluster map revealed a Moran's I value of 0.44 with a p-value of 0.001 [**Figure 3.12 (D)**]. This identified 111 "hotspots" and 48 "cold spots". The majority of hotspots are concentrated in Northern states (Himachal Pradesh, Jammu & Kashmir, Uttarakhand), Eastern states (parts of Bihar, Jharkhand, Orissa, West Bengal), Central regions (Uttar Pradesh and Madhya Pradesh), and North Eastern states (Assam, Arunachal Pradesh, Meghalaya, and Tripura). Conversely, hotspot incidence is lower in certain parts of Southern states (such as Karnataka, Andhra Pradesh, Tamil Nadu) and Western states (Maharashtra, Gujarat) in India.

In the case of poor households, a total of 188 hot-spot districts have been identified (Moran's I = 0.77, p-value < 0.001) [**Figure 3.12 (E)**]. The hot-spot districts are located in the following regions: North-eastern states (Assam, Arunachal Pradesh, Meghalaya, Manipur, Nagaland, and Tripura), eastern states (Bihar, Jharkhand, Odisha, and West Bengal), central India (Madhya Pradesh, Uttar Pradesh, Chhattisgarh, and some districts of Madhya Pradesh). Additionally, 181 districts from southern states (Kerala, Karnataka, Tamil Nadu, and Telangana), western states (some parts of Rajasthan, Gujarat, and Maharashtra), and northern states (Punjab, Himachal Pradesh, Haryana, and Uttarakhand) formed the cold spots (low-low) of poor wealth quintile children across India.

In addition, the Univariate LISA cluster map of literate mothers showed a Moran's I of 0.68 with a p-value of 0.001, and it identified 124 hotspots and 166 cold spots [**Figure 3.12 (F)**]. The hotspots were observed in districts located in Central India (Uttar Pradesh, Madhya Pradesh, and Chhattisgarh), Eastern India (Bihar and Jharkhand), South India (Telangana and Karnataka), and some districts in the Western part (Rajasthan, Gujarat, and Maharashtra). On the other hand, the cold spots were found in districts located in Southern India (Tamil Nadu, Kerala, Karnataka), Northern India, and in some districts in Western India (Maharashtra) and Northeastern states (Tripura, Mizoram, and Sikkim) in India.

The Univariate LISA cluster map of mother's smoking behaviour (Moran's I = 0.79, p-value = 0.001) revealed 57 hotspots and 233 cold spots [**Figure 3.12 (G)**]. The majority of the hotspots are situated in the North-eastern region (Tripura, Mizoram, Manipur, Meghalaya, and Assam), with some in southern areas (Andhra Pradesh and Telangana) and a few in the central part (Madhya Pradesh) of India. The cold-spot districts are located in the Northern (Jammu & Kashmir, Delhi, Uttarakhand, Punjab, and Haryana), Eastern (Bihar, Jharkhand, and West Bengal), and southern parts (Maharashtra, Karnataka, Tamil Nadu, and Andhra Pradesh) of the country.

Similarly, in the univariate LISA cluster map of mothers with asthma/respiratory infection, a Moran's I of 0.29 with a p-value of less than 0.001 identified 58 hotspots and 66 cold spots [**Figure 3.12 (H)**]. Most of the hotspots are in Central (Uttar Pradesh and Madhya Pradesh), northern (Ladakh, Jammu & Kashmir, Rajasthan, Panjab), and western (Maharashtra) regions. The cold-spot districts are located in the Western region (Gujarat), Northern (Himachal Pradesh), and Southern (Tamil Nadu and Kerala) parts of India.

Likewise, the univariate LISA cluster map of children born with Low Birth Weights (LBW) revealed a Moran's I of 0.56 with a p-value of less than 0.001, identifying 118 hotspots and 99 cold spots [**Figure 3.12 (I)**]. The majority of hotspots are in the Eastern region (West Bengal), Central (Uttar Pradesh and Madhya Pradesh), western (Gujarat and Maharashtra), and some parts of the northern (Punjab and Haryana). The cold-spot districts are located in the Northeastern region (Assam, Meghalaya, Manipur, Mizoram, and Arunachal Pradesh), northern (Jammu & Kashmir, Rajasthan), and southern (Andhra Pradesh and Telangana) parts of India.

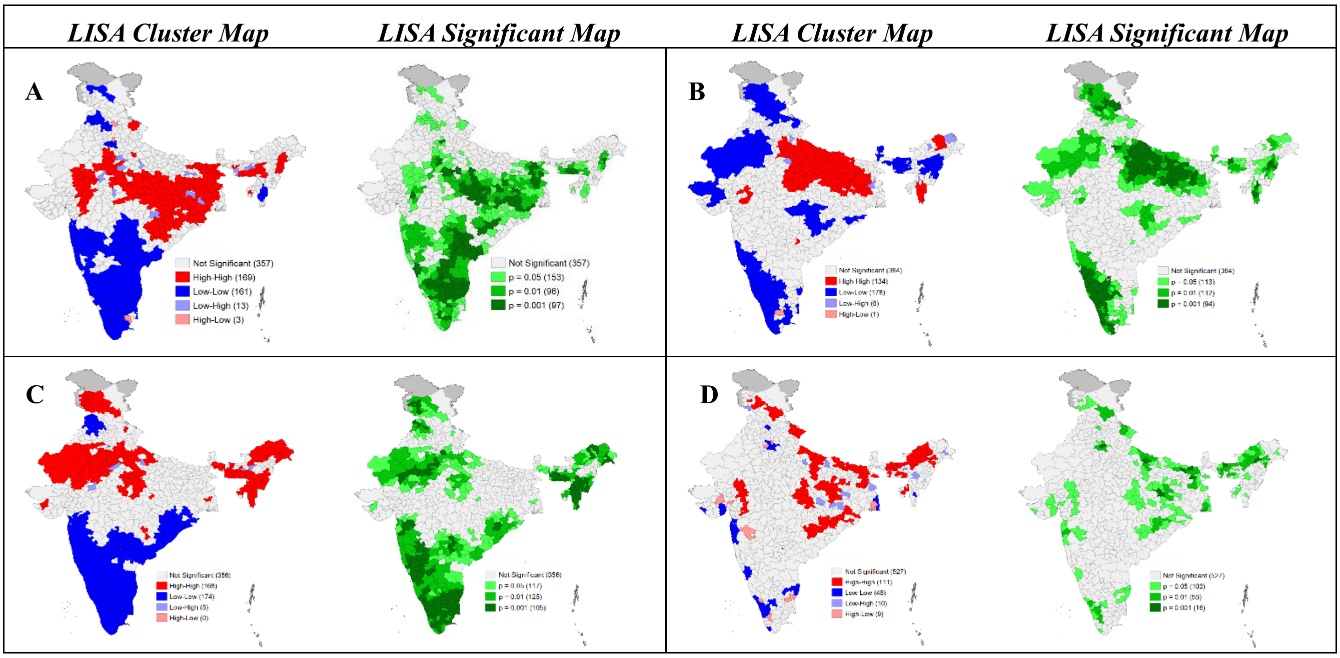
Similarly, the univariate LISA cluster map of underweight children revealed a Moran's I of 0.66 with a p-value of less than 0.001, identifying 148 hotspots and 135 cold spots [**Figure 3.12 (J)**]. The majority of hotspots were in the Eastern region (Bihar, West Bengal, Odisha, and Jharkhand), western (Gujarat and Maharashtra), some parts of central (Madhya Pradesh and Chhattisgarh), and southern (Karnataka and Telangana) India. The cold-spot districts were located in the northeastern, northern, and southern parts of India.

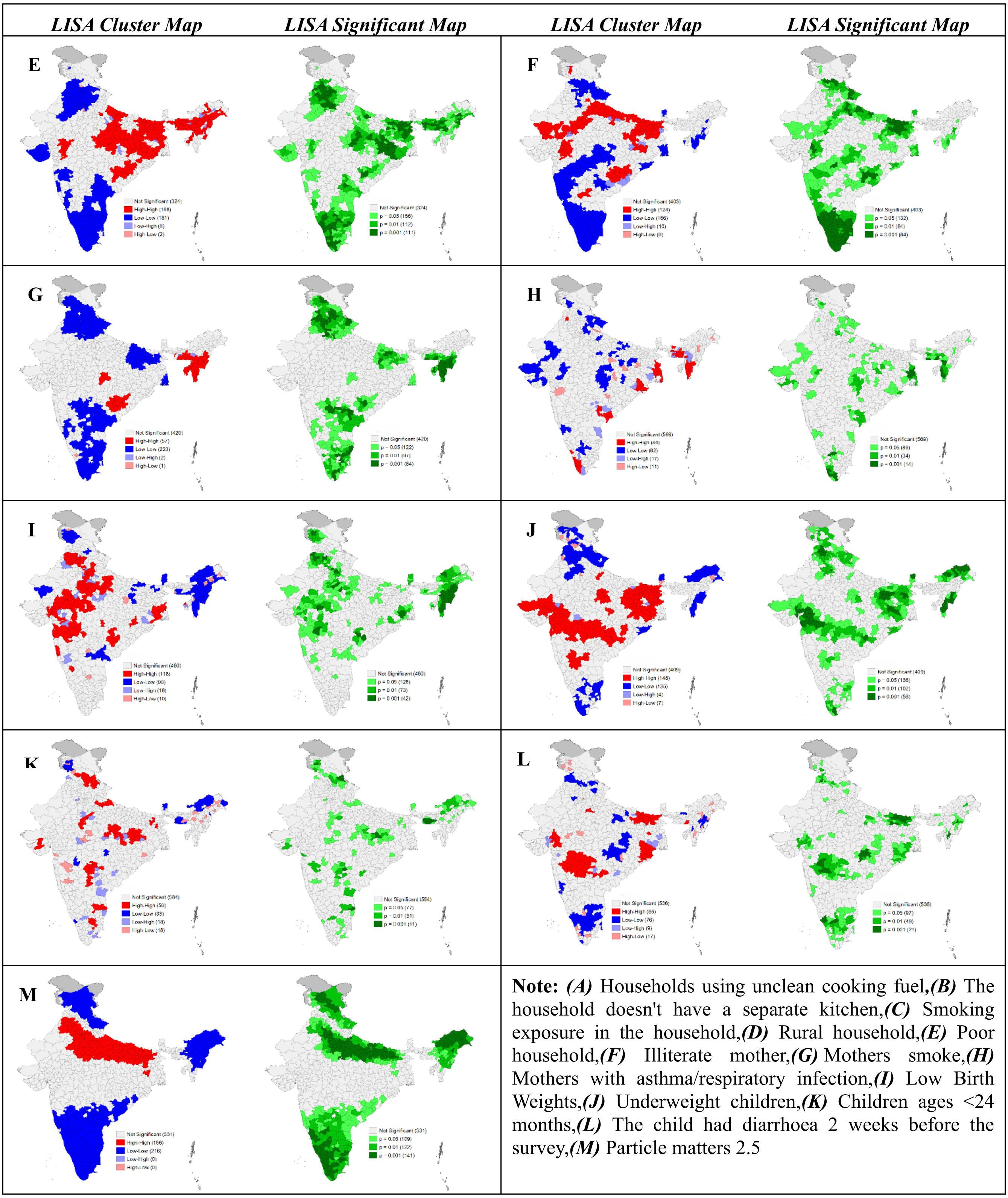
The univariate LISA cluster map of children ages under 24 months showed a Moran's I of 0.18 with a p-value below 0.001 [**Figure 3.12 (K)**]. This identified 50 hotspots and 33 cold spots. The majority of hotspots were found in the Eastern (Bihar and Jharkhand), Central (Uttar

Pradesh and Madhya Pradesh), Southern (Tamil Nadu and Karnataka), and Northern (Himachal Pradesh and Uttarakhand) parts of India. The cold-spot districts were located in the Northeastern part (Assam, Arunachal Pradesh, and Meghalaya) and the Northern part (Jammu & Kashmir) of India.

The univariate LISA cluster map of The child had diarrhoea 2 weeks before the survey showed a Moran's I of 0.41 with a p-value below 0.001, indicating 65 hotspots and 76 cold spots [**Figure 3.12 (L)**]. The majority of hotspots were found in the Eastern region (Bihar and Odisha) and western parts of India (Gujarat and Maharashtra). The cold-spot districts were located in Southern India (Tamil Nadu and Kerala), some parts of northern India (Nagaland and Manipur), and northern India (Punjab, Uttarakhand, and Himachal Pradesh).

The univariate LISA cluster map of Particulate Matter 2.5 revealed a Moran's I value of 0.95, indicating statistical significance with a p-value less than 0.001 [**Figure 3.12 (M)**]. The analysis identified 156 hotspots and 216 cold spots. Hotspots were predominantly concentrated in the Central region (Uttar Pradesh, Bihar, Madhya Pradesh) and northern region (Punjab, Haryana, and Rajasthan). Cold-spot districts were primarily located in the southern and northeastern states, as well as in certain areas of northern India.





Note: ***(A)*** Households using unclean cooking fuel,***(B)*** The household doesn't have a separate kitchen,***(C)*** Smoking exposure in the household,***(D)*** Rural household,***(E)*** Poor household,***(F)*** Illiterate mother,***(G)*** Mothers smoke,***(H)*** Mothers with asthma/respiratory infection,***(I)*** Low Birth Weights,***(J)*** Underweight children,***(K)*** Children ages <24 months,***(L)*** The child had diarrhoea 2 weeks before the survey,***(M)*** Particle matters 2.5

Figure 3.12: Univariate LISA cluster and significance maps for independent variables for districts of India, 2019–21

Bivariate LISA:

The LISA cluster map shows the spatial correlation between the prevalence of Acute Respiratory Infection (ARI) among children and various factors in the districts of India. On the other hand, the LISA significance map indicates that districts are clustered with a significance level of ≤ 5% (**Figure 3.13)**.

The LISA cluster map identifies 82 hot spots for ARI and households using unclean cooking fuel out of 707 districts [**Figure 3.13 (A)**]. These hot spots are located in the Central (Uttar Pradesh, Madhya Pradesh, Chhattisgarh), Eastern (Bihar, Orissa, Jharkhand, West Bengal), and northeastern (Assam, Meghalaya) regions of India. On the other hand, 110 districts have been identified as cold-spot areas in Southern (Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, and Kerala) and some districts in northern (Punjab and Haryana) and northeast (Mizoram) states in India. The level of significance map shows that approximately 346 districts are clustered with a significance level of ≤ 5%.

Additionally, the LISA cluster map identifies 78 hot spots for ARI and households without a separate kitchen [**Figure 3.13 (B)**]. These hot spots are located in the eastern (Bihar, Jharkhand and West Bengal) and central (Uttar Pradesh and Madhya Pradesh) areas of India. On the other hand, 120 districts have been identified as cold-spot areas in South (Karnataka, Tamil Nadu, and Kerala), North (Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Punjab, and Rajasthan), West (Gujarat), and northeast (Assam, Nagaland, and Manipur) in India. The level of significance map shows that approximately 319 districts are clustered with a significance level of ≤ 5%.

Furthermore, the LISA cluster map identifies 73 hot spots for ARI and smoking exposure in households out of 707 districts [**Figure 3.13 (C)**]. These hot spots are located in the Western (Rajasthan), Central (Uttar Pradesh and Madhya Pradesh), Northern (Jammu & Kashmir, Ladakh), and Northeastern (Assam, Meghalaya, Arunachal Pradesh) regions of India. On the other hand, 121 districts have been identified as cold-spot areas in Southern (Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, and Kerala) and some districts in northern (Punjab and Haryana) states in India. The level of significance map shows that approximately 347 districts are clustered with a significance level of ≤ 5%.

Moreover, the LISA cluster map identifies 50 hot spots for ARI and rural households out of 707 districts [**Figure 3.13 (D)**]. These hot spots are located in the Eastern (Bihar and Jharkhand), Central (Uttar Pradesh, Madhya Pradesh, and Chhattisgarh), and Northeast (Assam, Meghalaya, and Arunachal Pradesh) in India. On the other hand, 35 districts have been identified as cold-spot areas in the South (Tamil Nadu and Kerala) and some districts in the West (Gujarat and Maharashtra) and East (West Bengal) of India. The level of significance map shows that approximately 176 districts are clustered with a significance level of ≤ 5%.

Additionally, the LISA cluster map identifies 86 hot spots for ARI and poor households out of 707 districts [**Figure 3.13 (E)**]. These hot spots are located in the Eastern (Bihar, Jharkhand, Orissa, West Bengal), Central (Uttar Pradesh, Madhya Pradesh), and Northeastern (Assam, Meghalaya, Arunachal Pradesh) in India. On the other hand, 121 districts have been identified as cold-spot areas in Southern (Kerala, Karnataka, and Tamil Nadu), Western (Gujarat and Maharashtra), and northern (Punjab, Haryana, Himachal Pradesh, and Uttarakhand) states in India. The level of significance map shows that approximately 379 districts are clustered with a significance level of ≤ 5%.

Furthermore, the LISA cluster map shows 72 hot spots for ARI and illiterate mothers out of 707 districts [**Figure 3.13 (F)**]. These hot spots are located in the Eastern (Bihar, Jharkhand, Orissa, West Bengal) and Central (Uttar Pradesh, Madhya Pradesh) regions of India. On the other hand, 114 districts have been identified as cold-spot areas in Southern (Karnataka, Kerala, and Tamil Nadu), Northern states (Mizoram, Manipur, and Nagaland), and Northern (Punjab, Haryana, Himachal Pradesh, and Uttarakhand) in India. The level of significance map shows that approximately 300 districts are clustered with a significance level of ≤ 5%.

Finally, the map demonstrates 17 hot spots for Acute Respiratory Infection (ARI) and exposure to maternal smokeout in 707 districts in India [**Figure 3.13 (G)**]. These hot spots are located in the Northeast region (specifically Assam and Meghalaya) and the Central region (Madhya Pradesh and Chhattisgarh). On the other hand, 133 districts have been identified as cold-spot areas in the Southern region (Kerala, Karnataka, Andhra Pradesh, and Tamil Nadu), the northern states (Jammu and Kashmir, Punjab, Haryana, Uttarakhand, and Himachal Pradesh), and some districts in the Eastern part (West Bengal and Bihar) of India. The significance map demonstrates that around 285 districts are clustered with a significance level of ≤ 5%.

The LISA cluster map identifies several hot spots for ARI in India [**Figure 3.13 (H)**]. Out of 707 districts examined, 27 hot spots for ARI and mothers with asthma/respiratory infection were found in the Northeast (Assam and Meghalaya), eastern (West Bengal and Orissa), and southern (Andhra Pradesh and Kerala) regions. Alternatively, 47 districts have been identified as cold-spot areas in central (Uttar Pradesh, Madhya Pradesh, and Chhattisgarh) and northern (Rajasthan, Himachal Pradesh, Uttarakhand) India. The level of significance map shows that approximately 133 districts are clustered with a significance level of ≤ 5%.

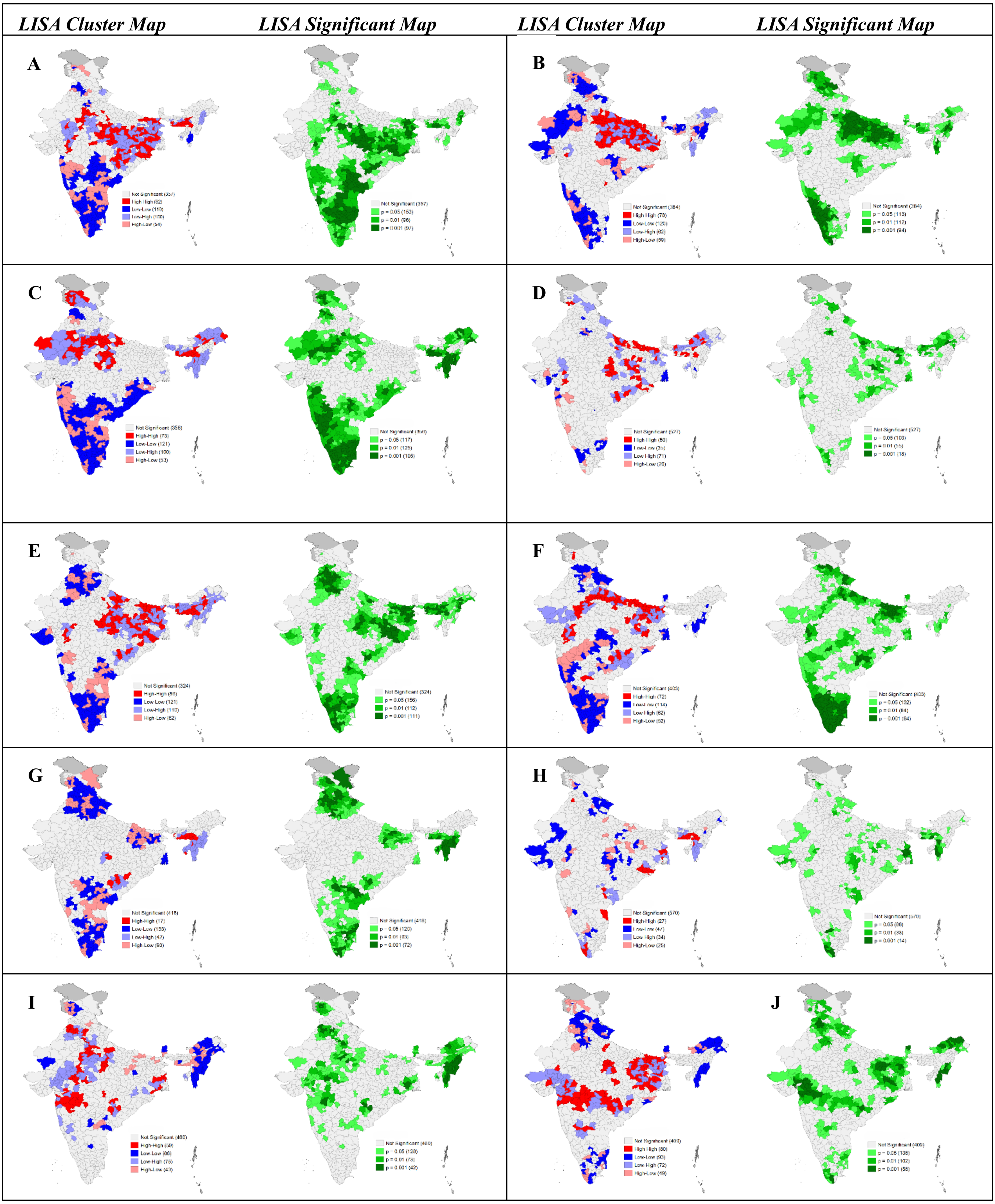
Additionally, the LISA cluster map also identifies hot spots for ARI and Low Birth Weights, with 59 hot spots located in the Western (Maharashtra), Central (Uttar Pradesh, Madhya Pradesh, and Chhattisgarh), Northern (Punjab, Haryana), and Eastern (West Bengal, Orissa) regions, and cold-spot areas located in Northeastern states (Arunachal Pradesh, Nagaland, Mizoram, Manipur, Sikkim) and some districts in northern India (Rajasthan and Jammu & Kashmir). The significance map shows that approximately 243 districts are clustered with a significance level of ≤ 5% [**Figure 3.13 (I)**].

Similarly, the LISA cluster map identifies hot spots for ARI and underweight children, with 80 hot spots located in the Eastern (West Bengal, Jharkhand, Bihar, and Orissa), Central (Madhya Pradesh, Uttar Pradesh, Chhattisgarh), Western (Maharashtra, Gujarat), and Southern (Karnataka) regions, and cold-spot areas in the Northern states, Northeast, and Southern regions of India. The level of significance map shows approximately 294 districts clustered with a significance level of ≤ 5% [**Figure 3.13 (J)**].

Moreover, hot spots for ARI and children ages <24 months are identified, with 21 hot spots located in Central (Chattisgarh, Uttar Pradash and Madhya Pradesh) and Southern India ((Andhra Pradesh, Tamil Nadu) and cold-spot areas identified in the Northeast (Arunachal Pradesh and Assam and Sikkim) and some districts from Northern (Jammu & Kashmir) state. The significance map shows approximately 119 districts clustered with a significance level of ≤ 5% [**Figure 3.13 (K)**].

Additionally, hot spots for ARI and children who had diarrhea 2 weeks before the survey are identified. The hot spots are located in the Western (Maharastra), Eastern (Orissa, West Bengal and Bihar), and Central region (Madhya Pradesh) of India, while cold-spot areas are found in Central, Southern, Northeastern, and Northern parts of India. The significance map shows that approximately 167 districts are clustered with a significance level of ≤ 5% [**Figure 3.13 (L)**].

Finally, hot spots for ARI and Particle Matter 2.5 are identified in the eastern (Bihar, West Bengal, and Jharkhand), central (Uttar Pradesh and Madhya Pradesh), and northern (Panjab, Haryana, Delhi) areas of India, while cold-spot areas are found in Northeastern (Arunachal Pradesh, Nagaland, Mizoram, Manipur, and Assam), Southern (Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, and Kerala), and Northern (Jammu & Kashmir, Himachal Pradesh, Uttrakhand) India. The significance map shows that approximately 372 districts are clustered with a significance level of ≤ 5% [**Figure 3.13 (M)**].


LISA Cluster Map
LISA Significant Map
LISA Cluster Map
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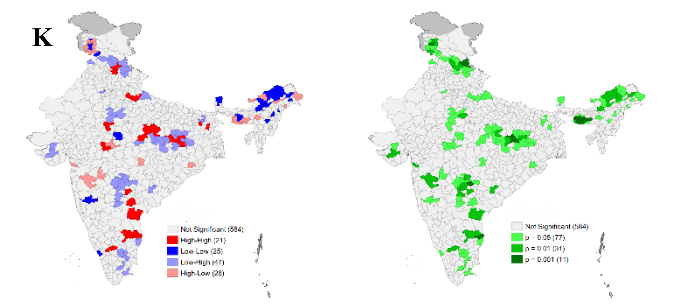
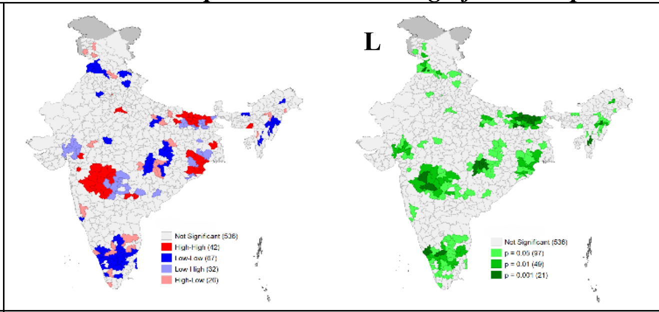
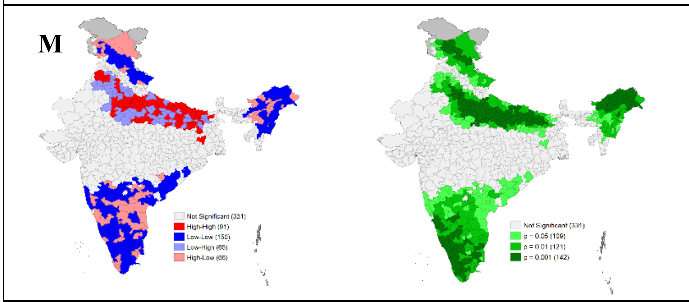
LISA Cluster Map	*LISA Significant Map*	*LISA Cluster Map*	*LISA Significant Map*







Note: Spatial association ARI and ***(A)*** Households using unclean cooking fuel,***(B)*** The household doesn't have a separate kitchen,***(C)*** Smoking exposure in the household,***(D)*** Rural household,***(E)*** Poor household,***(F)*** Illiterate mother,***(G)*** Mothers smoke,***(H)*** Mothers with asthma/respiratory infection,***(I)*** Low Birth Weights,***(J)*** Underweight children,***(K)*** Children ages <24 months,***(L)*** The child had diarrhoea 2 weeks before the survey,***(M)*** Particle matters 2.5

Figure 3.13: Bivariate LISA cluster and significance maps for childhood ARI and independent variables for districts of India, 2019–21

Spatial Association between ARI with the covariates across the districts in India (2019-21):
The spatial regression estimates for children with ARI and its covariates across 707 districts of India in 2021 are provided in **Table 3.7**. We examined three models: OLS, SLM, and SEM. A value of $\boldsymbol{\lambda}$ 0.40 in SEM suggests a moderate positive spatial autocorrelation in the error terms. This means that if one location has a high error term, nearby locations are also likely to have high error terms. On the other hand, a value of $\boldsymbol{\rho}$ 0.35 in SLM suggests a moderate positive spatial dependence in the dependent variable. This means that high values of the dependent variable at one location are moderately associated with high values at nearby locations. According to the theory of spatial regression models, the model with the lowest AIC value and the highest R^2 value is regarded as the best-fit model.

Based on the Ordinary Least Squares (OLS) estimate, it was confirmed that smoking exposure in the household (β: 0.2, $p < 0.001$), living in a rural area (β: 0.01), having an illiterate mother (β: 0.01, $p < 0.001$), having a mother with asthma/respiratory infection (β: 0.33), and low birth weight (β: 0.06, $p < 0.001$) were all significant predictors of children's Acute Respiratory Infection (ARI) in India. Additionally, experiencing diarrhea two weeks before the survey (β: 0.14) and exposure to particle matters 2.5 (β: 0.02) were found to be significant spatial predictors of children's ARI. The adjusted R^2 value was 0.25, and the AIC value was 2,849.

The Spatial Lag Model (SLM) estimate confirmed that smoking exposure in the household (β: 0.02), living in rural households (β: 0.01), having a mother with asthma/respiratory infection (β: 0.28), low birth weight (β: 0.05), experiencing diarrhea two weeks before the survey (β: 0.13), and exposure to particle matters 2.5 (β: 0.01) were significant spatial predictors of children's ARI in India. The adjusted R 2 value was 0.32, and the AIC value was 2,803.

According to our model estimates, the spatial error model (SEM) had the lowest AIC and the highest adjusted R^2 value, making it the best-fit model among the three. The spatial error model had an AIC value of 2,795 and an adjusted R-squared value of 0.33. Interestingly, the value of Lambda (spatial autoregressive coefficient)/error lag value was 0.40 ($p < 0.001$), which indicates that spatial influence on ARI prevalence exists due to omitted variables do not present in the SEM.

The results show that Smoking exposure in the household (β: 0.03, $p<0.05$), mothers with asthma/respiratory infection (β: 0.27, $p<0.001$), children born with low birth weights (β: 0.06, $p<0.01$), children who had diarrhea 2 weeks before the survey (β: 0.15, $p<0.001$), and concentration of particulate matter 2.5 (β: 0.02, $p<0.001$) were positively associated with ARI prevalence.

The model shows that if household smoking exposure in a district increases by 10%, then the prevalence of ARI in children increases by 3%. Similarly, if the percentage of mothers with asthma/respiratory infection in a district increases by 10%, then the prevalence of ARI in children increases by 27%. Likewise, an increase of 10% in the prevalence of low birth weight and diarrhea in children in a district results in a 6% and 15% increase in ARI prevalence, respectively. Additionally, if the concentration of particulate matter 2.5 in a district increases by 10%, then the ARI prevalence increases by 2%.

In summary, these results indicate that districts with higher instances of household smoking exposure, mothers with asthma/respiratory infection, children born with low birth weight, children who had diarrhea in the past 2 weeks, and increased concentrations of particulate matter 2.5 have a higher likelihood of having children infected with ARI.

Table 3.7: Spatial regression model for estimating spatial association between ARI prevalence and covariates in India, 2019-21

Covariates	OLS	SLM	SEM
Households using unclean cooking fuel (%)	-0.02	-0.02*	-0.02
The household doesn't have a separate kitchen (%)	-0.01	-0.01	-0.01
Smoking exposure in the household (%)	0.02***	0.02***	0.03*
Rural household (%)	0.01*	0.01*	0.01

Covariates	OLS	SLM	SEM
Poor household (%)	0.02	0.01	0.01
Illiterate mother (%)	0.01*	0.01	0.01
Mothers smoke (%)	-0.02**	-0.02	-0.01
Mothers with asthma/respiratory infection (%)	0.33***	0.28***	0.27***
Low Birth Weights (%)	0.06***	0.05***	0.06**
Underweight children (%)	-0.01	-0.01	0.01
Children ages <24 months (%)	-0.04*	-0.04*	-0.04
The child had diarrhoea 2 weeks before the survey	0.14***	0.13***	0.15***
Particle matters 2.5	0.02***	0.01*	0.02*
Number of Observations	707	707	707
Lag coefficient (Rho) *[ρ]*	-	0.35***	-
Lag coefficient (Lambda) *[λ]*	-	-	0.40***
Akaike info criterion (AIC)	2849.29	2802.87	2794.77
Adjusted R-squared	0.252754	0.318969	0.330429

Note: OLS: Ordinary least square; SLM: Spatial lag model; SEM: Spatial error model; ***p<0.001, **p<0.01, *p<0.05

3.1.6 Key Findings

Prevalence and Spatial clustering of ARI among children in India

- The prevalence of ARI has decreased from 5.8 percent to 2.8 percent overall from 2005 to 2021.
- However, the prevalence has slightly increased from 2.7% to 2.8% between NFHS-IV (2015-16) and NFHS-V (2019-21). Similarly, there has been a slight increase in the prevalence in rural areas from 2.9% to 3.0% from NFHS-IV to NFHS-V.
- Delhi shows the highest prevalence of ARI at 5.6%, while Dadra & Nagar Haveli/Daman & Diu shows a low prevalence of ARI at 0.3% in 2021. Approximately 72% of States/UTs show a higher ARI prevalence among children compared to the national average (2.8%).
- The districts level spatial analysis indicates that approximately 36% of districts (254 out of 707) in India reported a prevalence of ARI higher than the national average of 2.8%. These high prevalence districts are primarily located in Uttar Pradesh, Bihar,

Madhya Pradesh, Jammu & Kashmir, Chhattisgarh, Meghalaya, Delhi, Odisha, Rajasthan, Telangana, and Andhra Pradesh.

- Additionally, districts from Uttar Pradesh, Bihar, Punjab, Haryana, and West Bengal show a high prevalence of ARI and PM 2.5 levels. Additionally, most of the districts located in Northern, Eastern, Central, and Western India show a high prevalence of ARI and PM 2.5 levels.
- Delhi reported the highest increase in prevalence at 3.2%, while Chandigarh showed the highest decrease at -2.5%. Sixteen states and union territories recorded an increase in the prevalence rate of ARI. Most of the districts with increasing prevalence belong to Madhya Pradesh, Karnataka, Andhra Pradesh, Assam, Bihar, Gujarat, Maharashtra, Nagaland, Odisha, Rajasthan, Uttar Pradesh, and West Bengal. On the other hand, three districts, Dhule (Maharashtra), Jalaun (Uttar Pradesh), and the south district of Sikkim showed no change.
- The results of Moran's I indicate that spatial clustering exists in the prevalence of ARI across the districts in India (Moran's Index = 0.27; $p < 0.001$). It has highlighted that out of 707 districts, 58 districts are detected as hots-pots area. The most of the hot-spot districts were located in Uttar Pradesh, Maharashtra, Delhi, Punjab, Jammu & Kashmir, Odisha, and Assam.
- The Univariate Moran's I indicates that there is spatial autocorrelation between children who had ARI and those living in areas with high levels of Particulate Matter 2.5 (M'I = 0.229), children with illiterate mothers (M'I = 0.157), children who had diarrhea 2 weeks before the survey (M'I = 0.139), exposure to smoking in the household, low birth weight (M'I = 0.068), and underweight children (M'I = 0.052).
- The highest univariate Moran's I among the predictors was the concentration of Particulate Matter 2.5 (Moran's I = 0.953, $p < 0.001$), followed by smoking exposure in the household (Moran's I = 0.81; $p < 0.001$), mothers' smoking behaviour (Moran's I = 0.778, p-value = 0.001), and poor household (Moran's I = 0.769; $p < 0.001$).
- Spatial regression model estimates, the spatial error model (SEM) had the lowest AIC and the highest adjusted R2 value, making it the best-fit model among the three. These results indicate that districts with higher instances of household smoking exposure, mothers with asthma/respiratory infection, children born with low birth weight, children who had diarrhea in the past 2 weeks, and increased concentrations of particulate matter 2.5 have a higher likelihood of having children infected with ARI.

Summary: The prevalence of ARI among children has increased 2.7 percent to 2.8 percent from 2016 to 2021. Delhi reported the highest prevalence while Dadra & Nagar Haveli/Daman & Diu showed the lowest. The high prevalence districts are primarily located in Uttar Pradesh, Bihar, Madhya Pradesh, Jammu & Kashmir, Chhattisgarh, Meghalaya, Delhi, Odisha, Rajasthan, Telangana, and Andhra Pradesh. The spatial clustering analysis highlights significant geographic patterns, with a notable concentration of ARI "hotspots" in districts of Uttar Pradesh, Maharashtra, Punjab, Jammu & Kashmir, Odisha, and Assam. The spatial error model (SEM), identified as the best fit, suggests that children in districts with higher household smoking, mother's respiratory health issues, low birth weight, and poor environmental conditions are at greater risk for ARI. These results indicate that targeted interventions addressing environmental pollution, maternal health, and household conditions are critical for reducing ARI prevalence in India.

3.2 The Contextual Risks Associated with ARI in India and Rural West Bengal

Introduction

In the first section, we discussed the prevalence of ARI across the states/UTs and districts in India. In this section, we have observed the spatio-temporal changes of ARI, also identifying the hot-spot districts of India. . If we identify the risk factors along with the prevalence, it will be more specific. Policy makers can implement targeted policies by highlighting hot-spot districts and identifying the risk factors to prevent the prevalence of ARI across the districts. Therefore, this chapter will help identify the risk factors for ARI in India, as well as rural West Bengal.

While the overall objective is to identify possible risk factors for ARI among children, the specific (sub) objectives are:

- To identify the contextual determinants of ARI among children in India using NFHS.
- To identify the risk factors associated with ARI among children in rural West Bengal.

Data Source and Methodology

The study utilized data from the two most recent rounds of the NFHS. STATA 14 software was employed for the data analysis. To demonstrate the relationship between ARI and background variables, bivariate analysis with chi-square test was utilized. Furthermore, multilevel logistic regression was applied to ascertain the risk factors associated with ARI. Subsequently, multivariable logistic regression was conducted to identify the risk factors associated with ARI in rural West Bengal. A comprehensive methodology is outlined in the methodology chapter (***Chapter: 2***).

3.2.1 Risk Factors Associated with ARI among Children in India

Distribution of the sample with the background characteristics: The distribution of the study variable has been described in ***Table 3.8***. In NFHS-IV, we used a sample of 238,945 children, while in NFHS-V, we analysed a sample of 222,223 children. The detailed distribution is presented in the table below.

Table 3.8: Percentage Distribution of Key Study Variables (NFHS-IV and NFHS-V).

Background characteristics	NFHS-IV		NFHS-V	
	N	%	N	%
A. Household Environment				
House type				
Kuchha	1,194	0.5	517	0.2
Semi-Pucca	56,562	23.7	40,537	18.2
Pacca	1,81,190	75.8	1,81,178	81.5
Household cooking environment				
Clean cooking environment	83,029	34.7	1,11,637	50.2
Unclean cooking environment	1,55,917	65.3	1,10,596	49.8
Smoking exposure in the household				
No	1,26,193	52.8	1,20,699	54.3
Yes	1,12,752	47.2	1,01,534	45.7
Separate kitchen in the household				
No	86,805	36.3	60,635	27.3
Yes	1,52,141	63.7	1,61,598	72.7
Persons per room used for sleeping				
≤ 3 persons	1,02,540	42.9	1,12,029	50.4
More than 3 persons	1,34,938	56.5	1,08,496	48.8
No room for sleeping	1,467	0.6	1,708	0.8
Season of interview				
Winter Season	8,308	3.5	83,938	37.8
Summer Season	1,61,979	67.8	70,685	31.8
Rainy Season	68,658	28.7	67,610	30.4
Place of hand washing in household				
Not observed	8,197	3.4	8,184	3.7
Observed	2,30,748	96.6	2,14,049	96.3
B. Socio-Economic Characteristics				
Place of residence				
Urban	67,958	28.4	59,780	26.9
Rural	1,70,987	71.6	1,62,452	73.1
Social group				
SC	51,209	21.4	51,395	23.1
ST	25,051	10.5	22,135	10.0
OBC	1,05,385	44.1	96,762	43.5
Others	57,300	24.0	51,941	23.4
Religion rroup				
Hindu	1,87,795	78.6	1,76,335	79.3
Non-Hindu	51,150	21.4	45,897	20.7
Household wealth quintile				
Poor	59,416	24.9	53,817	24.2

Background characteristics	NFHS-IV		NFHS-V	
	N	%	N	%
Poorer	52,153	21.8	47,984	21.6
Middle	47,494	19.9	43,519	19.6
Richer	43,896	18.4	41,242	18.6
Richest	35,986	15.1	35,671	16.1
Mother's education				
Not educated	70,636	29.6	46,635	21.0
primary	33,239	13.9	27,133	12.2
Secondary	1,09,445	45.8	1,13,099	50.9
Higher	25,626	10.7	35,366	15.9
Mother's age				
14-24 Years	83,444	34.9	72,967	32.8
25-34 Years	1,35,474	56.7	1,30,954	58.9
35 Years and above	20,028	8.4	18,312	8.2
C. Mother's Behavioural and Health Characteristics				
Mother smoking exposure				
Yes	2,29,421	96.0	2,15,130	96.8
No	9,524	4.0	7,102	3.2
Mother exposure to mass media				
No	63,142	26.4	63,206	28.4
Yes	1,75,804	73.6	1,59,026	71.6
Mother had respiratory diseases/asthma				
No	2,36,139	98.8	2,20,275	99.1
Yes	2,807	1.2	1,958	0.9
D. Child Characteristics				
Age of child (months)				
0-11 Months	46,108	19.3	44,493	20.0
12-23 Months	47,839	20.0	43,247	19.5
24-35 Months	47,398	19.8	43,916	19.8
36 to 47 Months	49,829	20.9	44,075	19.8
48 to 59 Months	47,771	20.0	46,503	20.9
Child weight during birth				
Low birth weight (<2.50 Kg)	33,358	14.0	35,939	16.2
Normal (>2.50 Kg)	1,55,620	65.1	1,67,149	75.2
Not weighed at birth/don't know	49,967	20.9	19,145	8.6
Child's birth order				
Less than 3	1,69,359	70.9	1,62,289	73.0
3 and above	69,587	29.1	59,944	27.0
Child nutrition status				
Normal	1,38,506	58.0	1,39,995	63.0
Underweight	53,344	22.3	44,232	19.9

Background characteristics	NFHS-IV		NFHS-V	
	N	**%**	**N**	**%**
Severely Underweight	23,661	9.9	21,885	9.8
Missing	23,434	9.8	16,120	7.3
Whether the child had diarrhoea				
No	2,17,026	90.8	2,06,020	92.7
Yes	21,919	9.2	16,213	7.3
E. Other Characteristics				
Regions in India				
North	31,622	13.2	29,962	13.5
Central	63,451	26.6	61,096	27.5
East	60,802	25.4	57,887	26.0
Northeast	8,446	3.5	8,114	3.7
West	30,903	12.9	27,916	12.6
South	43,721	18.3	37,256	16.8
Total	**2,38,945**	**100**	**2,22,223**	**100**

Note: *N= Number of children. %=Weighted percentage, SC: Scheduled Caste , ST: Scheduled Tribe , OBC: Other Backward Caste.*

Prevalence of ARI among children (0-59 months) with the background characteristics in India 2015-16:

Table 3.9 provides data on the prevalence of Acute Respiratory Infection (ARI) among children between 0-59 months of age in India, along with their background characteristics, during 2015-16 (NFHS-IV). The chi-square test has been used to analyze the association between ARI and various background characteristics such as household environment, socioeconomic status, mother's behaviour, and child's characteristics.

The findings reveal that several household environmental factors are significantly associated with ARI prevalence. These include house type ($\chi2= 116.82$, $p<.001$), household cooking fuel ($\chi2= 12.72$, $p<.001$), smoking exposure in the household ($\chi2= 17.66$, $p<.001$), separate kitchen in the household ($\chi2= 29.11$, $p<.001$), person per room used for sleeping ($\chi2= 13.85$, $p<.001$) as well as the season of interview ($\chi2= 261.63$, $p<.001$). Interestingly, the study found that the place of hand washing was not showing any significant association. The data reveals that the prevalence of ARI is highest among children who live in kuchha houses (4.1%), followed by semi-pucca (3.6%) and pucca houses (2.5%). Moreover, households using unclean cooking fuel (2.9%) show a higher prevalence of ARI compared to households using clean cooking fuel (2.4%). Children from households exposed to smoking (2.9%) have a higher prevalence of ARI compared to those in non-smoking households. Children living in households with a separate kitchen (2.5%) have a lower prevalence of ARI as compared to those living in households without a separate kitchen (3.1%). Additionally, the prevalence of ARI among children is 2.6% and 2.8% respectively for households with a sleeping room accommodating 3 or more than 3 persons. It has been observed that the prevalence of ARI is highest during the winter season (3.1%), followed by the summer season (3.09%) and the rainy season (1.9%).

The prevalence of childhood ARI is significantly associated with various socio-economic characteristics such as place of residence ($\chi2= 29.27$, $p<.001$), social group $\chi2= 107.39$, $p<.001$), religious group ($\chi2= 60.03$, $p<.001$), and wealth quantile ($\chi2= 21.78$, $p<.001$).

The prevalence of ARI is higher among children living in rural areas (2.9%) as compared to urban areas. Among different social groups, children belonging to the Scheduled Caste (SC) show the highest prevalence of ARI (3.1%), followed by Other Backward Classes (OBC) (2.7%), Scheduled Tribe (ST) (2.2%) and others.

Mother's education ($\chi2= 13.93$, $p=.003$), mother's age ($\chi2= 18.89$, $p<.001$) andMothers with respiratory diseases/asthma had a significant association with children's ARI. However, there was no significant association between the mother's behavioural characteristics such as smoking ($\chi2= 0.4$, $p=0.531$) and mass media ($\chi2= 1.19$, $p=0.277$) exposure with children's ARI. ARI is more prevalent among children belonging to poor (3.1%) households followed by poorer (2.9%), middle (2.7%), richer (2.6%), and richest (2.3%). Children of mothers who passed primary school (3.05%) and were aged between 15-24 (3%) had a higher prevalence of ARI compared to their counterparts. ARI was higher in children whose mothers had a history of respiratory diseases or asthma (5.2%), as compared to those whose mothers didn't have any history of respiratory diseases or asthma.

There is a significant association between childhood ARI and various characteristics of the child. These characteristics include the age of the child (280.71, $p<.001$), birth weight ($\chi2= 70.39$, $p<.001$), birth order ($\chi2= 10.56$, $p=0.001$), child nutrition ($\chi2= 25.63$, $p<.001$), and whether the child had diarrhoea ($\chi2= 3915.7$, $p<.001$). ARI prevalence was highest among children aged 0-11 months (3.4%), followed by 12-23 months (3.3%), 24-35 months (2.6%), 36-47 months (2.6%), and 49-59 months (2%). Children with low birth weight (3.2%), severe underweight (3%), and diarrhoea (8.8%) before the last 2 weeks of the survey have a higher prevalence of acute respiratory infection compared to their peers.

The prevalence of childhood ARI was highest in the central region (3.8%) and lowest in the southern region (1.7%) of India.

Table 3.9: Prevalence of ARI among children (0-59 months) in India by background characteristics, NFHS IV and NFHS-V.

Background characteristics	**NFHS-IV (2015-16)**		**NFHS-V (2019-21)**	
	Prevalence N (%)	*95% CI [Lower, Upper]*	*Prevalence N (%)*	*95% CI [Lower, Upper]*
A. Household Environment				
House type	**$\chi2$= 116.82, p<0.001***		**$\chi2$= 57.63, p<0.001***	
Kuchha	49 (4.11)	[3.09-5.35]	14 (2.75)	[1.57-4.39]
Semi-pucca	2036 (3.61)	[3.45-3.76]	1489 (3.68)	[3.5-3.86]
Pacca	4444 (2.46)	[2.39-2.53]	4694 (2.6)	[2.52-2.67]
Household cooking environment	**$\chi2$= 12.72, p<0.001***		**$\chi2$= 10.77, p<0.001***	
Clean cooking environment	1980 (2.39)	[2.29-2.5]	2899 (2.6)	[2.51-2.7]
Unclean cooking environment	4549 (2.92)	[2.84-3.01]	3299 (2.99)	[2.89-3.09]
Smoking exposure in the household	**$\chi2$= 17.66, p<0.001***		**$\chi2$= 70.3, p<0.001***	
No	3303 (2.62)	[2.54-2.71]	2990 (2.48)	[2.4-2.57]
Yes	3226 (2.87)	[2.77-2.96]	3208 (3.16)	[3.06-3.27]
Separate kitchen in the household	**$\chi2$= 29.11, p<0.001***		**$\chi2$= 37.73, p<0.001***	
No	2684 (3.1)	[2.98-3.21]	1991 (3.29)	[3.15-3.43]
Yes	3846 (2.53)	[2.45-2.61]	4206 (2.61)	[2.53-2.69]
Persons per room used for sleeping	**$\chi2$= 13.85, p<0.001***		**$\chi2$= 4.21, p=0.121**	
≤ 3 persons	2715 (2.65)	[2.56-2.75]	3106 (2.78)	[2.68-2.87]
More than 3 persons	3778 (2.8)	[2.72-2.89]	3037 (2.8)	[2.71-2.9]
No room for sleeping	36 (2.46)	[1.76-3.35]	54 (3.18)	[2.41-4.08]
Season of interview	**$\chi2$= 261.63, p<0.001***		**$\chi2$= 20.99, p<0.001***	
Winter Season	258 (3.11)	[2.75-3.5]	2421 (2.89)	[2.78-3]
Summer Season	4999 (3.09)	[3.01-3.18]	1985 (2.81)	[2.69-2.94]
Rainy Season	1272 (1.86)	[1.76-1.96]	1792 (2.65)	[2.54-2.78]
Place of hand washing in household	**$\chi2$= 0.03, p=0.875**		**$\chi2$= 0.37, p=0.548**	
Not observed	226 (2.76)	[2.42-3.13]	257 (3.15)	[2.78-3.54]
Observed	6303 (2.74)	[2.67-2.8]	5941 (2.78)	[2.71-2.85]
B. Socio-economic Characteristics				

Background characteristics	NFHS-IV (2015-16)		NFHS-V (2019-21)	
	Prevalence N (%)	*95% CI [Lower, Upper]*	*Prevalence N (%)*	*95% CI [Lower, Upper]*
Place of residence	**χ2= 29.27, p<.001***		**χ2= 15.07, p<.001***	
Urban	1567 (2.31)	[2.2-2.43]	1378 (2.31)	[2.19-2.43]
Rural	4962 (2.91)	[2.83-2.99]	4820 (2.97)	[2.89-3.06]
Social group	**χ2= 107.39, p<0.001***		**χ2= 37.08, p<.001***	
SC	1559 (3.05)	[2.9-3.2]	1551 (3.02)	[2.88-3.17]
ST	556 (2.22)	[2.05-2.41]	532 (2.41)	[2.21-2.62]
OBC	2859 (2.72)	[2.62-2.82]	2676 (2.77)	[2.67-2.88]
Others	1556 (2.72)	[2.59-2.86]	1438 (2.77)	[2.64-2.92]
Religion group	**χ2= 60.03, p<0.001***		**χ2= 0.54, p=0.466**	
Hindu	4965 (2.65)	[2.58-2.72]	4927 (2.8)	[2.72-2.88]
Non-Hindu	1564 (3.06)	[2.92-3.21]	1271 (2.77)	[2.63-2.93]
Household wealth quintile	**χ2= 21.78, p<0.001***		**χ2= 32.67, p<0.001***	
Poor	1825 (3.08)	[2.94-3.22]	1723 (3.21)	[3.06-3.36]
Poorer	1495 (2.87)	[2.73-3.02]	1472 (3.07)	[2.92-3.23]
Middle	1275 (2.69)	[2.55-2.84]	1167 (2.69)	[2.54-2.84]
Richer	1123 (2.56)	[2.42-2.71]	993 (2.41)	[2.27-2.56]
Richest	811 (2.26)	[2.11-2.42]	844 (2.37)	[2.22-2.53]
Mother's education	**χ2= 13.93, p=0.003***		**χ2= 50.98, p<0.001***	
Not educated	1895 (2.69)	[2.57-2.81]	1343 (2.88)	[2.74-3.04]
primary	1012 (3.05)	[2.87-3.24]	915 (3.38)	[3.17-3.6]
Secondary	3005 (2.75)	[2.66-2.85]	3169 (2.81)	[2.71-2.9]
Higher	618 (2.42)	[2.23-2.61]	772 (2.19)	[2.04-2.34]
Mother's age	**χ2= 18.89, p<0.001***		**χ2= 26.65, p<0.001***	
15-24 Years	2471 (2.97)	[2.85-3.08]	2269 (3.12)	[2.99-3.24]
25-34 Years	3515 (2.6)	[2.52-2.69]	3458 (2.65)	[2.56-2.73]
35 Years and above	543 (2.71)	[2.5-2.95]	470 (2.57)	[2.35-2.81]
C. Mother's Behavioural and Health Characteristics				
Mother smoking exposure	**χ2= 0.4, p=0.531**		**χ2= 42.8, p<0.001***	
Yes	6224 (2.72)	[2.65-2.78]	5909 (2.75)	[2.68-2.82]
No	305 (3.21)	[2.87-3.58]	289 (4.07)	[3.63-4.55]
Mother exposure to mass media	**χ2= 1.19, p=0.277**		**χ2= 1.48, p=0.224**	
No	1797 (2.85)	[2.72-2.98]	1781 (2.82)	[2.7-2.95]
Yes	4733 (2.7)	[2.62-2.77]	4416 (2.78)	[2.7-2.86]
Mother had respiratory diseases/asthma	**χ2= 139.4, p<0.001***		**χ2= 139.5, p<0.001***	
No	6383 (2.71)	[2.64-2.77]	6060 (2.76)	[2.69-2.83]
Yes	147 (5.23)	[4.46-6.11]	138 (7.03)	[5.98-8.25]
D. Child Characteristics				

Background characteristics	NFHS-IV (2015-16)		NFHS-V (2019-21)	
	Prevalence N (%)	*95% CI [Lower, Upper]*	*Prevalence N (%)*	*95% CI [Lower, Upper]*
Age of child	**χ2= 280.71, p<0.001***		**χ2= 138.92,p<.001***	
0-11 Months	1545 (3.36)	[3.19-3.52]	1489 (3.35)	[3.19-3.52]
12-23 Months	1578 (3.3)	[3.15-3.47]	1429 (3.31)	[3.14-3.48]
24-35 Months	1233 (2.61)	[2.47-2.75]	1193 (2.72)	[2.57-2.88]
36 to 47 Months	1216 (2.45)	[2.31-2.58]	1104 (2.51)	[2.37-2.66]
48 to 59 Months	957 (2.01)	[1.89-2.14]	983 (2.12)	[1.99-2.25]
Child weight during birth	**χ2= 70.39, p<0.001***		**χ2= 32.56, p<0.001***	
Low birth weight (<2.50 Kg)	1052 (3.16)	[2.98-3.35]	1142 (3.18)	[3.01-3.37]
Normal (>2.50 Kg)	3904 (2.51)	[2.44-2.59]	4446 (2.66)	[2.59-2.74]
Not weighed at birth/don't know	1574 (3.15)	[3-3.31]	609 (3.19)	[2.94-3.44]
Child's birth order	**χ2= 10.56, p<0.001***		**χ2= 13.27, p<0.001***	
Less than 3	4427 (2.62)	[2.54-2.7]	4383 (2.71)	[2.63-2.79]
3 and above	2102 (3.03)	[2.9-3.15]	1815 (3.03)	[2.9-3.17]
Child nutrition status	**χ2= 25.63, p<0.001***		**χ2= 37, p<0.001***	
Normal	3840 (2.78)	[2.69-2.86]	3916 (2.8)	[2.72-2.89]
Underweight	1536 (2.89)	[2.75-3.03]	1288 (2.92)	[2.76-3.08]
Severely Underweight	701 (2.97)	[2.76-3.19]	690 (3.16)	[2.93-3.4]
Missing	452 (1.94)	[1.76-2.12]	304 (1.89)	[1.69-2.11]
Whether child had diarrhoea	**χ2= 3915.7, p<0.001***		**χ2= 2511.06, p<0.001***	
No	4606 (2.13)	[2.07-2.19]	4812 (2.34)	[2.28-2.41]
Yes	1924 (8.78)	[8.41-9.16]	1386 (8.55)	[8.13-8.99]
E. Other Characteristics				
Regions in India	**χ2= 488.09, p<0.001***		**χ2= 160.32, p<0.001***	
North	921 (2.92)	[2.74-3.11]	893 (2.99)	[2.8-3.18]
Central	2405 (3.8)	[3.65-3.95]	1945 (3.19)	[3.05-3.33]
East	1705 (2.81)	[2.68-2.94]	1816 (3.14)	[3-3.29]
Northeast	138 (1.64)	[1.38-1.93]	204 (2.51)	[2.2-2.88]
West	630 (2.05)	[1.89-2.21]	676 (2.43)	[2.25-2.61]
South	729 (1.67)	[1.56-1.8]	664 (1.79)	[1.66-1.93]
Total	**6529 (2.73)**	**[2.67-2.80]**	**6198 (2.79)**	**[2.72-2.86]**

Note: *N: number of ARI cases; %: Percentage of ARI (Row percentage), χ2:Chi-square test (applied for each variable), *=p-value <0.05 (Significance), CI: Confidence interval, SC: Scheduled Caste, ST: Scheduled Tribe, OBC: Other Backward Caste*

Prevalence of ARI among children (0-59 months) with background characteristics in India 2019-21:

Table 3.9 shows the prevalence of ARI among children in India from 2019 to 2021. The table examines the relationship between ARI and various background factors, such as household environmental variables, socioeconomic characteristics, mothers' behavioural characteristics, and child characteristics. The chi-square test was used to measure the association between these variables.

The analysis revealed that the prevalence of ARI is significantly associated with the type of house ($\chi2$= 57.63, p<.001), the type of cooking fuel used in the household ($\chi2$= 10.77, p.001), smoking exposure in the household ($\chi2$= 70.3, p<.001), and the presence of a separate kitchen in the household ($\chi2$= 37.73, p<.001). The study found that semi-pucca (3.7%) houses and households using unclean cooking fuel (2.9%) have a higher prevalence of ARI compared to their counterparts. Additionally, households with smoking exposure (3.2%) and without separate kitchens (3.3%) also have a higher prevalence of childhood ARI.

The prevalence of childhood ARI has significantly associated with various socioeconomic variables i.e place of residence ($\chi2$= 15.07, p<.001), social group ($\chi2$= 37.08, p<.001), and wealth quantile ($\chi2$= 32.67, p<.001). However, religious group does not seem to have a significant relationship. The results indicate that children from rural areas (3%) and poor households (3.2%) have a higher prevalence of ARI compared to their counterparts. Among social groups, the prevalence was highest among children belonging to the SC cast (3.0%) and lowest in the ST (2.4%) caste group.

Based on the mother's characteristics, it was found that there is a significant association between the mother's education ($\chi2$= 50.98, p<.001), and mother's age ($\chi2$= 26.65, p<.001) mother's smoking exposure ($\chi2$= 42.8, p<.001) and her having respiratory diseases/asthma ($\chi2$= 139.5, p<.001) with childhood ARI. Mothers with primary education (3.4%) and those aged 15-24 years (3.1%) also have a higher incidence of childhood ARI. It was observed that the prevalence of childhood ARI was higher (7%) if the mother had respiratory diseases/asthma. Interestingly, Children of smoking mothers have a significantly lower incidence of ARI than those of non-smoking mothers.

Factors associated with ARI among children (0-59 Months) in India (2015-16):

A multilevel logistic regression model was used to assess the factors associated with acute ARI among children aged 0-59 months in the districts of India by using NFHS-IV (2015-16) (***in Table 3.10***). In considering the household environmental characteristics, it was found that children living in Pacca houses were 0.74 times less likely to contract ARI as compared to those living in Kuchha houses. Additionally, the odds of ARI were getting lower (AOR: 0.74; 95% CI: 0.62-0.88) for children interviewed during the rainy season ompared to the winter season.

Socioeconomic status is a significant risk factor in childhood. Non-Hindu children are 1.16 times (AOR: 1.16, 95% CI: 1.09-1.25) more likely to suffer from ARIs compared to Hindu children.

After considering maternal characteristics, it was found that the mother's education level can increase the risk of ARI in children. Mothers who have completed primary education (AOR: 1.24; 95% CI: 1.15-1.35), secondary education (AOR: 1.22; 95% CI: 1.14-1.31), and higher education (AOR: 1.2; 95% CI: 1.07-1.35) have a higher likelihood of their children developing ARI compared to illiterate mothers. Additionally, a mother's smoking behaviour was identified as a significant risk factor for ARI in children. If a mother is exposed to smoking, her children have 1.28 times (AOR: 1.28; 95% CI: 1.15-1.42) higher risk of ARI compared to children of non-smoking mothers. Interestingly, exposure to mass media was also found to increase the risk of ARI in children if the mother is exposed (AOR: 1.12; 95% CI: 1.05-1.2) as compared to mothers not exposed to mass media. Finally, mothers with respiratory diseases or asthma were found to have a significantly higher risk of their children developing ARI. Mothers with respiratory diseases or asthma have 2.13 times (NFHS-IV) and 2.33 times (NFHS-V) higher risk of their children developing ARI compared to mothers without these conditions.

Considering the children’s characteristics, the risk of ARI decreases as the child gets older. Children aged 24-35 months (AOR: 0.88; 95% CI: 0.82-0.95), 36-47 months (AOR: 0.84; 95% CI: 0.77-0.90), and 48-59 months (AOR: 0.73; 95% CI: 0.67-0.79) have significantly lower chances of getting the disease compared to children aged 0-11 months. The risk of ARI was 0.83 times (AOR: 0.83; 95% CI: 0.78-0.90) less likely among children with normal birth weight than those with low birth weight. Children suffering from diarrhoea were 3.67 times (AOR: 3.67, 95% CI: 3.47-3.89) more likely to have ARI than those not suffering from diarrhoea within two weeks before the survey. The risk of developing ARI was less likely in the northeast

(AOR: 0.49; 95% CI: 0.38-0.62), west (AOR: 0.61; 95% CI: 0.47-0.78), and south (AOR: 0.58; 95% CI: 0.47-0.73) regions compared to the north region.

Table 3.10: Multilevel logistic regression model assessing the factors associated with ARI among children (0-59 Months) in the districts of India, in NFHS IV and NFHS V

Background characteristics	NFHS-IV (2015-16)	NFHS-V (2019-21)
	AOR 95% CI [Lower, Upper]	***AOR 95% CI [Lower, Upper]***
A. Household Environment		
House type		
Kuchha	***Ref.***	***Ref.***
Semi-pucca	0.78 (0.58-1.05)	1.24 (0.73-2.11)
Pacca	0.74 (0.55-0.93)*	1.16 (0.68-1.97)
Household cooking environment		
Clean cooking environment	***Ref.***	***Ref.***
Unclean cooking environment	1 (0.93-1.08)	0.99 (0.93-1.07)
Smoking exposure in the household		
No	***Ref.***	***Ref.***
Yes	1.02 (0.97-1.08)	1.13 (1.06-1.19)***
Separate kitchen in the household		
No	***Ref.***	***Ref.***
Yes	0.97 (0.91-1.02)	0.95 (0.89-0.97)*
Persons per room used for sleeping		
3 persons	***Ref.***	***Ref.***
More than 3 persons	1.05 (0.99-1.11)	0.91 (0.86-0.97)**
No room for sleeping	0.99 (0.7-1.38)	1.19 (0.89-1.59)
Season of interview		
Winter Season	***Ref.***	***Ref.***
Summer Season	0.94 (0.8-1.1)	1.03 (0.91-1.15)
Rainy Season	0.74 (0.62-0.88)**	1.07 (0.94-1.22)
Place of hand washing in household		
Not-observed	***Ref.***	***Ref.***
Observed	1.04 (0.91-1.19)	1.02 (0.88-1.18)
B. Socio-Economic Characteristics		
Place of Residence		
Urban	***Ref.***	***Ref.***
Rural	1.06 (0.98-1.14)	1.05 (0.97-1.14)
Social group		
SC	***Ref.***	***Ref.***
ST	0.92 (0.83-1.02)	0.86 (0.77-0.95)**
OBC	0.97 (0.91-1.04)	0.97 (0.91-1.05)

Background characteristics	NFHS-IV (2015-16)	NFHS-V (2019-21)
	AOR 95% CI [Lower, Upper]	*AOR 95% CI [Lower, Upper]*
Others	1 (0.92-1.09)	0.99 (0.91-1.08)
Religion group		
Hindu	***Ref.***	***Ref.***
Non-Hindu	1.16 (1.09-1.25)***	1.03 (0.95-1.11)
Household wealth quintile		
Poor	***Ref.***	***Ref.***
Poorer	1.03 (0.95-1.11)	0.97 (0.89-1.05)
Middle	1.03 (0.94-1.13)	0.91 (0.83-1.01)*
Richer	0.96 (0.85-1.07)	0.89 (0.79-1)**
Richest	0.91 (0.79-1.05)	0.97 (0.84-1.12)
Mother's education		
Not educated	***Ref.***	***Ref.***
primary	1.24 (1.15-1.35)***	1.21 (1.11-1.32)***
Secondary	1.22 (1.14-1.31)***	1.08 (1-1.17)
Higher	1.2 (1.07-1.35)**	0.99 (0.89-1.11)
Mother's age		
14-24 Years	***Ref.***	***Ref.***
25-34 Years	0.97 (0.91-1.02)	0.94 (0.88-1)*
35 Years and above	0.99 (0.89-1.1)	0.99 (0.89-1.1)
C. Mother's Behavioural and Health Characteristics		
Mother smoking exposure		
Yes	***Ref.***	***Ref.***
No	1.28 (1.15-1.42)***	1.34 (1.2-1.5)***
Mother exposure to mass media		
No	***Ref.***	***Ref.***
Yes	1.12 (1.05-1.2)**	1.18 (1.1-1.26)***
Mother had respiratory diseases/asthma		
No	***Ref.***	***Ref.***
Yes	2.13 (1.79-2.53)***	2.33 (1.93-2.8)***
D. Child Characteristics		
Age of child		
0-11 Months	***Ref.***	***Ref.***
12-23 Months	1.04 (0.97-1.12)	1.02 (0.94-1.1)
24-35 Months	0.88 (0.82-0.95)**	0.89 (0.82-0.96)**
36 to 47 Months	0.84 (0.77-0.9)***	0.86 (0.79-0.93)***
48 to 59 Months	0.73 (0.67-0.79)***	0.77 (0.71-0.84)***
Child weight during birth		
Low birth weight (<2.50 Kg)	***Ref.***	***Ref.***
Normal (>2.50 Kg)	0.83 (0.78-0.9)***	0.9 (0.84-0.96)**

Background characteristics	NFHS-IV (2015-16)	NFHS-V (2019-21)
	AOR 95% CI [Lower, Upper]	*AOR 95% CI [Lower, Upper]*
Not weighed at birth/don't know	0.78 (0.71-0.84)***	0.83 (0.75-0.93)**
Child's birth order		
Less than 3	***Ref.***	***Ref.***
3 and above	1.05 (0.99-1.12)	1.06 (0.99-1.13)
Child nutrition status		
Normal	***Ref.***	***Ref.***
Underweight	1.01 (0.95-1.07)	1.01 (0.94-1.08)
Severely Underweight	1.07 (0.98-1.17)	1.08 (0.99-1.18)*
Missing	0.83 (0.75-0.91)***	0.8 (0.7-0.9)***
Whether child had diarrhoea		
No	***Ref.***	***Ref.***
Yes	3.67 (3.47-3.89)***	3.76 (3.52-4.02)***
E. Others Characteristics		
Regions in India		
North	***Ref.***	***Ref.***
Central	1.01 (0.83-1.22)	0.98 (0.81-1.19)
East	0.87 (0.71-1.07)	1.03 (0.83-1.27)
Northeast	0.49 (0.38-0.62)***	0.75 (0.6-0.95)*
West	0.61 (0.47-0.78)***	0.7 (0.54-0.91)**
South	0.58 (0.47-0.73)***	0.69 (0.56-0.86)**
Model Evaluation		
Constant	0.03 (p<0.001)	0.02 (p<0.001)
Var (constant)	0.5081522	0.5054478
Observation (weighted)	2,38,945	**2,22,223**
Districts (cluster in groups)	640	707
Log likelihood	-28997.459	-26294.028
Wald chi^2	2807.92 (p<0.001)	2090.51 (p<0.001)
LR test vs. logistic model: (chibar^2)	1790.7 (p<0.001)	1289.15 (p<0.001)
Intra-class correlation coefficient (ICC)	0.13 (CI=0.12-0.16)	0.13 (CI:0.12-0.15)

Note: AOR:Adjusted Odds Ratio, Ref: Reference Catagorey, CI: Confidence interval, ***p<0.001, **p<0.01, *p<0.05, SC: Scheduled Caste , ST: Scheduled Tribe , OBC: Other Backward Caste

Factors associated with ARI among children (0-59 Months) in India (2019-21):

A multilevel logistic regression model was used to assess the factors associated with ARI among children aged 0-59 months in the districts of India during NFHS 5 (2019-21) (In ***Table 3.10***).

Based on the household characteristics, it has been observed that the smoking behaviour of a household member increases the risk of childhood ARI by 1.13 times (AOR:1.13; 95% CI: 1.06-1.19) compared to households without smokers. On the other hand, households with separate kitchens have a reduced risk of ARI by 0.95 times (AOR:1.13; 95% CI:0.89-0.97) compared to households without a separate kitchen.

The research findings suggest that children from the Schedule Tribe (ST) group have a lower likelihood (AOR: 0.86; 95% CI: 0.77-0.95) of contracting Acute Respiratory Infection (ARI) compared to children from the Schedule Cast (SC) group. Furthermore, the study found that the household's wealth quantile is also significantly associated with the diseases, with children from middle (AOR: 0.91; 95% CI: 0.83-1.01) and richer (AOR: 0.89; 95% CI:0.79-1.0) households having a reduced risk of contracting ARI compared to those from poorer households.

Maternal characteristics also found to be a significant risk factor of childhood ARI. Mothers' smoking behaviour was also found to be a significant relation with the development of their children's ARI. Mothers with smoking exposure are 1.34 times more likely (AOR:1.34; 95% CI:1.2-1.5) to have their child ARI as compared to mothers who do to have smoking exposure. Surprisingly, mothers exposed to mass media (AOR: 1.18; 95% CI:1.1-1.26) and mothers with primary education (AOR: 1.21; 95% CI: 1.11-1.32) have increased the risk of the diseases as compared to their counterparts. It has been observed that mothers who have respiratory diseases or asthma have a significantly higher risk of their children developing ARI. Mothers with respiratory diseases or asthma have 2.33 times (AOR:2.33; 95% CI: 1.93-2.8) higher risk of their children getting ARI compared to mothers who do not have these conditions.

Considering the childhood characteristics, the risk of ARI decreases with increasing the child's age. Children aged 24-35 months (AOR: 0.89; 95% CI: 0.82-0.96), 36-47 months (AOR: 0.86; 95% CI: 0.79-0.93), and 48-59 months (AOR: 0.77; 95% CI: 0.71-0.84) have significantly lower chances of getting the disease compared to children aged 0-11 months. The risk of ARI was 0.9 times (AOR: 0.9; 95% CI: 0.84-0.96) less likely among children with normal birth weight than those with low birth weight. Moreover, the risk of ARI is higher among severely underweight children (AOR:1.08; 95% CI: 0.99-1.18) than normal-weight children.

Children suffering from diarrhoea were 3.76 times (AOR: 3.76, 95% CI: 3.52-4.02) more likely to have ARI than those not suffering from diarrhoea within two weeks before the survey. The risk of developing ARI was less likely in the northeast (AOR: 0.75; 95% CI: 0.6-0.95), west (AOR: 0.70; 95% CI: 0.54-0.91), and south (AOR: 0.69; 95% CI: 0.56-0.86) regions compared to the north region.

Risk of ARI from NFHS-IV to NFHS-V:

Table 3.11 presents the findings of the logistic regression analysis, which illustrates the odds ratio for Acute Respiratory Infection (ARI) in India between two rounds of data, namely NFHS-IV (2015-16) and NFHS-V (2019-21). The results indicate that the risk of ARI among children has increased by 1.06 times (AOR: 1.06; 95% CI: 1.02-1.11) compared to NFHS-IV.

Table 3.11: Odds ratios (with 95% CI) for ARI among children (0-59 Months) in India, Between NFHS-IV & NFHS-V

NFHS Round	**AOR 95% CI [Lower, Upper]**
NFHS-IV (2015-16)	***Ref.***
NFHS-V (2019-21)	1.06** (1.02-1.11)
Constant	.035 (p<0.001)
Total observation (NFHS-IV & V)	4,71,961
Log likelihood	-56930.568
Pseudo R^2	0.0478

Note: AOR: Adjusted Odds Ratio, Ref: Reference Catagorey, CI: Confidence interval, ***p<0.001, **p<0.01, *p<0.05

3.2.2 Risk Factors Associated with ARI among Children in Rural West Bengal

Distribution of Sample:

The above table (***Table: 3.12***), shows the distribution of the study population according to the various background characteristics. Looking to whether a child had ARI during the last 2 weeks before the survey date, the majority i.e.82 percent of the respondents said 'no' and around 18 percent replied affirmatively.

In terms of the household environment, the distribution based on the type of house revealed that roughly 43% and 20% of households resided in pucca and semi pucca houses respectively, while the remaining lived in kaccha houses. The majority of households (83%) were situated within a one-kilometer radius of a pucca road. However, 10%, 16%, and 9% of households were situated close to poultry farms, muri mills, and rice mills respectively. Over half of the households (55%) have contact with domestic or pet animals. Approximately 57 percent of the households used emergency lights as an alternative source of light during power outages, while the remaining households used kerosene lamps. Approximately 62% of households are exposed to smoking. Fifteen percent of households have a family history of respiratory illness. In terms of cooking fuel, 19 percent of households use firewood, kerosene, coal, and charcoal, while cow dung cakes are used by 48 percent. LPG/natural gas pipelines are used by approximately 33 percent of households. More than half of the respondents (51%) reported having a separate kitchen for cooking, while about 16 percent cooked inside the house but not in a separate kitchen. Approximately one-third cooked outside in the open. For most households, the frequency of cooking in a day was twice, and for 12 percent, it was once. Around 11 percent cooked more than once or twice. In terms of children being present during cooking, only about one-fourth of the respondents reported no child presence during cooking. Sixty-one percent reported children being present sometimes, and 15 percent reported children being present most of the time.

Looking at the socio-economic characteristics, 51 percent of the population followed the Hindu religion, while the remaining followed the Muslim religion. 51 percent of the population held APL ration cards, while the rest held BPL ration cards. The distribution by caste category showed that 26 percent of the population belonged to SC and ST, 42 percent belonged to OBC, and 32 percent were from the general caste. Regarding the type of family, about 36 percent of the population came from a nuclear family, while roughly one-third resided in a joint or extended type of family. 55 percent of the households had an annual family income in the range of Rs. 50000 to 75000, for around 16 percent, it was less than 50000, and for 30 percent, it was more than 75000.

After examining the characteristics of the mothers, it was found that the majority of them were young, with 43% falling into the age group of 20-24 years and 34% falling into the age group of 25-29 years. Around 8% of the mothers were less than 20 years old, and around 15% were over the age of 29. In terms of education level, about 34% had completed primary education, 42% had completed secondary education, and 24% had completed secondary education or higher. When it comes to the total number of children, around 49% of the mothers had one child, 42% had two children, and approximately 9% had more than two children. In regard to respiratory illness, the majority of the mothers (85%) did not report any such suffering within the past two weeks. Regarding media exposure, 68% of the mothers had been exposed to mass media, while the remaining mothers had not.

Concerning the characteristics of the children, 14 percent of them were less than 12 months old, while around a quarter of them were between 12-23 months (25%) and 24-35 months (26%) of age. Around 17 percent and around 19 percent of children were between 36-47 months and 48-59 months of age, respectively. In terms of gender, 53 percent were boys and 47 percent were girls. Around 16 percent of children had a low birth weight (less than 2.5 Kg.). In around 8 percent of children had suffered from diarrhoea in the prevoius two weeks. In the prevoius year, 40 percent of the children did not have any episode of diarrhoea, while around 24 percent of them had one episode and the remaining children had two or more episodes of diarrhoea.

Table 3.12: Distribution of study variables in rural West Bengal for 2022-23

Background Characteristics	**Distribution of Sample**
	N (%)
The child Had ARI (in the last 2 weeks)	
No	244 (82.4)
Yes	52 (17.6)
Household Environment	
Type of House	
Pucca	126 (42.5)
Semi Pucca	59 (20)
Kachha	111 (37.5)
Located Pucca Road (within 1Km)	
No	51 (17.3)
Yes	245 (82.7)
Poultry firm (within 1Km)	
No	268 (90.5)
Yes	28 (9.5)
Muri mill (within 1Km)	
No	248 (83.7)
Yes	48 (16.3)
Rice Mill (within 1Km)	
No	270 (91.3)
Yes	26 (8.7)
Contact with pet/domestic animals	
No	135 (45.6)
Yes	161 (54.4)

Background Characteristics	Distribution of Sample
	N (%)
Source of Alternative light during unavailability of electricity	
Kerosene lamp	129 (43.5)
Emergency light	167 (56.5)
Smoking anyone in the Household	
No	112 (37.9)
Yes	184 (62.2)
Family History of Respiratory Illness	
No	251 (84.8)
Yes	45 (15.3)
The main source of cooking fuel	
Firewood/ Kerosene/ Coal and charcoal	55 (18.6)
Cow dung cakes	142 (48)
LPG/Natural Gas Pipeline	99 (33.5)
Place of cooking	
Cooking in a separate kitchen	152 (51.4)
Cooking inside house, but not in separate kitchen	47 (15.9)
Cooking in open/ outside house	97 (32.8)
Frequency of cooking in a day	
Once	36 (12.2)
Twice	228 (77.1)
More	32 (10.9)
Presence of the child during cooking	
No	70 (23.7)
Sometimes	181 (61.2)
Most of the time	45 (15.3)
Socio-economic Characteristics	
Religion	
Hindu	152 (51.4)
Muslim	144 (48.7)
Social Category (Caste)	
SC & ST	77 (26.1)
OBC	125 (42.3)
General	94 (31.8)
PDS/Ration card type	
APL	151 (51.1)
BPL	145 (49)

Background Characteristics	Distribution of Sample
	N (%)
Type of family	
Joint	95 (32.1)
Nuclear	105 (35.5)
Extended	96 (32.5)
Family Income (Per Years)	
< Rs. 50,000	46 (15.6)
Rs. 50,000 to 75,000	162 (54.8)
> Rs. 75,000	88 (29.8)
Mother's Characteristics	
Mother's Age	
< 20 years	23 (7.8)
20 - 24 years	127 (43)
25 - 29 years	100 (33.8)
> 29 years	46 (15.6)
Mother's Education	
Primary	99 (33.5)
Secondary	125 (42.3)
Higher Secondary and above	72 (24.4)
Total number of children	
One Children	145 (49)
Two Children	125 (42.3)
More than two children	26 (8.8)
Mother Suffering from respiratory illness in the last 2 weeks	
No	251 (84.8)
Yes	45 (15.3)
Mass media exposure	
No	95 (32.1)
Yes	201 (68)
Children Characteristics	
Child age (in months)	
< 12 Months	41 (13.9)
12-23 Months	73 (24.7)
24-35 Months	78 (26.4)
36-47 Months	49 (16.6)
48-59 Months	55 (18.6)

Background Characteristics	Distribution of Sample
	N (%)
Sex of the child	
Boy	156 (52.8)
Girl	140 (47.3)
Child weight during birth/birth weight of child	
Normal (>2.50 KG)	246 (83.2)
Low birth weight (<2.50 KG)	50 (16.9)
The child had diarrohea (in the last 2 weeks)	
No	278 (94)
Yes	18 (6.1)
Diarrohea Episode (in last 1 year)	
No Episode	136 (46)
Single Episode	70 (23.7)
Two or More Episodes	90 (30.5)

Note: *N: number; %: Percentage (column), SC & ST*: Schedule tribe & schedule caste Km: Kilometer; KG: Kilogram

Prevalence of ARI among children in Rural West Bengal:

Table 3.13 illustrates the prevalence of ARI among children. The chi-square test has been conducted to examine the prevalence and association between ARI and other background variables in rural West Bengal (***Table 3.13***).

Children living within one kilometer of Pucca Road (19.6%) had a higher prevalence of ARI compared to their counterparts. children residing near Rice Mill (34.7%) also had a higher prevalence of ARI compared to those living farther away. Households having contact with pets/domestic animals had a relatively higher prevalence (24.3%) than those who did not have such a contact. The children from households that had Karocine as a source of alternative light during unavailability of electricity had a higher prevalence (24.1%) as against those who had emergency light as an alternative source.

Moreover, children belonging to households where any (or more) members were smokers had more prevalence (22.3 percent) as compared to those who did not have any such members. Similarly, the children who had a family history of respiratory illness had a higher prevalence (37.8%) than those who did not have such a history. Place of cooking was also found to be significant. Thus, children from households cooking in open/outside houses had the highest prevalence (25.8%), those from households that were cooking inside the house, but not in the separate kitchen had (17.1%) a higher prevalence whereas those from households which were cooking in a separate kitchen had (12.5%) prevalence.

Among the socio-economic characteristics, religion, caste, and income were found to be significant association with ARI prevalence. Thus, children from households following Hindu religion had a higher prevalence (23.1%) as compared to those following Muslim religion (11.9%). Children belonging to SC and ST had the highest prevalence (27.3%), as against General caste (20.3%) and OBC (9.6%) groups. The children from families with had annual income of Rs. less than 50,000 had the highest prevalence (52.2%), as compared to those with annual family income of 50000 to 75000 (13.6%) and those with annual family income (6.9%). The Children whose mothers were suffering from any respiratory illness in the last 2 weeks had a higher prevalence (33.4%) as compared to those whose mothers were not suffering from any kind of respiratory illness (14.8%).In the case of the children's characteristics, gender, birth weight and episode of diarrhoea in the last one year were the significant factors. The girls had a higher prevalence (22.2%) as compared to the boys (13.5%). The low birthweight babies had two times higher prevalence (30%) than the babies with normal birth weight (15.1%). The factors that were not found to be statistically significant in the occurrence of ARI among children are delineated below. The children staying in Pucca houses had the lowest prevalence of ARI (13.5%), as compared to those from semi-pucca houses (20.4%) and Kachha houses (20.8%). The children whose houses were located near to a poultry farm within one Km of range showed a higher prevalence of ARI. Children whose houses are situated within 1 km of Muri Mil showed higher prevalence than their counterparts. Households using LPG/Natural Gas pipelines as the main source of cooking fuel had the lowest prevalence (12.2%) of ARI as compared to those using Firewood/ Kerosene/ Coal and charcoal (18.2%) and those using cow dung cakes (21.2%). Moreover, households that reported the frequency of cooking in a day as once (16.7%), had the lowest prevalence (16.7%) as against those cooking twice (17.2%) or more times (21.9%) in a day. Again, households with the absence of a child during cooking had the lowest prevalence (11.5%) as compared to the households that had the presence of a child, sometimes (17.7 %) or most of the time (26.7%) during cooking. As regards the type of ration card, the children belonging to the households that had BPL cards had lower prevalence (15.2%) as compared to those APL card holders (19.9%). The children from nuclear type of families had the lowest prevalence (11.5%) as against those from joint families (17.9%) and from extended families (24%). Looking at mother’s age, children of mothers who were more than 29 years of age had the lowest prevalence (13.1%) whereas the children of very young age mothers i.e. less than 20 years, showed the highest prevalence (30.5%). The children whose mothers were in the age group 25-29 years had 21% prevalence followed by children of mothers aged 20 to 24 years (14.2%). The children whose mothers were educated up to higher secondary and above had the lowest prevalence (9.8%), those with mother's education of primary to secondary level had 19.2% prevalence whereas children of mothers who had less than primary schooling had highest prevalence (21.3%). The children of mothers who had more than two children had the lowest prevalence (7.7%) of ARI, whereas those whose mothers had one child had the highest prevalence (20.7%); children of mothers with two children had 16% prevalence. The children whose mothers had no mass media exposure had lower prevalence (13.7%) as compared to those of mothers who had such an exposure (19.5%). As regards children's characteristics, child's age and diarrhoea in the last 2 weeks were the factors which were not fond to be statistically significant. However, very young children i.e. less than 12 months, had the lowest prevalence (12.2%). On the other hand, children from the oldest age group, 48-59 months had the highest prevalence (21.9%). Children aged 12-23 months had 19.2% prevalence, those aged 24-35 months had 15.4% prevalence and those aged 36-47 months had 18.4 % prevalence of ARI. The children who did not have diarrhoea in the last 2 weeks had lower prevalence of ARI as compared to the children who had diarrhoea in the last 2 weeks.

Table 3.13: Prevalence of ARI among children in a rural part of West Bengal in 2022-23

Background Characteristics	Prevalence of ARI[a] (in %)	
	N (%)	*95% of CI (Lower-Upper)*
Household Environment		
Type of house	**$\chi 2$ = 2.5; p=0.284**	
Pucca	17 (13.5)	[8.4-20.3]
Semi Pucca	12 (20.4)	[11.7-31.9]
Kachha	23 (20.8)	[14-29]
Located pucca road (within 1Km)	**$\chi 2$ = 4.02; p=0.045***	
No	4 (7.9)	[2.8-17.6]
Yes	48 (19.6)	[15-25]
Poultry firm (within 1Km)	**$\chi 2$ = 2.6; p=0.108**	
No	44 (16.5)	[12.4-21.3]
Yes	8 (28.6)	[14.6-46.8]
Muri mill (within 1Km)	**$\chi 2$ = 1.42; p=0.516**	
No	42 (17)	[12.7-22]

Background Characteristics	Prevalence of ARI[a] (in %)	
	N (%)	*95% of CI (Lower-Upper)*
Yes	10 (20.9)	[11.3-33.9]
Rice mill (within 1Km)	**$\chi 2$ = 5.72; p=0.017***	
No	43 (16)	[12-20.7]
Yes	9 (34.7)	[18.8-53.8]
Contact with pet/domestic animals	**$\chi 2$ = 10.8; p<0.001****	
No	13 (9.7)	[5.6-15.5]
Yes	39 (24.3)	[18.2-31.3]
Source of alternative light during unavailability of electricity	**$\chi 2$ = 6.6; p=0.010***	
Kerosene lamp	31 (24.1)	[17.3-32]
Emergency light	21 (12.6)	[8.2-18.3]
Smoking anyone in the household	**$\chi 2$ = 7.46; p=0.006****	
No	11 (9.9)	[5.4-16.4]
Yes	41 (22.3)	[16.8-28.7]
Family history of respiratory illness	**$\chi 2$ = 14.97; p<0.001*****	
No	35 (14)	[10.1-18.7]
Yes	17 (37.8)	[24.8-52.4]
The main source of cooking fuel	**$\chi 2$ = 3.29; p=0.194**	
Firewood/ Kerosene/ Coal and charcoal	10 (18.2)	[9.8-29.9]
Cow dung cakes	30 (21.2)	[15.1-28.4]
LPG/Natural Gas Pipeline	12 (12.2)	[6.9-19.7]
Place of cooking	**$\chi 2$ = 7.251; p=0.027***	
Cooking in a separate kitchen	19 (12.5)	[8-18.5]
Cooking inside house, but not in separate kitchen	8 (17.1)	[8.4-29.6]
Cooking in open/ outside house	25 (25.8)	[17.9-35.1]
Frequency of cooking in a day	**$\chi 2$ = 0.46; p=0.793**	
Once	6 (16.7)	[7.3-31.2]
Twice	39 (17.2)	[12.7-22.4]
More	7 (21.9)	[10.4-38.3]
Presence of the child during cooking	**$\chi 2$ = 4.40; p=0.111**	
No	8 (11.5)	[5.6-20.5]
Sometimes	32 (17.7)	[12.7-23.8]
Most of the times	12 (26.7)	[15.5-40.8]
Socio-economic Characteristics		
Religion	**$\chi 2$ = 6.43; p=0.011***	
Hindu	35 (23.1)	[16.9-30.2]

Background Characteristics	Prevalence of ARI[a] (in %)	
	N (%)	*95% of CI (Lower-Upper)*
Muslim	17 (11.9)	[7.4-17.9]
Social Category (Caste)	**χ2 = 10.94; p=0.004****	
SC & ST	21 (27.3)	[18.3-38]
OBC	12 (9.6)	[5.4-15.7]
General	19 (20.3)	[13.1-29.2]
PDS/Ration card	**χ2 = 1.12; p=0.289**	
APL	30 (19.9)	[14.2-26.8]
BPL	22 (15.2)	[10.1-21.7]
Type of family	**χ2 = 5.45; p=0.066**	
Joint	17 (17.9)	[11.3-26.6]
Nuclear	12 (11.5)	[6.5-18.6]
Extended	23 (24)	[16.3-33.2]
Family Income (per year)	**χ2 = 46.84; p<0.001*****	
< Rs. 50,000	24 (52.2)	[38-66.2]
Rs. 50,000 to 75,000	22 (13.6)	[9-19.5]
> Rs. 75,000	6 (6.9)	[2.9-13.6]
Mother's Characteristics		
Mother's Age	**χ2 = 5.10; p=0.164**	
< 20 years	7 (30.5)	[14.8-50.7]
20 - 24 years	18 (14.2)	[9-21.1]
25 - 29 years	21 (21)	[14-29.8]
> 29 years	6 (13.1)	[5.7-25]
Mother's Education	**χ2 = 4.20; p=0.123**	
Primary	21 (21.3)	[14.1-30.1]
Secondary	24 (19.2)	[13.1-26.8]
Higher Secondary and above	7 (9.8)	[4.5-18.2]
Total number of children	**χ2 = 2.94; p=0.230**	
One Children	30 (20.7)	[14.8-27.9]
Two Children	20 (16)	[10.4-23.2]
More than two children	2 (7.7)	[1.7-22.5]
Mother suffering from respiratory illness for last 2 weeks	**χ2 = 9.10; p=0.003****	
No	37 (14.8)	[10.8-19.6]
Yes	15 (33.4)	[21-47.9]
Mass media exposure	**χ2 = 1.45; p=0.227**	
No	13 (13.7)	[7.9-21.7]

Background Characteristics	Prevalence of ARI[a] (in %)	
	N (%)	*95% of CI (Lower-Upper)*
Yes	39 (19.5)	[14.4-25.3]
Children Characteristics		
Child age (in months)	**$\chi2$ = 1.91; p=0.752**	
< 12 Months	5 (12.2)	[4.9-24.7]
12-23 Months	14 (19.2)	[11.5-29.4]
24-35 Months	12 (15.4)	[8.7-24.6]
36-47 Months	9 (18.4)	[9.5-30.9]
48-59 Months	12 (21.9)	[12.6-34]
Sex of the child	**$\chi2$ = 3.84; p=0.050***	
Boy	21 (13.5)	[8.8-19.5]
Girl	31 (22.2)	[15.9-29.6]
Child weight during birth	**$\chi2$ = 6.42; p=0.011***	
Normal (>2.50 KG)	37 (15.1)	[11-20]
Low birth weight (<2.50 KG)	15 (30)	[18.7-43.6]
Child had diarrohea (in last 2 weeks)	**$\chi2$ = 0.29; p=0.59**	
No	48 (17.3)	[13.2-22.1]
Yes	4 (22.3)	[8.1-44.6]
Diarrohea Episode (in last 1 year)	**$\chi2$ = 16.27; p<0.001*****	
No Episode	11 (8.1)	[4.4-13.6]
Single Episode	16 (22.9)	[14.3-33.7]
Two or More Episodes	25 (27.8)	[19.4-37.7]

Note: *N: number of ARI cases; %: Percentage of ARI, Prevalence of ARI: Row percentage. ARI Prevalence: 0=not suffered from ARI, 1=suffered from ARI, Chi-square test: p < 0.05 (***p<0.001, **p<0.01, *p<0.05) =significant*

Factors associated with ARI in rural West Bengal:

A primary study conducted in rural West Bengal, India in 2022-23 revealed several factors associated with ARI among children (0-59 months) (***Table 3.14***).

The findings indicated that households near the muri mill (within a 1 km range) were associated with an increased risk of childhood ARI (AOR: 2.2; 95% CI: 1.22-2.79) compared to households located 1km from the mill. Furthermore, household members who had contact with pets/domestic animals showed a 3.3 times higher risk of ARI for their children (AOR: 3.3, 95% CI: 1.17-9.35) than those without such contact. Family history of respiratory illness was also found to significantly increase the odds of childhood ARI by 9.94 times (AOR: 9.94, 95% CI:

2.97-33.3) compared to households without a history of respiratory illness. Cooking inside a non-separate kitchen was associated with an increased risk of childhood ARI (AOR: 1.47, 95% CI: 1.13-6.5) compared to cooking in a separate kitchen. Additionally, the presence of a child, especially with the mother, during cooking was identified as a significant contributing factor to childhood ARI (AOR: 6.54, 95% CI: 1.67-25.73).

In terms of socio-economic characteristics, the study found that higher household income was associated with a reduced prevalence of childhood ARI. Households with an annual income ranging from Rs. 50,000 to 75,000 (AOR: 0.07, 95% CI: 0.02-0.46) and >Rs. 75,000 (AOR: 0.04; 95% CI: 0.01-0.33) were found to have a reduced risk of childhood ARI compared to households with an income less than a certain threshold.

Regarding maternal characteristics, the study highlighted that a mother's recent respiratory illness increased the odds of her children having ARI (AOR: 3.58; 95% CI: 1.04-12.31) compared to mothers without recent respiratory illness.

Finally, the study revealed that female children (AOR: 2.49; 95% CI: 1.1-5.62) were more likely to suffer from ARI compared to male children. These findings shed light on the complex interplay of environmental, socio-economic, and maternal factors associated with childhood ARI in rural West Bengal, India.

Table 3.14: Logistic regression model assessing household environmental and other socio-economic characteristics associated with ARI among children (0-59 Months) in a rural part of West Bengal, India (2022-23)

Background Characteristics	AOR 95% of CI [Lower-Upper]
A. Household Environment	
Type of house	
Pucca	***Ref.***
Semi pucca	1.17 [0.26-5.35]
Kachha	0.71 [0.21-2.36]
Located pucca road (within 1Km)	
No	***Ref.***
Yes	2 [0.24-17.16]
Poultry firm (within 1Km)	
No	***Ref.***
Yes	0.37 [0.03-6.26]
Muri mill (within 1Km)	
No	***Ref.***

Background Characteristics	AOR 95% of CI [Lower-Upper]
Yes	2.2 [1.22-2.79]*
Rice mill (within 1Km)	
No	***Ref.***
Yes	1.03 [0.08-14.06]
Contact with pet/domestic animals	
No	***Ref.***
Yes	3.3 [1.17-9.35]*
Source of alternative light during unavailability of electricity	
Kerosene lamp	***Ref.***
Emergency light	0.48 [0.21-1.14]
Smoking anyone in the household	
No	***Ref.***
Yes	3.26 [0.83-12.84]
Family history of respiratory illness	
No	***Ref.***
Yes	9.94 [2.97-33.31]***
The main source of cooking fuel	
Firewood/ Kerosene/ Coal and charcoal	***Ref.***
Cow dung cakes	0.38 [0.09-1.58]
LPG/Natural Gas Pipeline	0.5 [0.09-2.88]
Place of cooking	
Cooking in a separate kitchen	***Ref.***
Cooking inside the house, but not in the separate kitchen	1.47 [1.13-6.57]**
Cooking in open/ outside house	1.06 [0.27-4.18]
Frequency of cooking in a day	
Once	***Ref.***
Twice	1.37 [0.28-6.75]
More	1.07 [0.15-8]
Presence of the child during cooking	
No	***Ref.***
Sometimes	1.52 [0.35-6.64]
Most of the time	6.54 [1.67-25.73]**
B. Socio-economic Characteristics	
Religion	
Hindu	***Ref.***

Background Characteristics	AOR 95% of CI [Lower-Upper]
Muslim	1.55 [0.26-9.55]
Social category (Caste)	
SC & ST	***Ref.***
OBC	0.3 [0.05-1.94]
General	1.65 [0.32-8.49]
PDS/Ration card	
APL	***Ref.***
BPL	1.7 [0.45-6.42]
Type of family	
Joint	***Ref.***
Nuclear	0.59 [0.12-2.97]
Extended	2.02 [0.63-6.55]
Family income (per year)	
< Rs. 50,000	***Ref.***
Rs. 50,000 to 75,000	0.07 [0.02-0.46]**
> Rs. 75,000	0.04 [0.01-0.33]**
C. Mother's characteristics	
Mother's age	
< 20 years	***Ref.***
20 - 24 years	0.77 [0.2-2.98]
25 - 29 years	1.48 [0.26-8.48]
> 29 years	0.76 [0.07-8.26]
Mother's education	
Primary	***Ref.***
Secondary	1.57 [0.38-6.56]
Higher secondary and above	1.02 [0.16-6.68]
Total number of children	
One child	***Ref.***
Two children	0.72 [0.27-1.91]
More than two children	0.24 [0.02-3.09]
Mother Suffering from respiratory illness for the last 2 weeks	
No	***Ref.***
Yes	3.58 [1.04-12.31]*
Mass media exposure	
No	***Ref.***

Background Characteristics	AOR 95% of CI [Lower-Upper]
Yes	0.65 [0.19-2.26]
D. Children Characteristics	
Child age (in months)	
< 12 months	***Ref.***
12-23 months	1.37 [0.17-11.17]
24-35 months	0.87 [0.1-7.97]
36-47 months	1.44 [0.17-12.56]
48-59 months	1.77 [0.22-14.36]
Sex of the child	
Boy	***Ref.***
Girl	2.49 [1.1-5.62]*
Child weight during birth	
Normal (>2.50 KG)	***Ref.***
Low birth weight (<2.50 KG)	0.82 [0.26-2.56]
The child had diarrohea (in the last 2 weeks)	
No	***Ref.***
Yes	1.32 [0.26-6.69]
Diarrohea episode (in last 1 year)	
No episode	***Ref.***
Single episode	2.93 [0.85-10.14]
Two or more episodes	1.68 [0.63-4.52]
Overall Model Evolution	
Number of Observations (N)	296
Log-likelihood	-78.864211
Likelihood Ratio (LR) Chi-square ($\chi 2$)	117.42
Chi-square ($\chi 2$) p value	<0.001
Pseudo R2	0.4267

Note: AOR: Adjusted Odds Ratio, Ref: Reference Category, CI: Confidence interval, ***p<0.001, **p<0.01, *p<0.05, SC: Scheduled Caste, ST: Scheduled Tribe, OBC: Other Backward Caste.

Association Between Household Environmental Vulnerability index (HEVI) and ARI among children in rural West Bengal:

The **table 3.14** demonstrates the correlation between the Household Environmental Vulnerability Index (HEVI) and Acute Respiratory Infection (ARI) prevalence among children aged 0-59 months in rural areas of West Bengal (**Table 3.15)**. The findings revealed that living in an unhealthy (AOR: 11.6; 95% CI: 2.6-51.4) or very unhealthy (AOR: 16.7; 95% CI: 2.9-96) household environment was associated with 11.6 times and 16.7 times higher odds of ARI, respectively, compared to residing in a good household environment.

Table 3.15: Logistic regression model assessing Household Environmental Vulnerability index (HEVI) with ARI among children (0-59 Months) in a rural part of West Bengal, India (2022-23)

Household Environmental Vulnerability	**Sample**	**[a]Prevalence of ARI**	**AOR [95% of CI]**
Good	52 (17.6)	2 (3.8)	Ref.
Moderate	144 (48.6)	17 (11.8)	3.3 [0.7-15]
Unhealthy	85 (28.7)	27 (31.8)	11.6 [2.6-51.4]**
Very Unhealthy	15 (5.1)	6 (40)	16.7 [2.9-96]**
Constant	0.03		
Observations	296		
Log likelihood	123.98		
Likelihood Ratio (LR) Chi-square ($\chi2$)	27.18		
Chi-square ($\chi2$) p value	<0.001		
Pseudo R2	0.10		

Note: Prevalence of ARI: Row percentage. AOR: Adjusted Odds Ratio, Ref: Reference Category, CI: Confidence interval, ***p<0.001, **p<0.01, *p<0.05,

3.2.3 Concentration Index in the Prevalence of ARI

Inequality in NFHS-IV and NFHS-V:

The concentration indices for ARI were negative (CI: -0.06, $p < 0.001$) in 2015-16 and (CI: -0.07, $p < 0.001$) in 2019-21. The results indicate that children in lower socioeconomic strata bear a significantly higher burden of ARI. This is evident in the concentration curves (see ***Figure 3.15***). The concentration curves largely overlap, suggesting a similar extent of inequality in ARI in both years.

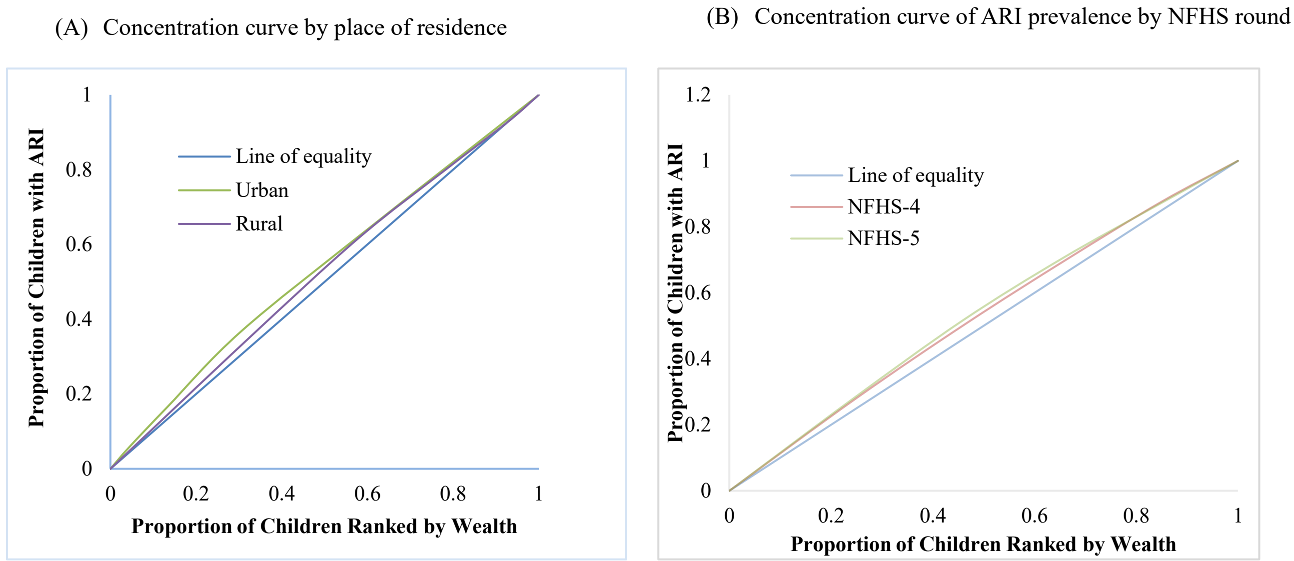


Figure 3.14: Concentration curve on ARI prevalence in India.

Inequality in place of residence (2021):

In 2021, the concentration indices for urban (-0.08) and rural (-0.04) areas in terms of place of residence were found to be negative. This indicates that children from lower socio-economic classes in urban and rural areas bear a significantly higher burden of ARI. This trend is reflected in the concentration curves (refer to ***Figure 3.14***). The overlapping of the concentration curves suggests a similar level of inequality in ARI in both urban and rural areas.

3.2.4 Key Findings

Factors Associated with ARI in Children (0-59 Months) in India (NFHS-IV 2015-16 and NFHS-V 2019-21)

Household and Environmental Factors:

- Children living in sturdier Pacca houses were less likely to contract ARI compared to those in flimsy Kuchha houses (AOR: 0.74; 95% CI: 0.62-0.88).
- Having a separate kitchen was also found to reduce the risk of ARI (AOR: 0.95; 95% CI: 0.89-0.97).
- In contrast, exposure to smoking in the household increased the risk by 1.13 times (AOR: 1.13; 95% CI: 1.06-1.19).

Socioeconomic and Maternal Factors:

- Non-Hindu children had a higher likelihood of suffering from ARI (AOR: 1.16; 95% CI: 1.09-1.25).
- Interestingly, maternal education was associated with an increased risk, indicating that children of mothers with primary education (AOR: 1.24; 95% CI: 1.15-1.35), secondary education (AOR: 1.22; 95% CI: 1.14-1.31), and higher education (AOR: 1.2; 95% CI: 1.07-1.35) were more likely to contract ARI. Its may be due to good knowledge.
- Maternal smoking behaviour significantly raised the risk of ARI in both survey rounds (AOR: 1.28; 95% CI: 1.15-1.42 in NFHS-IV, AOR: 1.34; 95% CI: 1.2-1.5 in NFHS-V). Maternal exposure to mass media also increased the ARI risk in both surveys (AOR: 1.12; 95% CI: 1.05-1.2 in NFHS-IV, AOR: 1.18; 95% CI: 1.1-1.26 in NFHS-V).
- Furthermore, mothers with respiratory diseases or asthma posed a significantly higher risk for their children (AOR: 2.13; 95% CI: 1.93-2.8 in NFHS-IV, AOR: 2.33; 95% CI: 1.93-2.8 in NFHS-V).

Child Characteristics and Regional Factors:

- The risk of ARI decreases as children get older. Additionally, children with normal birth weights have a lower risk of ARI (AOR: 0.83; 95% CI: 0.78-0.90 in NFHS-IV, AOR: 0.9; 95% CI: 0.84-0.96 in NFHS-V).
- Children who experience diarrhoea are significantly more likely to develop ARI in both surveys (AOR: 3.67; 95% CI: 3.47-3.89 in NFHS-IV, AOR: 3.76; 95% CI: 3.52-4.02 in NFHS-V).

- Regionally, the northeast, west, and south regions have a lower ARI risk compared to the north in both surveys.

Overall Change from NFHS-IV to NFHS-V:The overall risk of ARI increased by 1.06 times in NFHS-V compared to NFHS-IV (AOR: 1.06; 95% CI: 1.02-1.11). This suggests an increasing trend in ARI risk among children over the period from 2015-16 to 2019-21.

Concentration index: The concentration curves significantly overlap, indicating similar inequality in ARI across years and residential areas.

Summary: In India, the likelihood of Acute Respiratory Infection (ARI) among children is significantly influenced by several environmental, maternal, and child health factors. Notably, children with a history of low birth weight and those experiencing diarrhoea in the two weeks before the survey were found to be at an increased risk of ARI. Furthermore, mother's behaviors such as smoking, respiratory issues, also contributed to the heightened vulnerability of these children to ARI. On a positive note, certain living conditions have been linked to a reduced risk of ARI among children. Specifically, residing in a pucca house and having a household with a separate kitchen were identified as protective factors against the development of Acute Respiratory Infection in children. These findings highlight the importance of addressing specific health and environmental factors to mitigate the risk of ARI among children in India.

Factors Associated with ARI in Children (0-59 Months) in Rural West Bengal (2022-23):

- Households located within 1 km of a muri mill had a significantly higher risk of childhood ARI (AOR: 2.2; 95% CI: 1.22-2.79).
- Children from households with contact with pets or domestic animals had a 3.3 times higher risk of ARI (AOR: 3.3; 95% CI: 1.17-9.35).
- A family history of respiratory illness increased the risk of childhood ARI by nearly 10 times (AOR: 9.94; 95% CI: 2.97-33.3).
- Cooking inside a non-separate kitchen was associated with an increased risk of ARI (AOR: 1.47; 95% CI: 1.13-6.5).
- Children present during cooking, especially with their mothers, had a significantly higher risk of ARI (AOR: 6.54; 95% CI: 1.67-25.73).
- Households earning Rs. 50,000-75,000 and Households earning more than Rs. 75,000 (AOR: 0.04; 95% CI: 0.01-0.33) had a reduced risk of ARI (AOR: 0.07; 95% CI: 0.02-0.46).

- A recent maternal respiratory illness increased the likelihood of ARI in children (AOR: 3.58; 95% CI: 1.04-12.31).
- Female children were more likely to suffer from ARI compared to male children (AOR: 2.49; 95% CI: 1.1-5.62).

Summary: The study conducted in rural West Bengal in 2022-23 highlighted several factors influencing the risk of ARI among children aged 0-59 months. Factors increasing the risk of ARI include living near muri mills, contact with pets or domestic animals, a family history of respiratory illness, cooking in a non-separate kitchen, and having a child present during cooking. Factors decreasing the risk include higher household income, with those earning between Rs. 50,000-75,000 and above Rs. 75,000 showing reduced ARI risk. Additionally, maternal respiratory illness significantly increased ARI risk, while female children were more likely to suffer from ARI compared to male children. These findings underline the importance of addressing both environmental and socioeconomic conditions, as well as maternal health, to reduce ARI incidence among young children.

3.3 Factors Associated with the Treatment-seeking Behaviour for ARI in India

Introduction:

In the previous sections, the results of thorough investigation on the prevalence pf ARI among children in India have been discussed. The distribution of ARI across states and districts was examined, and areas with high and low prevalence were identified. A spatial clustering analysis revealed geographic patterns, highlighting "hotspot" districts with significantly higher ARI prevalence, particularly in regions with environmental risk factors such as elevated PM 2.5 levels. Additionally, factors associated with ARI were studied, uncovering a range of socio-economic, environmental, and maternal health-related determinants. Now, this chapter will explore the treatment-seeking behaviour for ARI among children in India, providing essential insights into healthcare access, utilization, and the challenges that affect the timely and effective management of ARI in vulnerable populations. The overall (sub)objectives of this sections are:

- To show the Treatment-seeking behaviour of ARI among children (0-59 months) across the State/UTs in India.
- To find out the factors associated with Treatment-seeking behaviour in India.

Data Source and Methodology:

Data from the most recent two rounds of the NFHS (NFHS-IV and NFHS-V) was used in the research. Data analysis was performed using STATA 14 software. Bivariate analysis with chi-square test was used to illustrate the connection between treatment seeking behaviour and background variables. Additionally, logistic regression was used to identify the factors influencing treatment seeking behaviour for ARI. A detailed description of the research methodology can be found in the methodology chapter (***Chapter: II; Page No. XX***).

3.3.1 Treatment-seeking Behaviour of ARI across the State/UTs in India

There was a reduction in treatment seeking behaviour for ARI among below 5 years children from NFHS-IV (78.10%) to NFHS-V (52.28%) in India (**Table 3.16**). During NFHS IV, out of the children aged less than five years, the South region had the highest percentage of children with treatment seeking behaviour of ARI in NFHS-IV, with 88.21 % of children below 5 years seeking treatment for ARI, which reduced to 53.45% in NFHS-V. The north-eastern region has the lowest percentage (63.77%) of below 5 children with treatment seeking behaviour of ARI in NFHS-IV, which decreased further to 48.61 % in NFHS-V. However, NFHS-V showed the Western region with the highest percentage of treatment seeking behaviour at 62.60% and the Central region with only 44.32 % of children, the lowest among all the regions with treatment seeking behaviour. All other States showed a decrease in treatment seeking behaviour among under 5 children except Chandigarh, Goa and Ladakh. Chandigarh showed an overall increase in treatment seeking behaviour from NFHS-IV (80.89 %) to NFHS-V (100 %). In Goa, 100% of the under 5 children showed seeking behaviour of ARI. NFHS-IV data of Ladakh was unavailable, hence no comparison could be made between the two surveys. Sikkim showed the highest reduction in treatment seeking behaviour from 100 % in NFHS-IV to 19.07 % in NFHS-V. In NFHS-V, Treatment seeking behaviour was lowest in Nagaland (9.43%), Sikkim (19.07 %), Mizoram (21.77 %), Manipur (26.88 %) and Tamil Nadu (32 %).

Table 3.16: Treatment-seeking behaviour of ARI among children (0-59 months) across the State/UTs in India by, NFHS IV and NFHS-V

State/UTs	**NFHS-IV (2015-16)**	**NFHS-V (2019-21)**
	Weighted %	*Weighted %*
A. North Region	**84.56**	**47.69**
Chandigarh	80.89	100.00
Delhi	71.87	55.10
Haryana	80.58	45.41
Himachal Pradesh	88.99	57.95
Jammu And Kashmir	81.90	47.14
Punjab	92.32	45.04
Rajasthan	87.79	44.19
Uttarakhand	80.14	63.89
Ladakh	NA	39.96
B. Central Region	**75.99**	**44.32**
Chhattisgarh	77.91	35.89
Madhya Pradesh	72.28	46.96
Uttar Pradesh	76.53	44.11
C. East Region	**71.15**	**59.21**
Bihar	67.96	62.66
Jharkhand	68.82	47.08
Odisha	70.74	40.62

West Bengal	76.79	64.29
D. Northeast Region	**63.77**	**48.61**
Arunachal Pradesh	51.33	46.69
Assam	62.74	45.51
Manipur	45.79	26.88
Meghalaya	76.26	67.94
Mizoram	63.58	21.77
Nagaland	32.28	9.43
Sikkim	100.00	19.07
Tripura	55.17	43.50
E. West Region	**86.98**	**62.60**
Dadra And Nagar Haveli/Daman And Diu	83.30	43.47
Goa	100.00	100.00
Gujarat	79.09	61.56
Maharashtra	89.34	62.67
F. South Region	**88.21**	**53.45**
Andaman And Nicobar Islands	100.00	36.22
Andhra Pradesh	72.78	51.01
Karnataka	91.47	56.46
Kerala	96.02	69.56
Lakshadweep	100.00	48.03
Puducherry	76.67	54.98
Tamil Nadu	88.61	32.00
Telangana	87.93	60.21
India	**78.10**	**52.28**

Note: *UTs: Union territory, Weighted %: Children suffering from ARI sought for any treatment, NA: Not available*

Distribution of Sample who seek treatment of ARI with the background characteristics in 2016 and 2021:

Table 3.17 presents the distribution of under-five children with ARI in India according to their background char-acteristics by NFHS IV and NFHS-V. The distribution of under-five children with ARI across NFHS-IV and NFHS-V was similar. Around 76% of the children in NFHS-IV and 77.77% of the children in NFHS-V resided in the rural. 27.96% of the Children belonged to the poorest and there is a gradual decline in the percentage of the children belonging to the higher wealth index with 12.43% in the richest. A similar distribution is seen in NFHS-V where 27.80 % belonged to the poorest and 13.61 % belonged to the richest quintile.

87.28 % of children in NFHS-IV and 82.76% in NFHS-V belonged to a household with a male head and 56.23% of the children in NFHS-IV and 56.15% of the children in NFHS-V were boys. 25.30% of the children in NFHS-IV and 26.15% in NFHS-V belonged to households with less than 4 members, while others belonged to households with 5 members or more. A major percentage of the children belonged to OBC and others were distributed among SC, ST and other social status. The percentage of children who belonged to a family who stated distance problem were 40.37% in NFHS-IV and 30.74% in NFHS-V and those who stated transport problem were 38.68% in NFHS-IV and 28.73% in NFHS-V. The percentage of children whose mothers were literate was 70.98% in NFHS-IV and 78.34% in NFHS-V and with mass media exposure was 27.52% in NFHS-IV and 28.74% in NFHS-V. The percentage of children increased as the age of the child increased. The highest percentage of children lived in the Central Region and the lowest percentage of children lived in the Northeastern region both in NFHS-IV and NFHS-V. 60.57% of the children in NFHS-IV and 61.13% in NFHS-V belonged to EAG States. The percentage of children decreased with an increase in age and increased with an increase in as the number born to women increased.

Table 3.17: Treatment-seeking behaviour of ARI among children (0-59 months) with the background characteristics in India by, NFHS IV and NFHS-V

Background characteristics	**NFHS-IV (2015-16)**		**NFHS-V (2019-20)**	
	N	***%***	***N***	***%***
Place of Resident				
Urban	1,567	24.00	1378	22.23
Rural	4,962	76.00	4820	77.77
Household Wealth Index				
Poorest	1,825	27.96	1723	27.80
Poorer	1,495	22.89	1472	23.75
Middle	1,275	19.52	1167	18.83
Richer	1,123	17.20	993	16.02
Richest	811	12.43	844	13.61
Gender of the Head of the Household				
Male	5,699	87.28	5129	82.76

Female	830	12.72	1069	17.24
Household Size				
≤ 4 Members	1,652	25.30	1620	26.15
5 and more members	4,877	74.70	4577	73.85
Religious group				
Hindu	4,965	76.04	4927	79.50
Non-Hindu	1,564	23.96	1271	20.50
Social Group				
SC	1,559	23.88	1551	25.03
ST	556	8.51	532	8.59
OBC	2,859	43.78	2676	43.18
Others	1,556	23.83	1438	23.20
Distance to health facility				
No/not a big problem	3,893	59.63	4293	69.26
Big problem	2,636	40.37	1905	30.74
Having to take transport				
No/not a big problem	4,004	61.32	4417	71.27
Big problem	2,525	38.68	1781	28.73
Mother's literacy				
Illiterate	1,895	29.02	1343	21.66
literate	4,635	70.98	4855	78.34
Mass Media Exposure				
No	1,797	27.52	1781	28.74
Yes	4,733	72.48	4416	71.26
Children ever born to women				
One children	1,900	29.10	1853	29.89
Two Children	2,231	34.17	2262	36.50
More than 2 children	2,398	36.73	2083	33.60
Age of the child				
0-11 Months	1,545	23.66	1489	24.03
12-23 Months	1,578	24.17	1429	23.05
24-35 Months	1,233	18.89	1193	19.25
36 to 47 Months	1,216	18.62	1104	17.81
48 to 59 Months	957	14.66	983	15.86
Sex of the Child				
Boy	3,671	56.23	3480	56.15
Girl	2,858	43.77	2718	43.85
Region in India				

North	921	14.11	893	14.41
Central	2,405	36.84	1945	31.39
East	1,705	26.12	1816	29.30
Northeast	138	2.11	204	3.28
West	630	9.66	676	10.90
South	729	11.16	664	10.72
State				
Non EAG	2,575	39.43	2409	38.87
EAG	3,955	60.57	3789	61.13
Total	**6,529**	**100.00**	**6198**	**100.00**

Note: N: Number, %: column percentage, EAG: Empowered action group

3.3.2 Determinants of Treatment-seeking Behaviour of ARI among Children in India

Prevalence of treatment-seeking behaviour of ARI among children (0-59 months) with the background characteristics in India:

Table 3.18 shows the prevalence of treatment seeking behaviour among below five children with ARI in India by NFHS-IV and NFHS-V based on their background characteristics. There is a decrease in the prevalence of treatment seeking behaviour across all the background characteristics from NFHS-IV to NFHS-V.

The prevalence of treatment seeking behaviour among urban children (86.21%) is significantly more than rural children (75.55%). However, no significant difference in prevalence is observed among the children based on the place of residence in NFHS-V. Households with a female gender as the head (56.37%) had higher treatment seeking behaviour compared to those with a male head (51.44%) in NFHS-V. However, there were no significant differences in prevalence based on the gender of the head of the household in NFHS-IV. The prevalence of treatment seeking behaviour is significantly highest among the Richest (90.05%) in NFHS-IV and among the Richer (55.87%) in NFHS-V and the prevalence is lowest among the Poorest (69.33%) in NFHS-IV and Richest (48.7%) in NFHS-V. It was found that the difference in prevalence was higher among the different quintiles of wealth index in NFHS-IV compared to NFHS-V, where the difference in prevalence was not much.

The prevalence of treatment seeking behaviour of ARI does not significantly differ among children based on household size, and religious group in both NFHS-IV and NFHS-V. The prevalence is significantly higher among boy children than girl children across both the NFHS-

IV and NFHS-V. The prevalence among different social groups significantly differed in NFHS-IV with the lowest prevalence among the ST groups. However, the prevalence among different social groups does not significantly differ in NFHS-V.

Those with distance problem and transport problem had significantly lower prevalence of treatment seeking behaviour in both the study. Children with literate mothers and those with mass media exposure had higher treatment seeking behaviour in NFHS-IV. However, no significant difference in prevalence is found based on Mother's literacy and Mass Media Exposure in NFHS-V. The prevalence of treatment seeking behaviour was significantly highest among 12-23 months old children (56.07%), followed by 0-11 months (52.9%), 48-59 months (52%), 24-35 months (49.86%) and 36-47 months (49.43%) in NFHS-V. However, there were no significant differences in prevalence based on age in NFHS-IV.

There was no significant difference in prevalence among under-5 children based on the number of children born to women in NFHS-V. However, there was a significant difference in prevalence in NFHS-IV, where the prevalence decreased with the increase in the number of children.

The highest percentage of children with treatment exposure belonged to the South Region (88.22%) in NFHS-IV and to the West Region (62.61%) in NFHS-V. The percentage of children with treatment exposure is lowest in Northeast Region (63.77%) in NFHS-IV and Central Region (44.44%) in NFHS-V.

Non- EAG States had a higher percentage of children (83.26% in NFHS-IV and 56.88% in NFHS-V) with treatment seeking behaviour compared to EAG States (74.75% in NFHS-IV and 49.36% in NFHS-V).

Table 3.18: Prevalence of treatment-seeking behaviour of ARI among children (0-59 months) with the background characteristics in India by, NFHS IV and NFHS-V

Background Variables	NFHS-IV		NFHS-V	
	Prevalence N (%)	*95% CI [Lower, Upper]*	*Prevalence N (%)*	*95% CI [Lower, Upper]*
Place of Resident	**$\chi2$=79.44,p<.001***		**$\chi2$=1.04,p.308**	
Urban	1351 (86.21)	[84.45-87.86]	737 (53.49)	[50.85-56.11]
Rural	3748 (75.55)	[74.33-76.72]	2503 (51.94)	[50.52-53.34]
Household Wealth Index	**$\chi2$=193.27, p<.001***		**$\chi2$=13.69,p.008***	
Poorest	1266 (69.33)	[67.23-71.46]	872 (50.64)	[48.25-52.97]

Poorer	1122 (75.11)	[72.81-77.2]	798 (54.22)	[51.67-56.75]
Middle	1026 (80.51)	[78.23-82.58]	605 (51.81)	[48.98-54.71]
Richer	955 (85.01)	[82.87-87.04]	555 (55.87)	[52.79-58.96]
Richest	731 (90.05)	[87.95-92.05]	411 (48.7)	[45.34-52.07]
Gender of the head of the Household	**χ2=2.13,p.145**		**χ2=8.63,p.003***	
Male	4467 (78.39)	[77.3-79.44]	2638 (51.44)	[50.07-52.8]
Female	632 (76.14)	[73.16-78.95]	602 (56.37)	[53.33-59.27]
Household Size	**χ2=0.78,p.379**		**χ2=1.09,p.297**	
4 Members	1303 (78.87)	[76.86-80.8]	865 (53.4)	[50.97-55.82]
5 and more members	3797 (77.85)	[76.68-79.01]	2375 (51.89)	[50.45-53.34]
Religious group	**χ2=0.38,p.541**		**χ2=0.22,p.642**	
Hindu	3869 (77.93)	[76.76-79.07]	2569 (52.14)	[50.75-53.54]
Non-Hindu	1231 (78.67)	[76.63-80.69]	672 (52.86)	[50.13-55.61]
Social Group	**χ2=21.71,p<.001***		**χ2=6.07,p.109**	
SC	1225 (78.58)	[76.49-80.56]	820 (52.88)	[50.39-55.35]
ST	391 (70.46)	[66.43-74.01]	256 (48.02)	[43.9-52.37]
OBC	2243 (78.46)	[76.92-79.94]	1387 (51.85)	[49.94-53.73]
Others	1240 (79.71)	[77.64-81.64]	777 (54.04)	[51.46-56.6]
Distance to health facility	**χ2=29.24,p<.001***		**χ2=6.47,p.011***	
No/not a big problem	3129 (80.38)	[79.11-81.6]	2291 (53.36)	[51.88-54.86]
Big problem	1970 (74.75)	[73.05-76.37]	950 (49.86)	[47.63-52.12]
Having to take transport	**χ2=42.73,p<.001***		**χ2=15.93,p<.001***	
No/not a big problem	3234 (80.76)	[79.53-81.97]	2380 (53.9)	[52.42-55.35]
Big problem	1866 (73.89)	[72.17-75.59]	860 (48.29)	[45.98-50.61]
Mother's literacy	**χ2=47.94,p<.001***		**χ2=1.89,p.169**	
Illiterate	1375 (72.55)	[70.52-74.54]	680 (50.62)	[47.97-53.31]
literate	3725 (80.38)	[79.21-81.5]	2561 (52.75)	[51.35-54.16]
Mass Media Exposure	**χ2=97.55,p<.001***		**χ2=1.25,p.265**	
No	1256 (69.91)	[67.75-71.99]	951 (53.4)	[51.08-55.71]
Yes	3843 (81.22)	[80.07-82.29]	2289 (51.84)	[50.36-53.31]
Community Interaction	**χ2=15.93,p<.001***		**χ2=6.47,p.011***	
No	2,150 (76.61)	[71.75-81.99]	996 (51.16)	[52.42-55.35]
Yes	3,285(79.11)	[74.75-86.99]	2,227 (53.41)	[51.46-56.6]
Children ever born to women	**χ2=55.11,p<.001***		**χ2=0.97,p.618**	
One child	1563 (82.24)	[80.5-83.94]	984 (53.11)	[50.83-55.37]
Two Children	1780 (79.76)	[78.09-81.42]	1167 (51.57)	[49.54-53.65]
More than 2 children	1757 (73.29)	[71.48-75.02]	1090 (52.33)	[50.19-54.47]

Age of the child	χ2=8.18,p.085		χ2=14.74,p.005*	
0-11 months	1213 (78.51)	[76.42-80.51]	788 (52.9)	[50.39-55.45]
12-23 Months	1258 (79.7)	[77.69-81.65]	801 (56.07)	[53.47-58.62]
24-35 months	969 (78.6)	[76.24-80.81]	595 (49.86)	[47.05-52.71]
36 to 47 months	942 (77.48)	[75.06-79.75]	546 (49.43)	[46.52-52.41]
48 to 59 months	718 (75)	[72.22-77.7]	511 (52)	[48.86-55.1]
Sex of the Child	**χ2=25.62,p<.001***		**χ2=6.01,p.014***	
Boy	2951 (80.38)	[79.08-81.65]	1867 (53.66)	[52-55.31]
Girl	2149 (75.18)	[73.59-76.75]	1373 (50.53)	[48.64-52.4]
Region in India	**χ2=166.35,p<.001***		**χ2=121.96,p<.001***	
North	779 (84.56)	[82.15-86.81]	426 (47.7)	[44.45-50.99]
Central	1828 (75.99)	[74.28-77.69]	862 (44.33)	[42.13-46.54]
East	1213 (71.15)	[68.96-73.26]	1075 (59.21)	[56.93-61.45]
Northeast	88 (63.77)	[55.53-71.44]	99 (48.62)	[41.74-55.37]
West	548 (86.99)	[84.19-89.45]	423 (62.61)	[58.88-66.17]
South	643 (88.22)	[85.72-90.4]	355 (53.45)	[49.67-57.24]
State	**χ2=66.09,p<.001***		**χ2=33.36,p<.001***	
Non EAG	2143 (83.26)	[81.75-84.63]	1370 (56.88)	[54.89-58.84]
EAG	2956 (74.75)	[73.37-76.08]	1870 (49.36)	[47.77-50.95]

Note: *χ2=Chi-square test (applied for each variable), *=p-value <0.05 (Significance), CI: Confidence interval, SC: Scheduled Caste, ST: Scheduled Tribe, OBC: Other Backward Caste*

Determinants of treatment-seeking behaviour of ARI among children in India (2016 and 2021):

The multivariable binary logistic regression was used to identify the factors associated with the treatment-seeking behaviour of ARI among children in India (**Table 3.19**). The results reveal that in NFHS-IV, factors such as the place of residence, household wealth index, gender of the head of the household, mass media exposure, age, sex of the child and the regions showed significant association with the treatment seeking behaviour of below 5 children. However, in NFHS-V, factors such as gender of the head of the household, transport, age, sex of the child, regions and the EAG Status of States showed significant association with the treatment seeking behaviour of below 5 children.

Children living in rural areas had significantly (P<0.05) 0.08 times lower odds (CI: 0.72-1.01) of having treatment-seeking behaviour compared to those living in urban areas. Also, in NFHS-IV the odds of treatment-seeking behaviour significantly increased with the increase in wealth index across all the categories compared to the very poor household. However, no significant association was found for place of residence and wealth index in NFHS-V. Children under 5 belonging to households with female heads had 1.05 times (CI: 0.88-1.25) higher odds in NFHS-IV and 1.32 times (CI: 1.15-1.51) higher odds in NFHS-V of having treatment for ARI as compared to children living under the male head household. In NFHS-V, under 5 children whose parents claimed taking transport is a problem had 0.87 (CI: 0.75-1) times lower odds of seeking treatment than those with no transport problem. However, this trend was not observed in NFHS-IV, where having to take transport was found to have no significant association. Interestingly, Mother's literacy was found to have no significant association with treatment seeking behaviour both in NFHS-IV and NFHS-V. Mass Media Exposure was significantly associated in NFHS-IV, where those with exposure had 1.23 (CI: 1.06-1.43) times higher odds of treatment seeking behaviour than those who had no exposure. However, no significant association of Mass Media exposure was found in NFHS-V. In NFHS-IV, Children who were in the age group of 48-59 months had 0.76 (CI: 0.63-0.92) times lower odds of having treatment seeking behaviour compared to those aged 0-11 months and in NFHS-V, Children who were in the age group of 36-47 months had 0.83 (CI: 0.7-0.97) times lower odds of having treatment seeking behaviour compared to those aged 0-11 months. Both in NFHS-IV and NFHS-V, Girl Child had a significantly lower odd (0.75 (CI: 0.67-0.93) times lower in NFHS-IV and 0.88 (0.79-0.97) times lower in NFHS-V) of having treatment seeking behaviour compared to Boy Child. In NFHS-IV, children belonging to the Central region had 0.75 (CI: 0.6-0.93) times lower odds, the East Region had 0.59 (CI: 0.48-0.74) times lower odds, the Northeast Region had 0.33 (0.26-0.43) times lower odds of having treatment seeking behaviour compared to children belonging to the North Region. However, in NFHS-V, children belonging to the Central region had significantly 0.75 (CI: 0.6-0.93) times lower odds, the East Region had significantly 1.56 (CI: 1.29-1.88) times higher odds and the West Region had significantly 1.21 (0.96-1.52) times higher odds of having treatment seeking behaviour compared to children belonging to the North Region. In NFHS-V, children belonging to EAG States had significantly 0.81 (CI: 0.67-0.99) times lower odds of having treatment seeking behaviour of ARI compared to those belonging to Non EAG States. However, the EAG status of the State was not significant in determining the treatment seeking behaviour in NFHS-IV.

Table 3.19: Logistic regression model assessing the factors associated with treatment-seeking behaviour of ARI among children (0-59 Months) in India, by NFHS IV and V

Background Characteristics	NFHS-IV	NFHS-V
	AOR 95% CI [Lower-Upper]	AOR 95% CI [Lower-Upper]
Place of Resident		
Urban	***Ref.***	***Ref.***
Rural	0.85 (0.72-1.01) *	1.13 (0.98-1.31)
Household Wealth Index		
Very Poor	***Ref.***	***Ref.***
Poorer	1.25 (1.07-1.47) **	1.15 (1-1.33)
Middle	1.45 (1.2-1.76) ***	1.11 (0.94-1.32)
Richer	1.54 (1.22-1.94) ***	1.16 (0.95-1.4)
Richest	2.06 (1.55-2.74) ***	0.96 (0.77-1.2)
Gender of the head of the Household		
Male	***Ref.***	***Ref.***
Female	1.05 (0.88-1.25) ***	1.32 (1.15-1.51) ***
Household Size		
4 Members	***Ref.***	***Ref.***
5 and more members	1.04 (0.9-1.21)	0.97 (0.85-1.09)
Religious group		
Hindu	***Ref.***	***Ref.***
Non-Hindu	1.15 (0.99-1.33)	1.05 (0.92-1.2)
Social Group		
SC	***Ref.***	***Ref.***
ST	0.85 (0.69-1.04)	0.92 (0.77-1.1)
OBC	0.94 (0.8-1.11)	1.07 (0.93-1.23)
Others	0.84 (0.7-1.01)	1 (0.85-1.17)
Distance to health facility		
No/not a big problem	***Ref.***	***Ref.***
Big problem	0.98 (0.83-1.15)	1.04 (0.9-1.19)
Having to take transport		
No/not a big problem	***Ref.***	***Ref.***
Big problem	0.97 (0.82-1.14)	0.87 (0.75-1) *
Mother's literacy		
Illiterate	***Ref.***	***Ref.***
literate	1.07 (0.93-1.24)	1.06 (0.93-1.22)

Background Characteristics	NFHS-IV AOR 95% CI [Lower-Upper]	NFHS-V AOR 95% CI [Lower-Upper]
Mass Media Exposure		
No	***Ref.***	***Ref.***
Yes	1.23 (1.06-1.43) **	0.9 (0.79-1.03)
Community Interaction		
No	***Ref.***	***Ref.***
Yes	1.19 (1.06-1.34) **	1.20 (1.07-1.33) **
Children ever born to women		
One child	***Ref.***	***Ref.***
Two Children	0.91 (0.78-1.07)	1.05 (0.92-1.19)
More than 2 children	0.79 (0.67-0.93)	1.12 (0.97-1.29)
Age of the child		
0-11 Months	***Ref.***	***Ref.***
12-23 Months	0.96 (0.81-1.13)	1.1 (0.95-1.28)
24-35 Months	0.88 (0.74-1.05)	0.9 (0.77-1.06)
36 to 47 Months	0.93 (0.77-1.12)	0.83 (0.7-0.97) *
48 to 59 Months	0.76 (0.63-0.92) **	0.91 (0.77-1.07)
Sex of the Child		
Boy	***Ref.***	***Ref.***
Girl	0.75 (0.67-0.84) ***	0.88 (0.79-0.97) **
Region in India		
North	***Ref.***	***Ref.***
Central	0.75 (0.6-0.93) **	0.91 (0.76-1.09)
East	0.59 (0.48-0.74) ***	1.56 (1.29-1.88) ***
Northeast	0.33 (0.26-0.43) ***	1.03 (0.82-1.29)
West	1.06 (0.74-1.52)	1.42 (1.12-1.81) **
South	1.1 (0.79-1.53)	1.21 (0.96-1.52)
State		
Non EAG	***Ref.***	***Ref.***
EAG	0.93 (0.74-1.18)	0.81 (0.67-0.99) *
Cons	5.34	0.95
Number of obs	6,529	6,198
Pseudo R2	0.0532	0.0172
LR chi2	402.9	145.7
Prob > chi2	<0.001	<0.001
Log-likelihood	-3585.6679	-4166.996

Note: AOR: Adjusted Odds Ratio, Ref: Reference Category, CI: Confidence interval, ***p<0.001, **p<0.01, *p<0.05, SC: Scheduled Caste, ST: Scheduled Tribe, OBC: Other Backward Caste, EAG=Empowered action group

3.3.3 Key Findings

Treatment-Seeking Behaviour for ARI in India:

- There was a significant reduction in treatment-seeking behaviour for ARI among children under 5, from 78.10% in NFHS-IV to 52.28% in NFHS-V.
- Five states namely Nagaland, Sikkim, Mizoram, Manipur, and Tamil Nadu show the lowest treatment-seeking behaviour in NFHS-V (2019-21).
- The highest treatment-seeking behaviour was in NFHS-IV (88.21%), but it dropped to 53.45% in NFHS-V. North-Eastern Region Had the lowest treatment-seeking behaviour in NFHS-IV (63.77%) and decreased to 48.61% in NFHS-V.
- Most states saw a decrease in treatment-seeking behaviour, except for Chandigarh, Goa, and Ladakh.
- He study highlighted that factors such as gender of the head of the household, having to take transport, age, sex of the child, regions and the EAG Status of States showed significant association with the treatment-seeking behaviour of below 5 children.
- Children residing in rural areas demonstrated lower rates of seeking treatment for ARI in comparison to their urban counterparts.
- The likelihood of seeking treatment notably increases with a higher wealth index.
- Furthermore, households led by female heads exhibited a higher propensity to seek treatment for their children in both NFHS-IV and NFHS-V as opposed to those with male heads.
- In addition, exposure to mass media was correlated with an increased likelihood of treatment-seeking behaviour for ARI.
- It is noteworthy that as children's age increased, there was a decrease in the inclination to seek treatment, with older children being less likely to receive treatment for ARI compared to their younger counterparts.
- It was observed that female children were less likely to seek treatment for ARI compared to male children.

- Furthermore, children from the Central, East, and Northeast regions showed lower likelihood of seeking treatment for ARI in comparison to those from the Northern region, highlighting regional variations in treatment-seeking behaviour.
- Moreover, parents encountering transport problemswere also found to be less inclined to seek treatment for their children.
- Additionally, children residing in economically weaker states (EAG states) demonstrated a lower propensity to seek treatment in contrast to those in non-EAG states.

Summary: These results indicate a significant decrease in the inclination to seek treatment for ARI among children under the age of 5, declining from 78.10% in NFHS-IV to 52.28% in NFHS-V. Various factors such as the gender of the household head, transportation constraints, the age and gender of the child, regional variations, and the economic condition of the states have notably influenced patterns of seeking treatment.For rural inhabitants, children from economically disadvantaged states (EAG states), and female children the treatment seeking is lower. Conversely, households with higher wealth and female headed were more likely to pursue treatment. Additionally, exposure to mass media also played a positive role in encouraging healthcare-seeking behavior. From 2016 to 2021, majority of states experienced a reduction in treatment-seeking behavior, with the North-Eastern region and states exhibiting the most significant decline. These findings underscore the necessity for targeted interventions to address geographic, economic, and gender-based disparities in healthcare access for children with ARI.

3.4 Economic Burden and Health-Seeking Behaviours of Families Dealing with ARI in Rural West Bengal.

Introduction

In the previous sections, we have extensively examined the prevalence of Acute Respiratory Infection (ARI) at a national level, with a specific focus on the contextual elements contributing to this widespread public health concern. Leveraging data from the National Family Health Survey (NFHS), our analysis aimed to elucidate the determinants influencing families' decision-making processes related to seeking treatment for ARI, identifying pivotal socio-demographic and economic variables that shape healthcare choices. Furthermore, through the utilization of primary data from rural West Bengal, we uncovered specific risk factors associated with ARI, shedding light on the localized influences driving ARI prevalence in this particular region.

In this section, our focus remains on comprehending the financial hardships experienced by families contending with ARI, and the subsequent impact on their healthcare-seeking behaviour. Our objective, based on primary data collected from rural West Bengal, entails evaluating both the direct and indirect costs incurred by households when a child suffers from ARI. By scrutinizing these financial ramifications, we endeavor to provide a clearer understanding of the economic adversities faced by rural families and the resultant influence on their responses to ARI. Furthermore, this section is focused on analyzing the healthcare-seeking behaviour of these families and understanding how socio-economic constraints shape their utilization of healthcare services as well as the promptness of treatment. This section discussed the findings derived from the following two (sub) objectives, :

- Assessing the economic burden on families dealing with ARI in terms of treatment costs in rural West Bengal.
- Understanding the health-seeking behaviour of children suffering from ARI in rural West Bengal.

Data Source and Methodology

The primary data has been utilized to fulfill the study objective in this section. Data analysis was conducted using STATA 14 software. Descriptive statistics, bivariate and univariate analysis has been utilized to estimate treatment cost and treatment seeking behaviour of children suffering from ARI.

3.4.1 Economic Burden

Household Expenditure on child's health for ARI:

Table 3.20 depicts the expenditure on a child's health for Acute Respiratory Infection (ARI), including traveling costs concerning the PDS distribution and type of health facility. The average expenditure based on the PDS card data indicates that BPL households (Rs. 1588) exhibit higher spending levels compared to APL households (Rs. 1196). Nevertheless, both groups display significant expenditure variability, as evidenced by the large standard deviations (Rs. 1155 for APL and Rs. 1480 for BPL). This notable range highlights disparities in spending patterns within each category, with certain households allocating minimal funds while others incurring substantially higher expenses.

In the case of public health facilities, the average expenditure is Rs. 520/-, with a standard deviation of Rs. 377/-, and range (Rs. 50 to 1120). Again, seeking advice or treatment at Private Health Facilities requires substantially higher costs than the public health facility, with an average expenditure of Rs. 2170/-, with a standard deviation of Rs. 1366/- and belonging to the range (Rs 500-5000).

Table 3.20: Expenditure on child's health for ARI (Excluding traveling cost)

Variables	Expenditure (In Rs.)			
	Mean	*Standard Deviation*	*Minimum*	*Maximum*
PDS/Ration card				
APL	1195.93	1154.84	4020.00	70.00
BPL	1587.50	1479.55	4000.00	50.00
Place of seeking advice or treatment				
Public Health Facility	520.00	376.23	1120.00	50.00
Private Health Facility	2170.00	1366.37	4020.00	420.00
Total	1362.55	1302.41	4020	50.00

Note: SD=Standard Deviation, RS. =Rupees**,** APL: Above Poverty Line, BPL: Below Poverty Line

3.4.2 Treatment-seeking Behaviour of ARI among Under-five Children in a Rural part of West Bengal

Duration of ARI:

The duration of ARI among children under five years of age in the study area is represented in Figure 3.15. Among the surveyed population, consisting of children, 52 were found to have suffered from acute respiratory infection (ARI). Out of these approximately 44 percent (N=23) of children experienced ARI symptoms for more than 5 days, 37 percent (N=19) for 3 days, and 19 percent (N=10) for 4 days respectively.

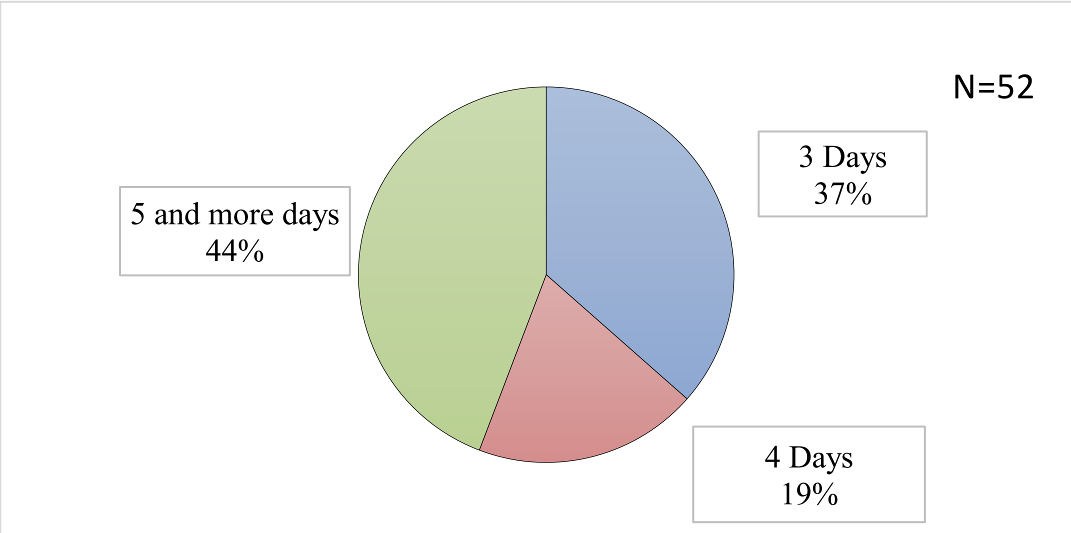


Figure 3.15: Duration of Acute Respiratory Infection (ARI) Among Children Under Five

Seeking advice for treatment for ARI:

Figure 3.16 depicts the percentage of children seeking treatment for ARI in the study area. It was found that around 90 percent of children received treatment, while 10 percent did not.

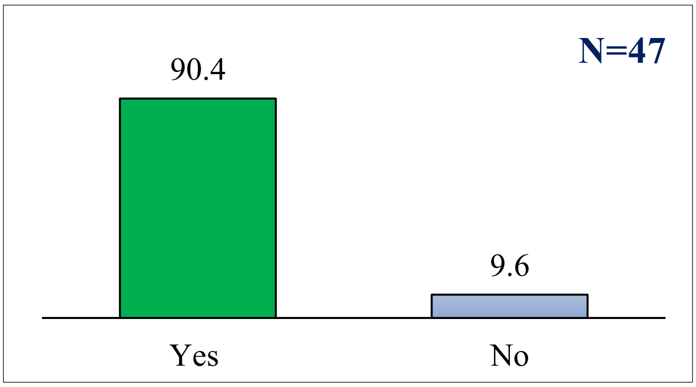


Figure 3.16: Children seek advice for treatment for ARI

Place of Treatment:

In the survey, a higher percentage of individuals preferred private health facilities over public health facilities, with 51 percent and 49 percent, respectively (**Figure: 3.17**).

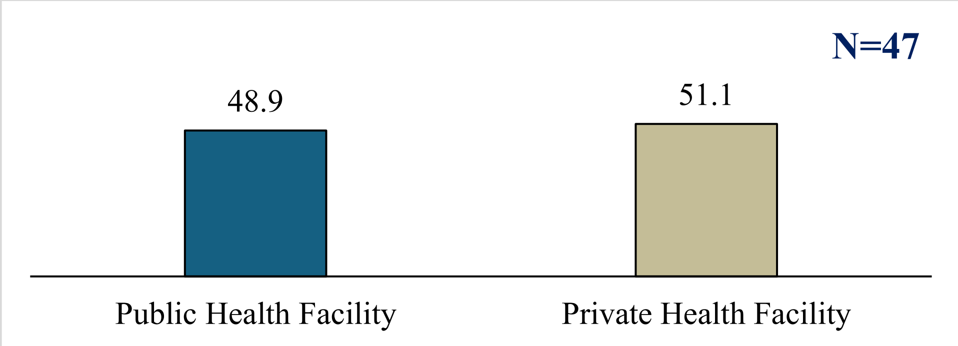


Figure 3.17: Place of treatment-seeking behaviour

Began to seek advice or treatment after the illness: Approximately 70% of individuals sought advice on the same day of detecting the disease, while 30% sought advice the following day or later (**Figure: 3.18**).

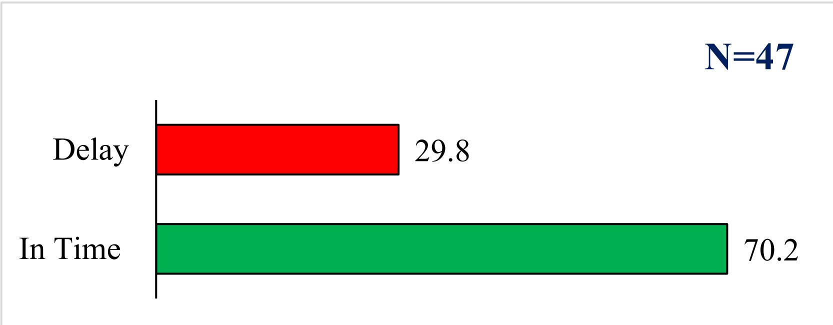


Figure 3.18: Began to seek advice or treatment after the illness

Reason for Delayin the treatment-seeking:

The table shows the association between various socio-demographic factors and the delay in seeking advice or treatment for Acute Respiratory Infection (ARI) among children under five (**Table 3.21**).

Individuals residing more than 1 km away from a healthcare facility exhibit less delay in seeking treatment in comparison to those living within 1 km. The delay in treatment-seeking is higher among Hindus (73.5%) in comparison to Muslims (13.3%). Moreover, the SC/ST groups (38.9%) show a higher percentage of delays compared to Non-SC/ST groups (24.1%). Those classified under BPL experience a 30% increase in delays in seeking treatment as opposed to APL individuals. Extended (36.4%) and nuclear (30%) families reflect a higher proportion of delays in contrast to joint families (20%). Additionally, smaller families (less than 4 members) (42.9%) tend to experience more delays than larger families. There is a correlation between lower family income and increased delays in seeking treatment. Furthermore, the level of the mother's education appears to influence treatment-seeking behaviour, with those having primary education being more likely to experience delays compared to those with secondary or higher education levels. Children of younger age (0-23 months) are also prone to more delays in seeking treatment compared to older children. Notably, girl children (31%) exhibit a higher delay in treatment-seeking than boy children (27.8%).

Table 3.21: Prevalence of Delay in Treatment Seeking behaviour for children in rural West Bengal

Background Variable	Distribution in Sample N (%)	Delay in treatment Seeking N (%)
Distance to nearby public health facility		
<1 Km	16 (34.04)	8 (50)
> 1 Km	31 (65.96)	6 (19.35)
Religion		
Hindu	32 (68.09)	12 (37.5)
Muslim	15 (31.91)	2 (13.3)
Social Category (Caste)		
SC/ST	18 (38.3)	7 (38.9)
Non-SC/ST	29 (61.7)	7 (24.1)
PDS/Ration card type		
APL	27 (57.45)	8 (29.61)
BPL	20 (42.55)	6 (30)
Type of family		
Joint	15 (31.91)	3 (20)
Nuclear	10 (21.28)	3 (30)
Extended		8 (36.4)
Size of Family		
< 4 Members	14 (29.79)	6 (42.9)
5 and more Members	33 (70.21)	8 (24.2)
Family Income (Year)		
Rs. <50,000	22 (46.81)	7 (31.8)
Rs. >50,000	25 (53.19)	7 (28)
Mother's Education		
Primary	18 (38.3)	8 (44.4)
Secondary and above	29 (61.7)	6 (20.7)

Background Variable	Distribution in Sample N (%)	Delay in treatment Seeking N (%)
Total number of children ever born		
One child	29 (61.7)	9 (31)
Two or more children	18 (38.3)	5 (27.7)
Age Group		
0-23 Months	17 (36.17)	8 (47.1)
24-47 Months	20 (42.55)	4 (20)
> 48 Months		2 (20)
Sex of the Child		
Boy	18 (38.3)	5 (27.8)
Girl	29 (61.7)	9 (31)
Total	47 (100)	14 (29.8)

Taking drugs for the illness after the treatment: The table displays the percentage of respondents who took medication for an illness after receiving treatment, based on a sample size of 47. The data indicates that almost all of the individuals in the sample (95.7%) followed medical advice by taking medication after receiving treatment for their illness. Only a small portion (4.3%) did not adhere to drug consumption after treatment (**Figure: 3.19**).

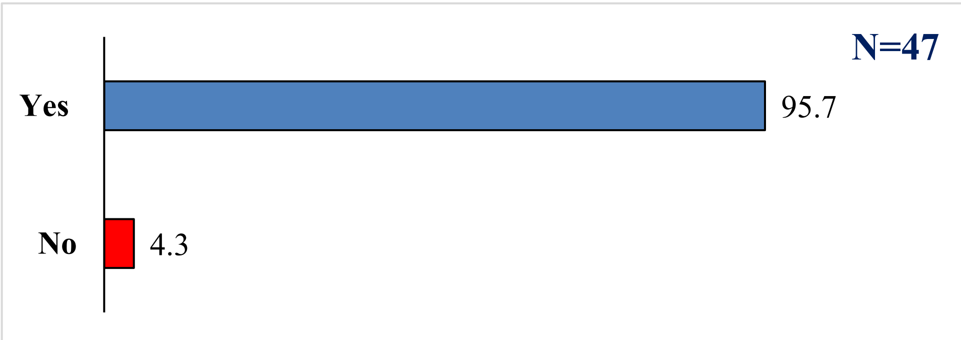


Figure 3.19: Take drugs for the illness after the treatment

Drug consumption behaviour:

Around 70 percent of the children began being advised for treatment on the same day and 30 percent were advised the next day and after. Around 96 percent of individuals take medication for treatment, out of those, 60 percent started taking medicine on the same day, 24 percent on the next day, and 16 percent two days later (**Figure: 3.20**).

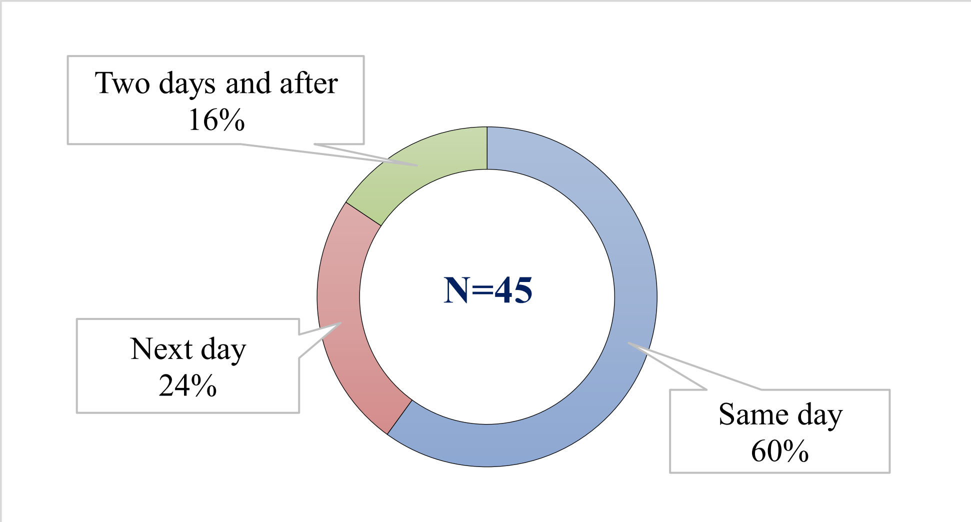


Figure 3.20: Consumption of drugs after treatment initiation

3.4.3 Key Findings

Economic Burden and health-seeking behaviours of families dealing with ARI in rural West Bengal:

- The average expenditure for the treatment of ARI in individual families is Rs. 1363/-.
- In public health facilities, the average expenditure was reported to be Rs. 520/-.
- Meanwhile, private health facilities had notably higher treatment costs (Rs. 2170/-).
- Similarly, the average expenditure for the treatment of ARI among BPL and APL families is Rs. 1588 and Rs. 1196/- respectively.
- The average expenditure for the treatment of ARI among BPL families is Rs. 1588/-, which the average of Rs. 1196/- spent by Above Poverty Line (APL) families.
- In public health facilities, the average expenditure was reported to be Rs. 520/-, with a S.D of Rs. 377.
- The average expenditure for ARI treatment at private health facilities was notably higher, amounting to Rs. 2170 for families seeking treatment.
- The average expenditure for the treatment of ARI among BPL and APL families is Rs. 1588 and Rs. 1196/- respectively.
- In public health facilities, the average expenditure for acute respiratory infection (ARI) treatment was reported to be modest, amounting to Rs. 520, with a standard deviation of Rs. 377.

- The average expenditure for ARI treatment at private health facilities was notably higher, amounting to Rs. 2170 for families seeking treatment.
- When considering both public and private healthcare facilities, the overall average expenditure for ARI treatment was Rs. 1498, with a standard deviation of Rs. 1421.
- Approximately 44 percent of children experienced acute respiratory infection (ARI) symptoms for more than 5 days, 37 percent for 3 days, and 19 percent for 4 days, respectively.
- It was found that around 90 percent of children received treatment, while 10 percent did not.
- Among those who received treatment, 49 percent of children sought treatment from public health facilities, whereas 51 percent sought treatment from private health facilities.
- Additionally, 30 percent of children experienced delays in their treatment.
- It was observed that certain groups were more prone to delays in seeking treatment. Specifically, SC/ST groups (38.9%), BPL (30%) households, extended (36.4%) and nuclear (30%) families, households with less than 4 members (42.9%), and younger age (0-23 months) were more susceptible to delays in seeking treatment compared to their counterparts.

Summary: The chapter reveals significant differences in the economic impact of ARI treatment among various socioeconomic groups. Families below the poverty line (BPL) spent more on treatment compared to above poverty line (APL) families. Treatment at public health facilities was relatively affordable, while private facilities were significantly more expensive. Most children experienced ARI symptoms for more than 5 days. Notably, one-third of children experienced delays in treatment, with SC/ST groups, BPL households, extended families, smaller households, and younger children (0-23 months) being more vulnerable to these delays.

3.5 Knowledge, Attitudes, and Practices (KAP) Regarding ARI among Mothers of Children Under Five in Rural West Bengal

Introduction

ARIs are a significant public health issue, especially among children under five years old in India. Previous sections of this thesis examined the prevalence and geographic concentration of ARI in different areas, emphasizing its impact in rural West Bengal. The factors contributing to ARI were studied, focusing on socio-economic, environmental, and healthcare access variables. Additionally, the behaviour of mothers in seeking treatment for their affected children was explored, providing valuable insights into healthcare utilization patterns.

Building on these discussions, this section aims to delve deeper into the knowledge, attitudes, and practices (KAP) of mothers in rural West Bengal regarding ARI. Understanding these aspects is crucial as mother's awareness and actions can significantly impact both the prevention and timely management of ARI in children. Gaps in knowledge or misconceptions may lead to delayed treatment and worsened health outcomes. Cultural attitudes and practices related to childcare and respiratory infections can also influence health-seeking behaviours.

This study seeks to identify critical areas for intervention by assessing the level of knowledge about ARI, the prevailing attitudes towards respiratory infections, and the day-to-day practices adopted by mothers. The insights gathered from this analysis can help to shape public health strategies, particularly in rural areas with limited healthcare access and strong traditional influences on health behaviour. Consequently, this section will provide a more comprehensive understanding of ARI management in rural West Bengal and offer practical recommendations for improving child health outcomes through targeted health education and community interventions.The specific (sub) objectives of the present section :

- To show the Mother's Knowledge, Attitude, and Practices of ARI in rural West Bengal.
- To show the association between Mother's Knowledge, Attitude, and Practices with the prevalence of ARI among children.

Data Source and Methodology

The primary data has been utilized to fulfill the study objective in this chapter. Data analysis was conducted using STATA 14 software. Bivariate analysis with chi-square test and logistic regression was utilized to demonstrate the relationship between Mother's Knowledge, Attitude, and Practices with the prevalence of ARI among children. For a detailed description of the research methodology, please refer to the methodology chapter (Chapter: II; Page No. XX).

3.5.1 Mother's Knowledge, Attitude, and Practices of ARI in Rural West Bengal

Knowledge of mothers on ARI in rural West Bengal:

Table 3.22 reflects the knowledge of mothers on ARI in rural West Bengal. According to the table, among 296 interviewed mothers, 63.5 percent believed that the ARI was caused by viruses, while 31.4 percent attributed it to bacterial causes, and 5.1 percent associated it with allergies. When asked about significant factors of ARI, 72.3 percent of mothers reported symptoms of cold and cough accompanied by fever, followed by 21.3 percent of mothers who reported solely experiencing fever, with 3.4 percent mentioning vomiting and 3 percent indicating pain in the ear, nose, and throat.

The survey examined the perceptions of mothers about the potential sources of ARI infection in children, focusing on factors such as clean air, smoky air, eating old or rotten foods, cooking inside the home with fire, and cooking outside the home with fire. The survey results indicate various perceptions regarding potential sources of infection. 81.8 percent of mothers reported that smoky air, rather than clean air, is the cause of ARI. Additionally, 61.8 percent of mothers pointed to eating old, rotten foods as a contributing factor, while 40.9 percent attributed ARI to cooking inside the home with fire and 37.2 percent to cooking outside the home with fire. Inquiries regarding complications of the disease revealed that 63.5% of respondents mentioned pneumonia, 34.5% mentioned bronchitis, 2.1% reported ear discharge, and multi-organ failure.

Table 3.22: Knowledge of mothers on ARI in rural West Bengal, India

Questions regarding Knowledge of ARI	N	%
The illnesses (ARI) caused by:		
Viruses	188	63.5
Bacteria	93	31.4
Allergies	15	5.1
What are the symptoms of ARI?		
Cold and Cough with fever	214	72.3
Only Fever	63	21.3
Vomiting	10	3.4
Pain in ear, nose, throat	9	3.0
What do you think, how does a child get an infection of respiratory diseases?		
Clean Air		
Yes	10	3.4
No	242	81.8
Don't Know	44	14.9
Smoky Air		
Yes	255	86.1
No	16	5.4
Don't Know	25	8.4
Eating old or rotten food		
Yes	183	61.8
No	56	18.9
Don't Know	57	19.3
Cooking inside with fire		
Yes	121	40.9
No	60	20.3
Don't Know	115	38.9
Cooking outside the home with a fire		
Yes	110	37.2
No	132	44.6
Don't Know	54	18.2
What are the complications of ARI?		
Bronchitis	102	34.5
Pneumonia	188	63.5
Ear discharge	2	0.7
Multi-organ failure	4	1.4

Knowledge of mothers regarding the ARI: Table **3.23** presents the results of a survey evaluating the knowledge of mothers regarding ARI (Acute Respiratory Infection). The findings indicate that the knowledge of the respondents regarding ARI varied significantly. Around 63.5 percent of the mothers correctly identified the causes of ARI, while 75 percent of them correctly identified the symptoms of ARI. In terms of the sources of respiratory disease infection in children, the majority of mothers (86.2%) has correct knowledge that smoky air is associated with ARI, while a significant proportion incorrectly answer that eating old rotten food (81%) is associated with this morbid condition and cooking inside with fire (59%) not a risk factors for child hood ARI . Only 36.5 percent of the respondents correctly identified the complications of ARI, while 44.6% provided incorrect responses.

Table 3.23: Evaluation of Knowledge of mothers regarding the ARI

Sl. No	**Questions regarding Knowledge of ARI**	**Incorrect N (%)**	**Correct N (%)**
1	The illnesses (ARI) caused by:	108 (36.5)	188 (63.5)
2	What are the symptoms of ARI?	73 (24.6)	223 (75.4)
3	What do you think, how does a child get an infection of respiratory diseases?		
3 (A)	Clean Air	54 (18.3)	242 (81.7)
3 (B)	Smoky Air	41 (13.8)	255 (86.2)
3 (C)	Eating old or rotten food	240 (81)	56 (19)
3 (D)	Cooking inside with fire	175 (59.2)	121 (40.8)
3 (E)	Cooking outside	164 (55.5)	132 (44.5)
4	What are the complications of ARI?	132 (44.6)	108 (36.5)

The attitude of mothers regarding the ARI:

Table 3.24 depicts the attitude of mothers towards ARI in rural West Bengal. In the context of the seriousness of the disease, 51.7 percent of mothers consider the disease as a serious one whereas 32.1% of them consider this a very serious disease, again 16.2 % don't find the disease as a serious one. When it comes to breathing clean air, 40.2 percent of mothers have considered the disease as serious whereas 47.3 percent deemed it as very serious. When it comes to the seriousness of a child having a runny or blocked nose, 65.9 percent of mothers found it as serious whereas 23.3 percent reported it as very serious. When it comes to the importance of building immunity against ARI among children, 20.6 percent of mothers found it as serious whereas 69.9 percent reported it as very serious.

Table 3.24: Attitude towards mother on ARI in rural West Bengal, India

Questions regarding the Attitude of ARI	Not Serious	Serious	Very Serious
Do you consider ARI as a Serious Illness?	48 (16.2)	153 (51.7)	95 (32.1)
How important do you think it is for your child to breathe clean air?	37 (12.5)	119 (40.2)	140 (47.3)
How serious do you think it is if your child is having difficulty breathing, they have a severe cough, or has a problem with their chest?	32 (10.8)	69 (23.3)	195 (65.9)
How serious do you think it is if your child has a runny or blocked nose?	44 (14.9)	63 (21.3)	189 (63.9)
How important are you to consider building the immunity of your child against ARI?	28 (9.5)	61 (20.6)	207 (69.9)

Practices of mothers on ARI in rural West Bengal:

Table **3.25** provides information on the practices of mothers related to Acute Respiratory Infection (ARI) in rural West Bengal. According to the table, during the winter season, 48.0 percent of mothers reported ventilating their room daily, while 12.2 percent reported weekly ventilation practices, and 15.5 percent reported never ventilating their house. In terms of seeking treatment for ARI in children, 54 percent of the mothers preferred medical facilities (private and public), followed by homeopathy doctors (24%), medicine shops (13.5%) and only 8 percent of the mothers relied on home-based treatment. Regarding the practice of maintaining separate eating utensils or drinking containers for children, 52.4 percent of mothers responded positively. However, only 31.8 percent of mothers maintained a safe distance from their children when suffering from cold and cough. During a child's illness, 57.4 percent of mothers cleaned the room daily, 22.6 percent every two days, and 19.9 percent in more than two days interval. Finally, in terms of visiting a doctor after observing symptoms in their child, 61.8 percent of mothers sought urgent medical attention, and 36.8 percent visited within 0 to 2 days, while only 1.4 percent delayed their visit for more than two days.

Table 3.25: Practices of mothers on ARI in rural West Bengal, India

Questions on Practices	Component	N	%
What is the frequency of air ventilation in your home in the winter season?	Never	46	15.5
	Daily	142	48.0
	Weekly	36	12.2

Questions on Practices	Component	N	%
	Occasionally	72	24.3
What is the frequency of air ventilation in your home in the winter season?	Never	46	15.5
	Occasionally	72	24.3
	weekly	36	12.2
	Daily	142	48.0
From where do you seek treatment for your children during ARI illness?	No treatment	0	0.0
	Home Treatment	24	8.1
	Homeopathy	71	24.0
	Medical Care	161	54.4
	Medicine shop	40	13.5
From where do you seek treatment for your children during ARI illness?	Home Treatment	24	8.1
	Medicine Shop	40	13.5
	Homeopathy Doctor	71	24.0
	Medical Care (Private & Public)	161	54.4
Do you maintain eating utensils or drinking containers separately for children?	Yes	155	52.4
	No	141	47.6
Do you maintain distancing from your child when you are suffering from a cold and cough?	Yes	94	31.8
	No	202	68.2
Duration of desensitizing/cleaning room during child illness	Every day	170	57.4
	2 days interval	67	22.6
	>2 days interval	59	19.9
When do you visit the doctor after the symptoms of your child?	Urgently	183	61.8
	0-2 Days	109	36.8
	>2 days interval	4	1.4

The data presented in **figure 3.21** sheds light on the common practices adopted by mothers in rural West Bengal for managing ARI in their children. The findings indicate that most of the mothers (56.4%) administer honey with Tulsi to their children, while 42.6% offer hot water and milk. Additionally, 20.9% use warm clothes and 17.9% regularly clean their children's noses. The least practiced option, chosen by only 3.7% of mothers, was providing turmeric with honey to their children.

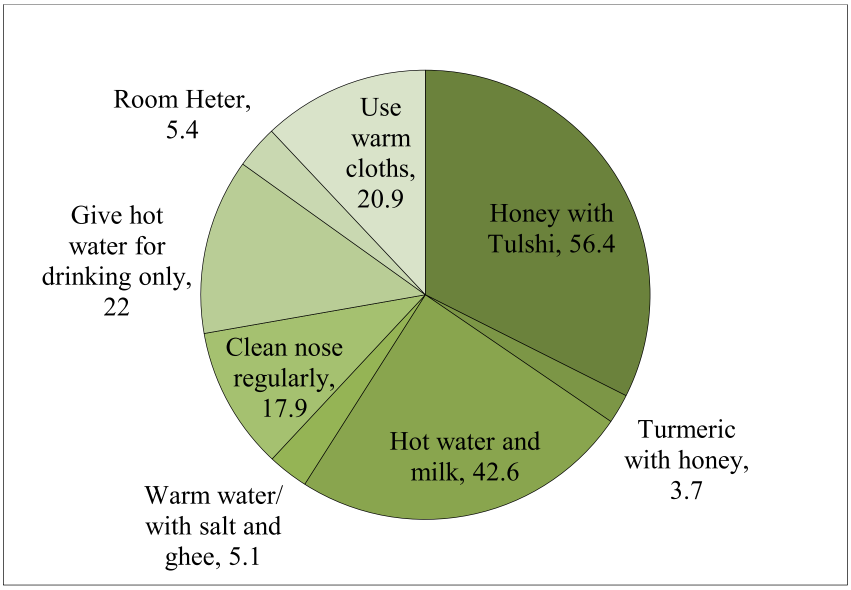


Figure 3.21: Mother's common practices regarding ARI among children in rural West Bengal, India

Mother's Knowledge, Attitude, and Practices of ARI:

Figure 3.22 presents the Knowledge, Attitudes, and Practices (KAP) of mothers regarding acute respiratory infection (ARI) among children under five. Specifically, it indicates that a considerable proportion of mothers lack adequate knowledge regarding ARI, with 41.2 percent showing poor understanding. However, the majority of mothers (54.4%) exhibit positive attitudes, suggesting an openness to improved practices for ARI prevention and treatment. Despite this, 55.7 percent are engage in poor practices related to ARI management. The comprehensive picture demonstrates that 61.1% of mothers have an average level of knowledge, attitude, and practice regarding ARI; however, only 16.9 percent of them exhibit good overall KAP. This underscores the necessity for targeted health interventions and educational campaigns aimed at bridging the identified gaps, thus enhancing health outcomes for children with ARI.

This data reveals that while attitudes are generally positive, there are significant gaps in both knowledge and practices. Addressing these gaps through targeted educational campaigns and behaviour change interventions could improve health outcomes for children with ARI.

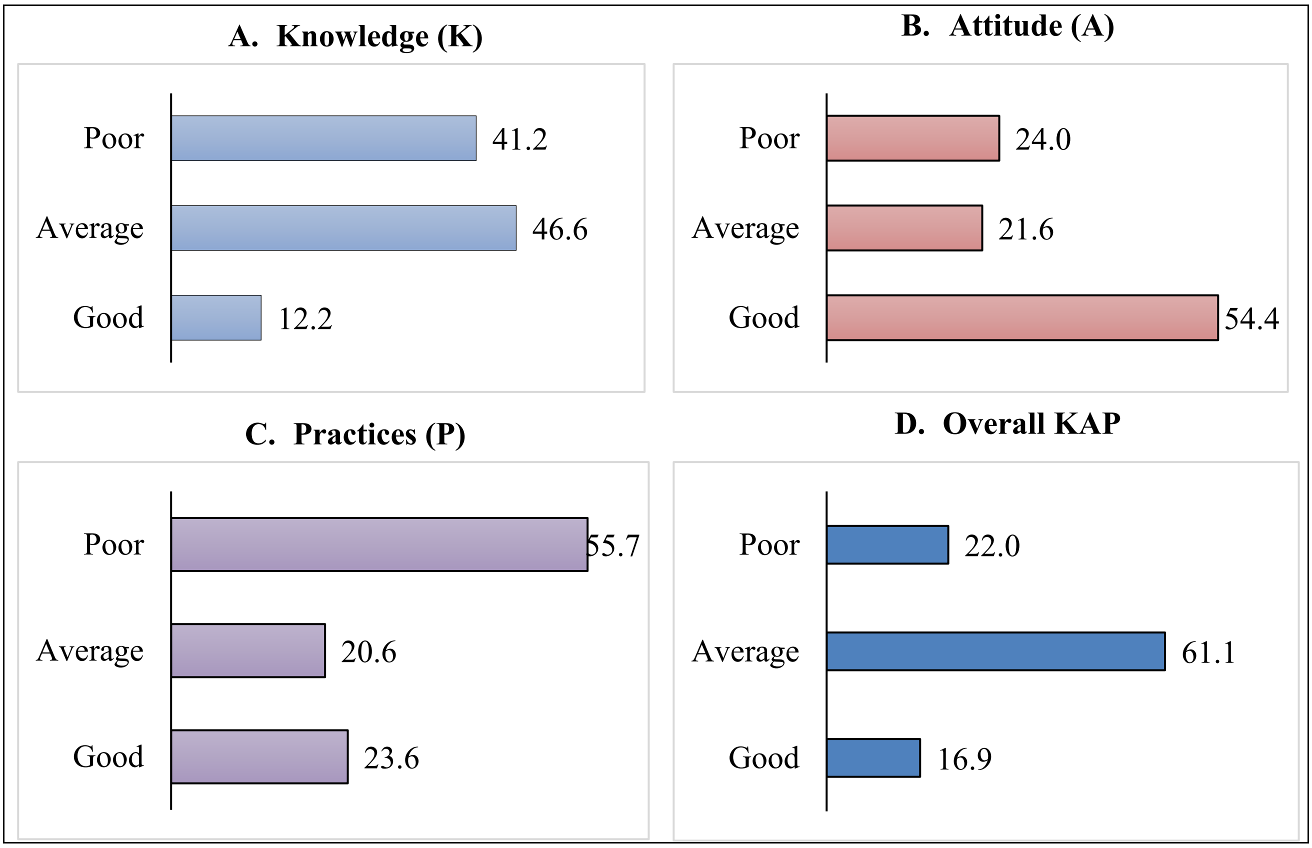


Figure 3.22: Mother's Knowledge, Attitude, and Practices of ARI

3.5.2 Association between Mother's KAP and ARI among Children (0-59 Months) in Rural West Bengal

Table 3.26 presents the relationship between the knowledge, attitude, and practices (KAP) of mothers and the prevalence of ARI among children under five years of age in rural West Bengal. The association between ARI and KAP was analyzed using the chi-square test. The results indicate that knowledge ($\chi2 = 17.78$; $p<0.001$), attitude ($\chi2 = 81.92$; $p < 0.001$), and KAP ($\chi2 = 76.19$; $p < 0.001$) are significantly associated with the prevalence of ARI in the area. However, there was no significant association between ARI and practices. The prevalence of ARI decreased as the mother's knowledge increased. The highest prevalence of ARI was observed among mothers with poor KAP (53.9%), and the lowest prevalence was observed among those with good KAP. Similarly, the prevalence of childhood ARI was highest when mothers had poor knowledge (28.7%), followed by those with average knowledge and good knowledge, respectively. Poor attitude (52.2%) and practices (18.2%) among mothers also increased the prevalence of childhood ARI.

The study used a logistic regression model to investigate the relationship between mother's knowledge, attitudes, and practices (KAP) and ARI among children living in rural areas of

West Bengal. The results showed that mothers with poor KAP were 8.7 times more likely (AOR: 8.7; 95% CI: 3.83-9.52) to have children with ARI compared to those with good KAP. Additionally, mothers with poor attitudes towards ARI had a 12.8 times higher risk of their children having ARI (AOR: 12.8, 95% CI: 2.96-55.64) compared to those with good knowledge.

Table 3.26: Association between mother's KAP and ARI among children (0-59 Months) in rural West Bengal, India (2022-23)

Mother's KAP on ARI	Sample N (%)	Prevalence of ARI N (%)	AOR [95% of CI]
Knowledge, Attitude, and Practice (KAP) of ARI		**$\chi2$ = 76.19 ; p<0.001**	
Good	50 (16.9)	2 (4)	Ref.
Average	181 (61.1)	15 (8.3)	1.5 [0.23-10.06]
Poor	65 (22)	35 (53.9)	8.7 [3.83-9.52]*
Knowledge of ARI		**$\chi2$ = 17.78 ; p<0.001**	
Good	36 (12.2)	4 (11.2)	Ref.
Average	138 (46.6)	13 (9.5)	0.3 [0.08-0.95]*
Poor	122 (41.2)	35 (28.7)	0.5 [0.16-1.74]
Attitude of ARI		**$\chi2$ = 81.92 ; p<0.001**	
Good	161 (54.4)	5 (3.2)	Ref.
Average	64 (21.6)	10 (15.7)	3.8 [0.91-15.71]
Poor	71 (24)	37 (52.2)	12.8 [2.96-55.64]**
Practice of ARI		**$\chi2$ = 3.02 ; p=0.214**	
Good	70 (23.6)	8 (11.5)	Ref.
Average	61 (20.6)	14 (23)	1.6 [0.48-5.39]
Poor	165 (55.7)	30 (18.2)	0.5 [0.14-1.7]
Model evolutions			
Constant		0.05	
No of Observation		296	
Wald chi-square		57.15	
P value		<0.001	
Log-likelihood		-89.27	
Pseudo R2		0.35	

Note: AOR: Adjusted Odds Ratio, Ref: Reference Category, CI: Confidence interval, ***p<0.001, **p<0.01, *p<0.05

3.5.3 Key Findings

Knowledge, attitudes, and practices (KAP) regarding ARI among mothers of children under five in rural West Bengal

- Around 41 percent of mothers do not have adequate knowledge regarding ARI. However, the majority of mothers (54.4%) exhibit positive attitudes. Despite this, 55.7 percent are engaged in poor practices related to ARI management.
- The comprehensive picture demonstrates that 61.1% of mothers have an average level of knowledge, attitude, and practice regarding ARI; however, only 16.9 percent of them exhibit good overall KAP.
- Around 63.5 percent of the mothers correctly identified the causes of ARI, while 75 percent of them correctly identified the symptoms of ARI.
- while a significant proportion incorrectly answers that eating old rotten food (81%) is associated with this morbid condition and cooking inside with fire (59%) is not a risk factor for childhood ARI.
- Only 36.5 percent of the respondents correctly identified the complications of ARI, while 44.6% provided incorrect responses.
- During the winter season, 48.0 percent of mothers reported ventilating their room daily, while 12.2 percent reported weekly ventilation practices, and 15.5 percent reported never ventilating their house.
- In terms of seeking treatment for ARI in children, 54 percent of the mothers preferred medical facilities (private and public), followed by homeopathy doctors (24%), medicine shops (13.5%) and only 8 percent of the mothers relied on home-based treatment.
- Around 52.4 percent of mothers responded that they maintain separate eating utensils or drinking containers for children.
- However, only 31.8 percent of mothers maintained a safe distance from their children when suffering from cold and cough.
- During a child's illness, 57.4 percent of mothers cleaned the room daily, 22.6 percent every two days, and 19.9 percent in more than two days intervals.

- The findings of this study underscore the significant role maternal knowledge, attitudes, and practices (KAP) play in influencing the occurrence of ARI among children in rural West Bengal.

Summary: This chapter reveals that while attitudes are generally positive, there are significant gaps in both knowledge and practices. Addressing these gaps through targeted educational campaigns and behaviour change interventions could improve health outcomes for children with ARI. Mothers with poor KAP were found to be much more likely to have children suffering from ARI compared to those with better KAP

CHAPTER 4: Discussion and Conclusion

This study aims to evaluate the geographical prevalence and identify spatial clusters of ARI among children aged 0-59 months in India. The study has also analyzed the contextual factors associated with ARI among children and health-seeking behaviour using data from the National Family Health Survey (NFHS) IV (2015-16) and NFHS V (2019-21).

Additionally, primary data has been collected to explore the knowledge, attitudes, and practices (KAP) regarding ARI among mothers of children under five in rural West Bengal. Furthermore, the study aims to assess household environmental and other socio-economic characteristics associated with ARI among children aged 0-59 months in rural West Bengal. Finally, the study will investigate the economic impact and health-seeking behaviours of families dealing with ARI in rural West Bengal.

5.1 Spatial Prevalence and spatial clustering of ARI in children under five years of age in India:

Over the study period, the prevalence of ARI has decreased from 5.8 percent to 2.8 percent from 2006 to 2021. However, the prevalence has slightly increased from 2.7 to 2.8 percent from 2016 to 2021. The children living in rural residences reported a higher prevalence of ARI as compared to urban residences in the entire three rounds. However, there is a slight increase in the prevalence in rural residences from NFHS-IV (2.7%) to NFHS-V (2.8%).

Delhi (5.6%) shows the highest prevalence of ARI whereas Dadra & Nagar Haveli/Daman & Diu (0.3%) shows a low prevalence of ARI in 2021. Around 72 percent of States/UTs show more ARI prevalence among children than the national average (i.e., 2.8%).

The absolute change in the prevalence of ARI was computed to measure the difference between 2016 and 2021. Delhi reported the highest increase in prevalence (3.2%) while Chandigarh showed the highest decrease (-2.5%). The 16 states and union territories, such as Manipur, Andaman & Nicobar Islands, Telangana, Karnataka, Sikkim, Lakshadweep, Madhya Pradesh, Odisha, Maharashtra, Rajasthan, Bihar, Assam, Kerala, Andhra Pradesh, and NCT of Delhi, recorded an increase in the prevalence rate of this condition.

The spatial map indicates that approximately 36% of districts (254 out of 640) in India reported a prevalence of ARI higher than the national average of 2.8 percent. These high-prevalence districts are located primarily in the states of Uttar Pradesh, Bihar, Madhya Pradesh, Jammu &

Kashmir, Chhattisgarh, Meghalaya, Delhi, Panjab, Odisha, Rajasthan, Telangana, and Andhra Pradesh.

Moran's I=0.27 ($p<0.001$) indicates that spatial clustering exists in the prevalence of ARI among children across the districts in India. As a result, it detects 58 hot-spot and 66 cold-spot districts in India. Most of the hot-spot districts are from Uttar Pradesh, Bihar, Delhi, and some districts from Maharashtra, Panjab, Jammu & Kashmir, Odisha and Assam. A study conducted by Balasubramani et al. (2022) also reveals that the districts with the highest occurrences of ARI cases were primarily located in the states/union territories of Uttar Pradesh, Bihar, Delhi, Haryana, and Punjab, which are inhabited by Indo-Gangetic Plain residents (Balasubramani et al., 2022). The literature suggests that the northern and northwest borders of the western section of Punjab are adjacent to the Khyber Pakhtun Khawan, the snowcapped Hindu Kush mountains, and the high Karakoram Range (Kumar et al., 2015; Aftab et al., 2022). The increased dry seasonal pattern in western Punjab (Kumar et al., 2015; Aftab et al., 2022) may result in a higher likelihood of children experiencing ARI symptoms. During dry seasons, pathogens are often transported in the air with dust, thereby increasing the risk of infections in children (Akinyemi & Morakinyo, 2018).

Our study highlighted that the concentration of PM2.5 is highest in Delhi and Uttar Pradesh, followed by the North Indian plain, West Bengal, and parts of Chhattisgarh. It is moderate in central India and relatively low in southern India, Uttarakhand, Himachal, and Northeast India. This indicates that the prevalence of ARI is associated with PM2.5 levels. Therefore, the level of PM 2.5 concentration may be a probable reason behind the hot spot. Several research studies have investigated the correlation between PM2.5 pollution and ARI in Indian children (Nidhi, & Jayaraman, 2007). In Delhi, a study revealed that exposure to PM2.5 pollution was associated with an increased likelihood of ARI in children (Nidhi, & Jayaraman, 2007; Jayaraman & Nidhi, 2008; Chhabra et al., 2001). Exposure to fine particulate matter (PM) can lead to oxidative stress and inflammation in the respiratory system, potentially causing damage to the respiratory epithelial cells and reducing their ability to remove pathogens and pollutants from the airways (Adhikary et al., 2024; Kelly 2003; Donaldson et al., 1996). This can result in an increased susceptibility to respiratory infections, such as ARI (Sigaud et al., 2007). Another finding is that PM pollution may hinder the immune system's function, especially in children with developing immune systems (Adhikary et al., 2024; Sigaud et al., 2007).

Numerous studies have suggested a correlation between higher population density and urbanization with an increased prevalence of ARI. Regions with high population density, such as Uttar Pradesh, Punjab, Bihar, and West Bengal (with a density of >800 persons/sq. km), have exhibited a high incidence of ARI (Balasubramani et al., 2022; Mueller et al., 2011). This association between high population density and ARI prevalence has been highlighted in various studies (Savitha & Gopalakrishnan, 2018; Hasan et al., 2022), indicating that population density may be a significant contributing factor to the prevalence of ARI. Another

Another thing is that bidi consumption is highly prevalent in the states of West Bengal, Himachal Pradesh, Haryana, Uttarakhand, and Madhya Pradesh so most of the hotspot districts for ARI hotspot located in those states (Balasubramani et al., 2022). Tobacco consumption and smoking behaviours, increase indoor air pollution, which increase the prevalence ARI (Balasubramani et al., 2022; Mueller et al., 2011).

The highest univariate Moran's I among the predictors was the concentration of Particle Matters 2.5 (Moran's I=0.953), followed by smoking exposure in the household (Moran's I=0.81), mothers' smoking behaviour (Moran's I = 0.778), and poor household (Moran's I=0.769) respectively. On the other hand bivariate and spatial regression model suggested that spatial autocorrelation exists between children who had ARI and those living in areas with high levels of Particulate Matter 2.5 (M'I=0.229), children with illiterate mothers (M'I=0.157), children who had diarrhoea 2 weeks before the survey (M'I=0.139), exposure to smoking in the household, low birth weight (M'I=0.068), and underweight children (M'I=0.052). The results show that households using unclean cooking fuel, mothers with asthma/respiratory infection children born with low birth weights, children who had diarrhoea 2 weeks before the survey, and a concentration of particulate matter 2.5 were positively associated with ARI prevalence.

5.2 Contextual risks associated with ARI in India and rural West Bengal:

We employed a logistic regression model to identify the factors influencing Acute Respiratory Infection (ARI) among children in India, specifically in rural West Bengal. The NFHS-IV (2019-21) was utilized to discern the risk factors in India, while primary data was gathered to address the risk factors prevalent in rural areas of West Bengal.

Association between Household Environment and ARI: Our research indicates that children residing in well-built pucca houses are less likely to experience ARI compared to those living in poorly constructed Kuchha houses. A study by Akinyemi & Morakinyo (2018) also found a significant association between living in houses with poor quality materials and an increased risk of ARI, particularly pneumonia and bronchiolitis among children (Akinyemi & Morakinyo, 2018).

Our primary data analysis indicates that households situated near the Muri and rice mills in rural West Bengal are at an elevated risk of childhood ARI. Existing studies also show that the respiratory infection of individuals is associated with occupational dusts, which is contingent upon the type of dust and the duration of exposure (Mengesha and Bekele, 1998; Avianty et al., 2021;). It also shows the areas surrounding rice and Muri mills are exposed to organic and inorganic dusts as well as synthetic chemicals, which could potentially have adverse effects on respiratory health (Ghosh et al., 2014; Rana et al., 2018).

In addition, our primary data highlighted that children living in households where the members have contact with pets or domestic animals show a greater risk of ARI compared to those without such contact. Our findings were similar to those of a study conducted in Haryana, India, which found that passive smoking and pets at home were factors associated with the presence of asthma symptoms (Hassen et al., 2020).

Furthermore, our investigation has revealed that (from NFHS-V data) the presence of individuals smoking in the household and the lack of a separate kitchen are contributing factors to the increased risk of ARI. This finding is consistent with previous studies (Mandal et al., 2020; Savitha & Gopalakrishnan, 2018; Varghese & Muhammad, 2023). Additionally, our primary data indicates that cooking inside a non-separate kitchen, and particularly in the presence of a child, especially with the mother, during food preparation constitutes a significant contributing factor to childhood acute respiratory infections. These findings align with previous studies indicating that exposure to household smoke can elevate children's risk of respiratory infections due to passive smoking (Mandal et al., 2020; Varghese & Muhammad, 2023). Additionally, having a separate room as a kitchen can help in preventing children from inhaling smoke, which can be particularly harmful if solid fuels are used for cooking (Savitha & Gopalakrishnan, 2018; Varghese & Muhammad, 2023).

Our study (both primary and secondary data) highlighted that children of mothers with respiratory diseases or asthma are more likely to get ARI compared to those without these conditions (Varghese & Muhammad, 2023; Ramani et al., 2016; Prajapati et al., 2012; Savitha et al., 2007; Mahalanabis et al., 2002). The possible reason may be that since children typically spend most of their time indoors, they are more vulnerable to contracting infections from family members with respiratory illnesses (Savitha & Gopalakrishnan, 2018).

In our study, we did not find any association between the use of solid fuels for cooking and handwashing habits and ARI. Although our initial analysis showed some significant differences, these factors were not found to be statistically significant in the logistic regression model when adjusted for other variables. Similar findings were also observed by Harerimana et al. in a study in Rwanda and by Lutpiatina et al. in a study conducted in Indonesia (Harerimana et al., 2016; Lutpiatina et al., 2022).

Our study illustrates that the risk of ARI among children is lower for those interviewed in the rainy season compared to the winter season. A similar relationship was observed in a longitudinal cohort study conducted in the city of Gulbarga, located in Karnataka (Lutpiatina et al., 2022). The inhalation of cold air during winter has been linked to an increased risk of respiratory tract infections (Mourtzoukou and Falagas, 2007).

Association between Socio-economic factors and ARI: The current study has revealed that the socioeconomic characteristics of the household significantly influence the development of children's ARIs. Notably, children from middle and higher-income households exhibit a reduced risk of contracting ARI as compared to those from lower-income households. Based on our study conducted in rural West Bengal, it was established that households with an annual income ranging from Rs. 50,000 to 75,000, and >Rs. 75,000, manifested a decreased risk of childhood ARI in contrast to households with an income falling below a certain threshold. Extant research suggests that children from rural areas and low-income families face an elevated risk of ARI (Sultana et al., 2019). This heightened susceptibility has been linked to the disadvantaged socioeconomic status of households in rural settings, aligning with comparable findings from other low- and middle-income countries (Sultana et al., 2019; Harerimana et al., 2016).

Association between Maternal characteristics and ARI: Maternal characteristics such as smoking behaviour, education, mass media exposure, and maternal respiratory/asthma illness were found to have a significant ($p < 0.05$) relationship with the development of their children's ARI. Our findings align with other studies, suggesting that maternal smoking increases the risk of ARI among children in India as well as rural West Bengal (Savitha et al., 2007; Mahalanabis et al., 2002; Ramani et al., 2016). A similar study demonstrated that ARI in children to be related to the smoking habits of family members, use of mosquito coils, occupancy density, and nutritional status (Lutpiatina et al., 2022; Taksande & Yeole, 2016). Our finding also shows children of those mothers who has expossure to mass media and mothers with primary education have increased risk of the diseases as compared to their counterparts. One potential explanation is that qualified women knowledgeable about this disease tend to remember and report more accurately (Mallick et al., 2021; Ghosh et al., 2021; Ghosh et al., 2023).

Association Between Children's Characteristics and ARI: When considering a child's characteristics, our study highlighted that age, sex, nutrition status, history of diarrhoea, and birth weight are significant ($p<0.05$) factors for ARI in India and rural West Bengal.

Our study findings indicate an inverse relationship between the incidence of ARI and the age of children, suggesting a decreasing risk as children grow up. These results are in alignment with the previous research (Merera, 2021, Sultana et al., 2019; UNICEF,2004). This is due to the immature immune system in younger children (UNICEF,2004).

Our research indicates that, malnourished children and those who have recently experienced diarrhoea are at a higher risk of contracting this infection. This correlation was also observed in recent research conducted in both India and Ethiopia (Hasan et al., 2022; Merera, 2021). A recent episode of diarrhea may indicate weakened immunity, which could make the child more susceptible to further infections.

Our study also found that children born with normal birth weight had a lower risk of ARI compared to those born with low birth weight. Birth weight plays a crucial role in the physical and mental growth and development of infants. Infants with low birth weight are at a higher risk of mortality compared to those with adequate birth weight, especially in the first few months after birth. This increased risk is due to the inadequate formation of anti-immune substances, which makes them more vulnerable to infectious diseases such as pneumonia and other respiratory illnesses. Low birth weight infants often encounter respiratory issues like ARIs because of the underdeveloped lungs and weak respiratory muscles (Walter et al., 2009).

5.3 Determinants of Treatment Seeking Behaviour in India:

The present research also identifies the factors influencing treatment-seeking behaviours in India. The study revealed that the prevalence of children suffering from ARI seeking treatment from a health facility/provider has decreased from 78 percent in 2016 to 56 percent in 2021 in India. Phase 2 of the NFHS-5 survey, conducted in 14 states/UTs, took place from 2nd January 2020 to 30th April 2021 (NFHS-V, 2021). The country was under total or partial lockdown during this period. Studies have shown a decrease in the number of people seeking medical treatment for acute health problems during the lockdown (Stalin et al., 2022; Yang et al., 2021). Therefore, one possible reason for this decline in seeking treatment for ARI could be the lockdown restrictions and the fear of contacting COVID-19 infection (Varghese & Muhammad, 2023). The data shows the Western region (62.6%) of the country has the highest percentage of treatment-seeking behaviours, while the Central region (44.3%) has the lowest among all the regions.

In rural areas, children exhibit significantly lower odds of seeking treatment compared to their urban counterparts. Moreover, treatment-seeking behaviours correlate positively with higher household wealth quantile scores. Other studies reported similar findings (Pinzón-Rondón et al., 2016; Ramani et al., 2016; Imran et al., 2019; Mourtzoukou & Falagas, 2007). Air pollution is higher in urban areas, which can increase the incidence and treatment-seeking behaviour of respiratory diseases as compared to rural residence (Varghese & Muhammad, 2023). A study conducted in Indonesia revealed that children from wealthy families were less vulnerable to acute respiratory infection (ARI) symptoms (Lutpiatina et al., 2022).

The present research finds that children under 5 belonging to households with female heads had higher odds of having treatment-seeking behaviour of ARI compared to those with male heads. The finding is comparable to a study conducted in sub-Saharan Africa (Akinyemi et al., 2019) and Tanzania (Kanté et al., 2015). This similarity could be attributed to the fact that households with female heads may not encounter the challenge of obtaining permission to seek care, which is a common barrier to healthcare utilization among women and children (Aragaw et al., 2024). Another possible explanation is that women who are heads of households tend to allocate the available resources they control towards prioritizing their children's health, thereby increasing their health-seeking behaviour (Aragaw et al., 2024).

Current study also indicated that children, whose parents face transport issues for reaching facilities have lower odds of having treatment-seeking behaviour than those with no transport problem. Prior research indicates that the usage of healthcare services is adversely affected by factors such as the significant distance to medical facilities, the absence of transportation options, and the subpar quality of roads (Astale et al., 2015; Okwaraji et al., 2012; Shiferaw et al., 2013; Varghese & Muhammad, 2023).

Research shows that mothers who has exposure to the media are more likely to seek healthcare for their children when they have symptoms of acute respiratory infection (ARI) compared to mothers who have not been exposed to the media. This finding is consistent with studies conducted in India (Chandwani & Pandor, 2015), West Bengal (Ghosh et al., 2013), and Tanzania (Adinan et al., 2017). One possible explanation is that exposure to mass media exposes people to healthcare messages, which improves their behaviour in seeking healthcare. Evidence suggests that exposure to the media plays a crucial role in promoting healthy behaviours (Aragaw et al., 2024; Adinan et al., 2017).

Our study found no significant relationship between mother's education and health-seeking behaviour. However, other studies have emphasized that educated mothers are more likely to seek care for their children with symptoms of ARIs than mothers with no education (Aragaw et al., 2024; Abegaz et al., 2019; Bogler et al., 2021). This might be due to the fact that mothers with higher education are more informed about the causes of diseases, symptoms of illness, warning signs, and their impacts (Degefa et al., 2018). As a result, they are more likely to seek better healthcare for their children. Moreover, education is likely to enhance women's autonomy, enabling them to make well-informed decisions regarding their children's healthcare (Aragaw et al., 2024).

Children belonging to the Central region had significantly lower odds, whereas the East and Western Region had significantly higher odds of having treatment-seeking behaviour compared to children belonging to the North Region. Additionally, children from EAG States were significantly less likely to seek treatment for ARI compared to those from non-EAG states. In India, there is a significant disparity in the accessibility and availability of healthcare between public health facilities in EAG (Empowered Action Group) and Non-EAG states (Rani et al., 2008; Kumar & Singh, 2016; Sanasam, 2020). The possible reason for the lower treatment-seeking behaviour in EAG states, which are mostly located in the northern and central regions, is the high percentage of the population living below the poverty line and a high proportion of women with limited access to education and mass media (NITI Ayog, 2015).

The concentration indices for ARI were negative for NFHS-IV and NFHS-V and children in lower socioeconomic strata bear a significantly higher burden of ARI. On the other hand, for the place of residence also concentration indices are negative. This indicates that children from lower socio-economic classes in urban and rural areas bear a significantly higher burden of ARI. The overlapping of the concentration curves suggests a similar level of inequality in ARI in both urban and rural areas.

5.4 The Economic Burden and Health-Seeking Behaviours of Families Dealing with ARI in Rural West Bengal:

Household Expenditure on child's health for ARI: The findings regarding the economic burden and health-seeking behaviours of families dealing with ARI in rural West Bengal reveal a significant disparity in healthcare expenditures and access to timely treatment across different socioeconomic groups. The financial burden of treating ARI is especially challenging for BPL families. On average, BPL families spent Rs. 1588/- on ARI treatment, which was significantly more than the Rs. 1196/- spent by APL families. This difference emphasizes the heavier economic strain experienced by BPL households despite their lower financial means. The variation in treatment costs is likely due to factors such as access to healthcare services and the type of facilities used for treatment. The average cost for ARI treatment at public health facilities was relatively low, at Rs. 520/-, indicating the affordability of government healthcare services. However, the significantly higher cost of Rs. 2170 for treatment at private health facilities highlights the financial challenges faced by families who choose or are compelled to use private healthcare, often due to perceived or actual shortcomings in public healthcare. The overall average expenditure for both public and private facilities combined was Rs. 1498/-, indicating significant cost differences based on the type and location of treatment.

There are several studies discussed about the costs associated with respiratory infections worldwide, with the majority originating from tertiary care facilities. The cost of an episode of pneumonia attributable to any cause ranges from US$22.62 to US$355 in lower and lower-middle income countries (Peasah et al., 2015; Hussain et al., 2008; Alvis-Guzman et al., 2013). Based on a study conducted in Haryana, it was found that the median costs of treating an episode in the outpatient department (OPD) and inpatient department (IPD) were INR 447 and INR 7506.06, respectively (Purakayastha et al., 2017). The study also revealed that the total cost of a respiratory episode requiring hospitalization was 1.5 times the per capita monthly income of an Indian.

Health-seeking behaviours:

Our study reveales that approximately 90 percent of children exhibiting Acute Respiratory Infection (ARI) symptoms sought medical treatment, indicating a high rate of healthcare utilization. However, it is concerning that 10 percent of children did not receive any treatment, possibly due to financial constraints, limited access to healthcare, or lack of awareness. The distribution of treatment-seeking behaviour was almost equal between public (49%) and private (51%) healthcare facilities, suggesting that families rely on both sectors, with some potentially favoring private facilities despite higher costs, possibly due to perceived better quality of care or shorter wait times. An important finding was the delay in seeking treatment. Data on the duration of ARI symptoms among children in rural West Bengal provides insight into the severity and persistence of the illness. Approximately 44 percent of children experienced ARI symptoms for more than 5 days, indicating a significant proportion of cases are prolonged, potentially increasing the risk of complications and highlighting the need for medical intervention. Meanwhile, 37 percent of children suffered from symptoms for 3 days, and 19 percent for 4 days. According to previous research, the average duration of ARI was found to be five days. This aligns with the findings of our study (Shahzad, 2009; Bham et al., 2016). These variations in symptom duration may reflect differences in the timeliness and effectiveness of treatment, access to healthcare, or the underlying health conditions of the children. Prolonged symptoms are particularly concerning, as they may indicate delayed treatment or inadequate care, reinforcing the importance of timely health-seeking behaviours and effective interventions in reducing the burden of ARI. About 30 percent of children experienced delays in accessing healthcare, which can exacerbate the severity of ARI and lead to poorer health outcomes. Certain demographic groups were more prone to delays, including SC/ST groups, BPL households, extended and nuclear families, households with fewer than 4 members, and younger children (0-23 months). Delays in treatment may be attributed to financial difficulties, lack of awareness, and geographical or logistical barriers in accessing healthcare services.

5.5 Knowledge, attitudes, and practices (KAP) regarding ARI among mothers of under-five children in rural West Bengal:

The results of this study provide valuable insights into the knowledge, attitude, and practices (KAP) of mothers concerning ARI in children. The primary data reveals that a significant percentage of mothers (41.2%) have insufficient knowledge about ARI, indicating a gap in understanding the causes, symptoms, and preventive measures associated with this condition. This lack of knowledge may significantly impact the management of ARI at the household level, as well-informed caregivers are crucial for early detection and effective treatment. Despite the knowledge gap, the majority of mothers (54.4%) exhibit positive attitudes toward ARI prevention and treatment, suggesting a willingness to embrace improved health practices with the appropriate tools and education. However, there is a notable disparity between attitude and practice, as 55.7% of mothers engage in poor practices related to ARI management. This discrepancy underscores a critical barrier to enhancing health outcomes, as effective practices are essential for preventing and managing ARI in children.The KAP assessment indicates that 61.1 percent of mothers have an average level of knowledge, attitude, and practice, with only 16.9% demonstrating good overall KAP. This highlights the need for targeted interventions to elevate the practices of a significant portion of mothers and underscores the necessity for practical, hands-on guidance and behavioural interventions that transcend awareness-raising efforts.

The survey results provided a thorough assessment of mothers' knowledge about ARI. The majority (63.5%) of the mothers displayed correct knowledge of the causes of ARI, indicating a moderate level of awareness. Additionally, a significant number of mothers (75%) accurately identified the symptoms of ARI, showing that most of them are familiar with respiratory issues in children. Surprisingly, when it comes to the sources of respiratory infections, particularly concerning exposure to smoky air, which is a well-established risk factor, mothers demonstrated poor knowledge. Furthermore, mothers incorrectly believed that consuming old rotten food and cooking indoors with fire could cause ARI. These findings underscore crucial areas where misinformation persists, particularly in distinguishing between respiratory and gastrointestinal causes. In terms of the complications of ARI, approximately one third of the respondents were able to correctly identify them, while a significant portion (45%) provided incorrect responses. This indicates a gap in understanding the potential severity of ARI, which may impede prompt and appropriate health-seeking behaviour.

The data suggests a generally positive attitude regarding the severity of the disease, the significance of breathing clean air, the occurrence of runny or blocked noses in children, ARI prevention and treatment, and the importance of building immunity. However, the continued lack of concern among some mothers regarding the severity of the disease highlights the necessity for additional awareness and educational initiatives to promote a more comprehensive understanding of the potential risks associated with ARI.

The practices of mothers in rural West Bengal regarding ARI, as outlined in our research, reveal a mixed adherence to recommended preventive and management behaviours. These practices play a crucial role in influencing the health outcomes of children suffering from ARI and highlight areas where interventions may be needed to improve maternal behaviours. Ventilation is a key factor in maintaining indoor air quality and reducing the risk of respiratory infections. Our research highlighted that around 50 percent of mothers ventilated their rooms daily during the winter season, which is an encouraging practice for preventing ARI. However, a notable proportion of mothers reported ventilating their rooms only on a weekly basis, or never ventilating their rooms. The lack of regular ventilation in households suggests that some families may be at higher risk for indoor air pollution, which is a known contributor to respiratory illnesses. There is a clear need for awareness programs to emphasize the importance of daily ventilation in preventing ARI. In terms of treatment for children with ARI, 54 percent of mothers preferred medical facilities (both private and public), demonstrating a generally positive health-seeking behaviour. However, 24 percent of mothers relied on homeopathy doctors, and 13.5 percent went to medicine shops, indicating that a significant portion of the population is opting for alternative or less formal healthcare options. Only 8 percent of mothers relied solely on home-based treatments, which is lower compared to other sources, but still highlights the need for education on the limitations of home remedies for serious conditions like ARI. Regarding hygiene practices, 52.4 percent of mothers reported using separate utensils or drinking containers for their children, a positive practice that can help limit the spread of infections within households. However, less than a third of mothers (31.8%) maintained a safe distance from their children when they themselves had a cold or cough, indicating a gap in infection control measures within the home. During periods of child illness, 57.4% of mothers reported cleaning the room daily, a good practice that reduces exposure to pathogens. However, 22.6 percent cleaned every two days, and 19.9 percent waited for more than two days to clean the room, which could increase the risk of prolonging or worsening the illness due to poor hygiene. The practice of maintaining cleanliness during a child's illness should be further reinforced, particularly among the 42.5% of mothers who are not cleaning the living environment on a daily basis. When symptoms of ARI appeared in children, 61.8% percnet of mothers sought urgent medical attention, reflecting an encouraging behaviour in recognizing the need for prompt care. Additionally, 36.8 percent of mothers sought medical help within 0 to 2 days of observing symptoms, which suggests a reasonably prompt response. However, the 1.4 percent who delayed seeking medical help for more than two days may benefit from awareness campaigns emphasizing the importance of timely medical intervention in preventing complications associated with ARI.

Association between mother's KAP and ARI among children (0-59 Months) in rural of West Bengal: The findings of this study underscore the significant role maternal knowledge, attitudes, and practices (KAP) play in influencing the occurrence of ARI among children in rural West Bengal. Mothers with poor KAP were found to be much more likely to have children suffering from ARI compared to those with better KAP. This emphasizes the importance of ensuring that mothers have a clear understanding of ARI prevention and management, as inadequate knowledge and poor practices can lead to a higher risk of infection in children.

In addition, poor attitudes of mothers towards ARI were also identified as a key factor contributing to the increased risk of children contracting ARI. Even when mothers may possess adequate knowledge, unfavourable attitudes can hinder timely health-seeking behaviours and necessary interventions. This finding suggests that addressing attitudes may be even more important than improving knowledge alone when it comes to reducing the incidence of ARI in children.

These results align with previous research that has emphasized the crucial role of parental KAP in preventing childhood diseases, particularly in under-resourced areas. The challenges posed by poor KAP, especially in rural settings like West Bengal, may be due to limited access to health information, cultural beliefs, or systemic barriers within the healthcare system. Therefore, it becomes essential to design and implement targeted interventions, such as health education programs, community awareness campaigns, and engagement initiatives, to improve maternal KAP and thereby reduce the risk of ARI.

These findings also highlight the importance of integrating mother'sl KAP into public health strategies. Health programs should not only focus on increasing knowledge but also aim to reshape attitudes and promote healthy practices among mothers. By ensuring that mothers are well-informed and motivated to take proactive measures in safeguarding their children's respiratory health, these programs can significantly contribute to reducing the ARI burden in children. Future studies should explore cultural or behavioural barriers contributing to poor KAP, helping to develop tailored interventions that address these challenges effectively.

In conclusion, this study reinforces the strong link between poor maternal KAP and the occurrence of ARI in children. Improving maternal knowledge, fostering positive attitudes, and encouraging healthy practices should be central to ARI prevention strategies, particularly in rural areas where the risk of infection is heightened.

5.6 Limitation of the study and further research scope:

This study has some limitations. The study were categorized as having ARI based on the signs and symptoms reported by their mothers. However, medical professionals did not confirm these findings, which is a significant limitation. Mothers were asked about the signs and symptoms their children experienced in the past two weeks, which raises concerns about recall bias potentially influencing the results. The study's cross-sectional design prevented the establishment of a cause-and-effect relationship. The study's emphasis on rural West Bengal may limit the applicability of its findings to other regions of India. While the study emphasizes the economic burden of ARI, it does not comprehensively analyze out-of-pocket expenses incurred by families for ARI treatment, thus constraining the understanding of financial strain on households, particularly those dependent on private healthcare. Additionally, the study predominantly relies on quantitative data, overlooking the qualitative insights that could have been gained from healthcare professionals and community members, thereby limiting a deeper understanding of healthcare provider perspectives and cultural practices related to ARI treatment. A more extensive sample focusing on the reasons for treatment delays in certain populations could offer more detailed and reliable findings. Furthermore, the study does not thoroughly explore the cultural and behavioural factors contributing to delayed health-seeking or suboptimal practices, which are crucial in understanding the obstacles to effective ARI management. Evaluating the cost-effectiveness of various interventions, such as public health campaigns, community health worker engagement, and subsidized healthcare for ARI, could provide valuable guidance for policy and resource allocation. Future research endeavors could assess how differences in healthcare infrastructure, such as the availability of trained healthcare personnel, facility accessibility, and service quality, impact ARI treatment outcomes and family expenditures. Research could also assess the effectiveness of targeted maternal education programs aimed at improving knowledge, attitudes, and practices related to ARI, potentially including randomized controlled trials (RCTs) or community-based intervention studies to gauge improvements in health outcomes and practices. Furthermore, additional research could explore the association between child nutrition, maternal nutrition knowledge, and ARI incidence, given that malnutrition can significantly heighten susceptibility to infections like ARI.

5.7 Policy Implications:

The study highlighted 16 States/UTs with increased ARI prevalence from 2016 to 2021. So policymakers should focus on setting a state-specific policy to control the prevalence and burden of diseases in India.

The spatial clustering analysis shows that an autocorrelation has been detected in 2021 for ARI among children across the districts in India. As we know, spatial autocorrelation in health events may be the sign of underlying causal factors leading to the localization of disease clusters; it is a serious public health concern in the country. Overall hot spots are detected from Uttar Pradesh, Maharashtra, Panjab, Jammu & Kashmir, Odisha and Assam. The highlighted hot-spot districts can focus to make a district-level policy to prevent the prevalence of ARI. The Government of India has identified around 125 districts (In Phase I:115 & Phase II: 9) as aspirational districts (https://my.msme.gov.in/MyMsme/List_of_AspirationalDistricts.aspx). Most of the aspirational districts are Jharkhand, Bihar, Uttar Pradesh, Odisha, and Maharashtra. Some of these detected spots also from the aspirational districts. So, government can implement policy related to ARI prevention can help to decrease such morbid conditions among children in India.

The study identified the factors that contribute to ARI. It has been found that living in a kuchha house, exposure to smoking in the household, living near a rice or muri (puffed rice) mill, contact with pets or domestic animals, mothers with respiratory illness/asthma, cooking inside the house but not in a separate kitchen, and the winter season increased the risk of ARI among children in India. Based on these findings, the study recommends that public health programs focus on these indicators and implement a district and state-level policy to control the incidence and burden of childhood ARI in India.

The Pradhan Mantri Ujjwala Yojana, introduced by the Ministry of Petroleum and Natural Gas (MoPNG) in 2016, stands as a significant initiative. It aimed to provide access to clean cooking fuel, such as LPG, to underserved and rural families who had previously relied on traditional cooking fuels like firewood, coal, and cow-dung cakes. On the other hand, the Ministry of Housing & Urban Poverty Alleviation also estimated that such demand resulted from housing shortages in the country from 2012 to 2016. The government has also taken various steps to help the 'poor'to construct houses (like Indira Awas Yojona, the Slum Rehabilitation Authority project). The Indira Awaas Yojana (IAY), initiated under the Rural Landless Employment Guarantee Programme (RLEGP) by the Ministry of Rural Development, aims to facilitate the provision of grants for house construction. This initiative targets Scheduled Castes (SC)/Scheduled Tribes (ST), individuals freed from bonded labour, and those belonging to non-SC/ST categories who live below the poverty line. We know a gap exists between supply and demand for concrete housing and LPG Gas distribution, mainly for the middle-class population. The targeted beneficiaries cannot apply for these benefits without the assistance of mediators or the direct intervention of government officials (Chattopadhyay & Barnwal, 2013; Knowledge at Wharton Staff, 2007). Local authorities should engage in community development through innovative programs, possibly with support from public-private partnerships (PPP) to promote healthy living (Chattopadhyay & Barnwal, 2013). Improving the schemes in rural areas may improve their housing material and coking fuel, mitigating respiratory illness among children.

As already mentioned our studies and prevoius studies also shows children with recent episode of diarrhea , underweight children , or have low birth weight children are at a higher risk of ARI. In response to this issue, the government of India has introduced various initiatives. So nutritional status of mother and children are extremely important and some of the intiavtives by Government of India like the Integrated Child Development Services (ICDS) in 1975 and the POSHAN Abhiyaan in 2022, aimed at improving the nutritional status of mothers and children, as well as reducing the number of low-birth-weight children. Furthermore, the Government of India has implemented the Swachh Bharat Mission to improve sanitation, although many households still lack proper facilities. Improving sanitation may reduce the prevalence of diarrheal diseases among children. Therefore, the government needs to implement additional policies to improve the availability of sanitation and drinking water facilities. Strengthening these initiatives in the highlighted states and districts can help prevent malnutrition, diarrhea, and low birth weight among children, indirectly leading to a reduction in ARI prevalence among children.

The knowledge, attitudes, and practices of mothers have been found to play a crucial role in preventing ARI in their children. Conducting awareness sessions on the symptoms and treatment of ARI by the Primary Health Center and Sub-Center in the community could be an impactful initiative. These interventions can contribute to early detection of the infection and can help to prevent fatalities.

Finally, The Indian government utilizes the public health system (PHC/SC/CHC/SDH/DH) to provide free healthcare services. At the village and community level, PHC and SC are readily available. In 2018, the Ministry of Health and Family Welfare (MoHFW) successfully upgraded PHC and SC into Health and Wellness Centers, offering 12 services, including referral services. These changes robustly aim to heighten community awareness and significantly reduce the financial burden of ARI on individual households.

Conclusion

The objectives of the entire study have been addressed by the data from NFHS-IV (2015-16) , NFHS-V (2019-21) and primary data from rural West Bengal. The study highlighted 16 States/UTs with increased ARI prevalence among under five children from 2016 to 2021. So, policymakers should focus on setting a state-specific policy to control the prevalence and burden of this disease in India. The spatial clustering analysis shows that an autocorrelation has been detected in 2021 for ARI among children across the districts in India. So the district level policy might be required for the highlighted hot spot districts.

Our study finds out the factors associated with childhood ARI. It has identified that living in a kuchha house, exposure to smoking in the household, living near a rice or muri mill, contact with pet or domestic animals, mothers with respiratory illness/asthma, cooking inside the house but not in a separate kitchen, and the winter season increased the risk of ARI among children in India as well as in rural West Bengal. Based on these findings, the study recommends that public health programs should focus on these indicators and implement a district and state-level policy to control the incidence and burden of childhood ARI in India.

The findings regarding the economic burden and health-seeking behaviours of families in rural West Bengal reveal a significant disparity in healthcare expenditures and access to timely treatment across different socioeconomic groups. The economic and health-seeking behaviour data underscore the need for targeted interventions to alleviate the financial burden on vulnerable populations, particularly BPL families. Enhancing the affordability and accessibility of public healthcare services is crucial to reduce the economic strain and to ensure timely treatment. Additionally, addressing the factors contributing to delays in treatment, especially for marginalized groups such as SC/ST and younger children, should be a priority for public health initiatives. Improved awareness, better infrastructure, and community health programs can play a significant role in mitigating these challenges. In a nutshell , the study highlights the pressing need for strategies that will not only reduce the economic burden of ARI treatment but also promote timely and equitable access to healthcare services for all children in rural West Bengal.

The research illuminates the notable disparities in mother's knowledge, attitudes, and practices (KAP) concerning ARI in children in rural West Bengal. A significant number of mothers lack adequate knowledge about ARI, which may impede the timely identification and proper management of the condition within the household. Nevertheless, more than half of the mothers exhibit positive attitudes toward ARI prevention and treatment, indicating their readiness to embrace healthier behaviours with appropriate support. However, the disparity between positive attitudes and inadequate practices presents a substantial obstacle to enhancing children's health outcomes. The comprehensive KAP assessment indicates that only a small number of mothers possess satisfactory KAP, with the majority falling into the average category. Practices like daily room ventilation and timely medical care are being adopted by a majority, but a sizable proportion of mothers are still relying on medicine shops, and some are not engaging in daily cleaning or ventilation during illness. All these practices show a need for greater awareness of infection control measures within households. The knowledge, attitudes, and practices of mothers have been found to play a crucial role in preventing ARI in their children. Conducting awareness sessions on the symptoms and treatment of ARI by the Primary Health Centre and Sub-Centre in the community could be an impactful initiative.

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ANNEXURE

ANNEXURE-I

A. Consent Form (English)

Household ID: ☐☐☐☐ **Investigator ID:** ☐☐ **Date of Visit: ……/……./2022**

Spatial clustering and its contextual determinants of Acute respiratory infections (ARI) and its association with mother's knowledge & Environmental condition: A study of rural part of West Bengal and India.

INFORMED CONSENT FORM

Namaste!!!

My name is ………………………………………………………………..and I am deputed on behalf of Koustav Ghosh, for conducting the survey for his Ph.D research purpose. The study will focus on Acute Respiratory Infection (ARI) among children and its impact on household environmental conditions and knowledge of the mothers. This survey will help to understand the factors associated with ARI in the study population. Basic information about household viz. demographic characteristics, living conditions, and details of the members of the household also would be collected. The\ interview schedule would take approximately 20 minutes. All the information collected will be solely used for the study purpose and would be kept strictly confidential. Participation in this survey is fully voluntary and you may withdraw from the study at any time during the interview.

Name of Respondant: (Only Mothers of the children <6 years old):

____

Name & Sign of Investigator:

Date of Visit: ..../.........../2022

B. Consent Form (Bengali)

Household ID: | | | | | **Investigator ID:** | | | **Date of Visit: ……/……./2022**

Spatial clustering and its contextual determinants of Acute respiratory infections (ARI) and its association with mother's knowledge & Environmental condition: A study of rural part of West Bengal and India.

Education : An Ennobling Influence
Gopal Krishna Gokhale

Education : An Ennobling Influence
Gopal Krishna Gokhale

সম্মতি পত্র

নমোস্কার !!!

আমার নাম ____এবং আমি কৌস্তভ ঘোষের পক্ষ থেকে তার পিএইচডি গবেষণার উদ্দেশ্যে জরিপ পরিচালনা করার জন্য নিযুক্ত আছি। গবেষণাটি শিশুদের মধ্যে তীব্র শ্বাসযন্ত্রের সংক্রমণ (ARI) এবং পরিবারের পরিবেশ পরিস্থিতি এবং মায়েদের জ্ঞানের উপর এর প্রভাবের উপর ফোকাস করবে। এই সমীক্ষা অধ্যয়ন জনসংখ্যার মধ্যে ARI-এর সাথে সম্পর্কিত কারণগুলি বুঝতে সাহায্য করবে৷ পরিবারের প্রাথমিক তথ্য যেমন. জনসংখ্যাগত বৈশিষ্ট্য, জীবনযাত্রার অবস্থা এবং পরিবারের সদস্যদের বিবরণও সংগ্রহ করা হবে। ইন্টারভিউ সময়সূচী আনুমানিক 20 মিনিট সময় লাগবে. সংগৃহীত সমস্ত তথ্য শুধুমাত্র অধ্যয়নের উদ্দেশ্যে ব্যবহার করা হবে এবং কঠোরভাবে গোপনীয় রাখা হবে। এই সমীক্ষায় অংশগ্রহণ সম্পূর্ণরূপে স্বেচ্ছায় এবং আপনি সাক্ষাত্কারের সময় যে কোনো সময় অধ্যয়ন থেকে প্রত্যাহার করতে পারেন।

উত্তরদাতার নাম:- শুধুমাত্র শিশুদের মায়েরা (<6 বছর বয়সী):

____

তদন্তকারীর নাম ও স্বাক্ষর:____

পরিদর্শনের তারিখ: …………/……………../2022

ANNEXURE-II

Questionnaires Schedule (English & Bengali)

Household ID: [ ][ ][ ][ ] **Investigator ID:** [ ][ ] **Date of Visit: ……/……./2022**

Spatial clustering and its contextual determinants of Acute respiratory infections (ARI) and its association with mother's knowledge & Environmental condition: A study of rural part of West Bengal and India.

SECTION 1: SOCIO DEMOGAPHY (সোসিও ডেমোগাফি)

#	Question (প্রশ্ন)	Response (প্রতিক্রিয়া)	Skip	Code
1.	Distance to nearby public health facility? (নিকটবর্তী স্বাস্থ্য কেন্দ্রের দূরত্ব?)	Distance in Km (দূরত্ব কিমি)		
2.	Religion (ধর্ম)	Hindu হিন্দু…………….1 Muslim (মুসলিম)………২ Others অন্যান্য ________7		
3.	Social Category (Caste) সামাজিক বিভাগ	তফসিলি জাতি (SC)……1 তফসিলি উপজাতি (ST)..**2** অন্যান্য অনগ্রসর জাতি (OBC)...3 সাধারণ (Others)……….4		
4.	What type of PDS/Ration card does your household possess? আপনার পরিবারের কি ধরনের রেশন কার্ড আছে?	ABL কার্ড........1 BPL কার্ড……2		
5.	Type of family পরিবারের ধরন	Joint (যুগ্ম পরিবার) …….1 Nuclear (অণু পরিবার)…….**2** Extended (যৌথ পরিবার)...3		
6.	Family size পরিবারের সদস্যদের সংখ্যা			
7.	household annual income পরিবারের বার্ষিক আয়	In Rs.		
8.	Family History of Respiratory Illness [e.g. asthma, frequent cold and cough] শ্বাসযন্ত্রের অসুস্থতার পারিবারিক ইতিহাস [যেমন হাঁপানি, ঘন ঘন সর্দি এবং কাশি]	No (না)……….0 Yes (হ্যাঁ)………1		

SECTION 2: HOUSEHOLD LIVING CONDITIONS বিভাগ 2: গৃহস্থালীর জীবনযাত্রার অবস্থা

#	প্রশ্ন	প্রতিক্রিয়া	Skip	code
9.	Is there anything locate near to your house? (With in 1km Landmark) আপনার বাড়ির কাছাকাছি কিছু আছে? (1কিমি ল্যান্ডমার্ক সহ)	Pucca road (পাকা রাস্তা)….1 Poultry firm (পোল্ট্রি ফার্ম)…..**2** Muri mill (মুড়ি মিল)…..3 Rice Mill (রাইস মিল)…..4 Others (অন্যান্য)___________7		
10.	What is the type of house? (Observe and note) ঘরের ধরন কি?	পাকা (Pucca).............1 আধা পাকা (Semi Pucca)......2 কুচ্ছা (Kuchcha)....3		
11.	How many rooms in this household are used for sleeping এই বাড়ির কয়টা ঘর ঘুমানোর জন্য ব্যবহার করা হয়	ঘুমানোর জন্য ঘর সংখ্যা		
12.	Availability of electricity (in Hours বিদ্যুতের প্রাপ্যতা (ঘণ্টায়)	Hours ঘন্টা		

13.	Alternative option when electricity not available বিদ্যুত উপলব্ধ না হলে বিকল্প বিকল্প	Kerosene lamp (কেরোসিন বাতি)…….**1** Emergency light জরুরী আলো...**......2** অন্যান্য………..**3**		
14.	Does anyone smoke (Cigarettes/Beedi and tobacco) inside your House?আপনার বাড়িতে কি কেউ ধূমপান করে (সিগারেট/বিড়ি এবং তামাক)?	No না……..0 Only Cigarettes/Beedi শুধু সিগারেট/বিড়ি….1 Only Tobacco শুধুমাত্র তামাক………2 উভয়ই…………3		
15.	Which is the main source of cooking fuel? রান্নার জ্বালানির প্রধান উৎস কোনটি?	Firewood/ Kerosene/ Coal and charcoal (ফায়ারউড/কেরোসিন/কয়লা এবং কাঠকয়লা)……………………………1 Cow dung cakes (গোবরের পিঠা)…**…….2** LPG/Natural Gas Pipe Line (এলপিজি/প্রাকৃতিক গ্যাস পাইপ লাইন)….3 Electricity (বিদ্যুৎ) …………4 Others(অন্যান্য) ___________________7		
16.	Where do you cook? কোথায় রান্না করেন?	Cooking in kitchen রান্নাঘরে ……..1 Cooking inside house, but not in kitchen ঘরের ভিতরে, কিন্তু রান্নাঘরে নয়…….…**2** Cooking in open/ outside house ঘরের বাইরে রান্না ……..3		
17.	How clean is the air in your h ome when you are cooking? আপনি রান্না করার সময় আপনার বাড়ির বাতাস কতটা পরিষ্কার থাকে?	Very Smoky খুব ধোঁয়াটে ………1 Somewhat Smoky কিছুটা ধোঁয়াটে………2 A little Smoky একটু ধোঁয়াটে …………3 Not Smoky ধোঁয়াটে নয়……….4		
18.	Do you have a separate Kitchen? আপনার কি আলাদা রান্নাঘর আছে?	No না……….0 ~~If No~~ যদি না হয় Yes হ্যাঁ………1	**21 এ চলে যান**	
19.	Presence of a kitchen exhaust fan একটি রান্নাঘরের নিষ্কাশন ফ্যানের উপস্থিতি	No না……….0 Yes হ্যাঁ………1		
20.	Open doors and windows during cooking রান্নার সময় দরজা-জানালা খুলুন	No না……….0 Yes হ্যাঁ………1		
21.	Frequency of cooking in a day এক দিনে রান্নার ফ্রিকোয়েন্সি	Once একবার….1 Twice দুবার…..**2** Morr আরো………3		
22.	Is your child present around you when you are cooking? আপনি রান্না করার সময় আপনার বাচ্চা কি আপনার চারপাশে উপস্থিত থাকে?	No না……….0 Sometimes কখনও কখনও…….1 Most of the times বেশিরভাগ সময়………2		
23.	What is the main source of drinking water for members of your household? আপনার পরিবারের সদস্যদের জন্য পানীয় জলের প্রধান উৎস কি?	Own Hand pump নিজস্ব হ্যান্ড পাম্প……1 Motor মোটর…….**2** Community Hand pump কমিউনিটি হ্যান্ড পাম্প…….**2** Sajal Dhara সজল ধারা ………….3 Purchase from shop দোকান থেকে কিনুন …….4 Others অন্যান্য _______________7		
24.	What kind of Toilet facility does your household use? আপনার পরিবার কি ধরনের টয়লেট সুবিধা ব্যবহার করে?	Open air defecation খোলা বাতাসে মলত্যাগ…….1 Own latrine নিজস্ব ল্যাট্রিন ………2 Both উভয়ই …………………3		
25.	Contact with pet/domestic animals (e.g., cattle, pigs, goats, sheep, or poultry) (Children and parents) পোষা/গৃহপালিত প্রাণীর সাথে যোগাযোগ (যেমন, গবাদি পশু, শূকর, ছাগল, ভেড়া বা হাঁস) (শিশু এবং পিতামাতা)	No না……….0 Yes হ্যাঁ………1		

SECTION 3: MOTHER CHARACTERISTICS বিভাগ 3: মায়ের বৈশিষ্ট্য				
#	**Question প্রশ্ন**	**Response প্রতিক্রিয়া**	**Skip**	**Code**
26.	Name of the mother মায়ের নাম			
27.	Name of the children (youngest child <6 Years) শিশুর নাম (কনিষ্ঠ শিশু <6 বছর)			
28.	Age of the mother মায়ের বয়স	বয়স পূর্ণ হয়েছে (বছর)		
29.	Mother's Education মায়ের শিক্ষা	Illiterate নিরক্ষর……….1 Primary প্রাথমিক……….2 Secondary মাধ্যমিক …….3 Higher Secondary উচ্চ মাধ্যমিক….4 Graduate স্নাতক………….5 Post graduate and above স্নাতকোত্তর এবং তদূর্ধ্ব……….6		
30.	Mother's Occupation মায়ের পেশা	Domestic work গার্হস্থ্য কাজ………….1 Own agriculture নিজস্ব কৃষি……….২ Daily wage labourer দৈনিক মজুরি শ্রমিক….3 Small/big business ছোট/বড় ব্যবসা -----4 Private service বেসরকারি কর্মচারী……5 Govt. service সরকারি কর্মচারী……….6 অন্যান্য ………………….7		
31.	Father's Education বাবার শিক্ষা	Illiterate নিরক্ষর……….1 Primary প্রাথমিক……….2 Secondary মাধ্যমিক …….3 Higher Secondary উচ্চ মাধ্যমিক….4 Graduate স্নাতক………….5 Post graduate and above স্নাতকোত্তর এবং তদূর্ধ্ব……….6		
32.	Father's Occupations বাবার পেশা	Not working কাজ করছে না ………….1 Own agriculture নিজস্ব কৃষি……….২ Daily wage labourer দৈনিক মজুরি শ্রমিক……….3 Small/big business ছোট/বড় ব্যবসা -----4 Private service বেসরকারি কর্মচারী ………5 Govt. service সরকারি কর্মচারী ……….6 Others অন্যান্য ……………………….7		
33.	Total number of children ever born এ পর্যন্ত জন্ম নেওয়া শিশুদের মোট সংখ্যা	মোট শিশুদের সংখ্যা		
34.	Place of delivery of the last born child (name of the child) সর্বশেষ জন্ম নেওয়া সন্তানের প্রসবের স্থান (সন্তানের নাম)	Govt. helath facility সরকারি স্বাস্থ্য কেন্দ্র….1 Pvt. helath facility বেসরকারি স্বাস্থ্য কেন্দ্র….**2** Others অন্যান্য......7		
35.	Mode of delivery of the last child(name of the child) শেষ সন্তানের প্রসবের পদ্ধতি (সন্তানের নাম)	স্বাভাবিক (Normal)……….1 সি-সেকশন (C-section)…….**2**		
36.	Child's weight at the time of birth জন্মের সময় শিশুর ওজন	Normal স্বাভাবিক (>2.50 কেজি) …….1 Low birth weight কম জন্মের ওজন (<2.50 কেজি)…..**2**		
37.	After birth when did you start breastfeeding (NAME)? জন্মের পর আপনি কখন বুকের দুধ খাওয়ানো শুরু করেছিলেন (NAME)?	< 1 hour <1 ঘন্টা......1 >1 hour > 1 ঘন্টা….**2** >1 day >1 দিন….3		
38.	Were you suffering from any illness in last 2 weeks? (Mother) আপনি কি গত 2 সপ্তাহে কোন অসুস্থতায় ভুগছিলেন? **(মা)**	No না……….0 যদি, না Yes হ্যাঁ………1	**40 এ চলে যান**	

39.	Type of Illness রোগের ধরন	Diarrhea ডায়রিয়া……….1 Fever জ্বর …………2 Fever with Cold/cough সর্দি/কাশি সহ জ্বর…3 Others অন্যান্য ………………7		
40.	How often do you read a newspaper or a magazine? আপনি কত ঘন ঘন একটি সংবাদপত্র বা একটি ম্যাগাজিন পড়েন?	Never কখনই না…….**0** A few times in a month মাসে কয়েকবার……**2** Once in a week সপ্তাহে একবার……….**3** Almost Every day প্রায় প্রতিদিনই …….**4**		
41.	How often do you listen to the radio? আপনি কত ঘন ঘন রেডিও শোনেন?	Never কখনই না…….**0** A few times in a month মাসে কয়েকবার……**2** Once in a week সপ্তাহে একবার……….**3** Almost Every day প্রায় প্রতিদিনই …….**4**		
42.	How often do you watch TV? আপনি কত ঘন ঘন টিভি দেখেন?	Never কখনই না…….**0** A few times in a month মাসে কয়েকবার……**2** Once in a week সপ্তাহে একবার……….**3** Almost Every day প্রায় প্রতিদিনই …….**4**		

SECTION 4: Characteristics of Children বিভাগ 4: শিশুর বৈশিষ্ট্য

#	প্রশ্ন	প্রতিক্রিয়া	Skip	Code
43.	Age of the child (In Months) শিশুর বয়স (মাসে)	মাস		
44.	Sex of the Child সন্তানের লিঙ্গ	Boy ছেলে….1 Girl মেয়ে……2		
45.	Height of the child সন্তানের উচ্চতা	Height in উচ্চতা সেমি		
46.	Weight of the child সন্তানের ওজন	Weight in Kg কেজিতে ওজন		
47.	Nutritional Status of the child? শিশুর পুষ্টির অবস্থা?	Normal (Green) সাধারণ ……**1** Moderately Malnourished (Yellow) মাঝারিভাবে অপুষ্ট (হলুদ)**…2** Severely Malnourished মারাত্মকভাবে অপুষ্টিতে ভুগছে (লাল)……..3		
48.	Has your child received national Immunization as per the schedule? আপনার শিশু কি সময়সূচী অনুযায়ী জাতীয় টিকা পেয়েছে?	No না……………0 Yes হ্যাঁ……….1 Yes but not completely on schedule হ্যাঁ কিন্তু সম্পূর্ণরূপে সময়সূচীতে নয়……….3		
49.	Has (NAME) had diarrhoea in the last 2 weeks? (শিশু) কি গত 2 সপ্তাহে ডায়রিয়া হয়েছে?	No না……………0 Yes হ্যাঁ……….1		
50.	Frequency of diarrhoea episode in last year? গত বছরে ডায়রিয়া পর্বের ফ্রিকোয়েন্সি?	Episodes পর্বগুলি		
51.	Has the child been ill with a fever at any time in the last 2 weeks? শিশুটি কি গত 2 সপ্তাহের মধ্যে কোনো সময়ে জ্বরে আক্রান্ত হয়েছে?	No না……………0 Yes হ্যাঁ……….1		
52.	Has (NAME) had an illness with a cough at any time in the last 2 weeks? (NAME) কি গত 2 সপ্তাহের মধ্যে কোন সময়ে কাশি সহ অসুস্থতায় ভুগছেন?	No না……………0 Yes হ্যাঁ………..1		
53.	Has (NAME) had fast, short, rapid breaths or difficulty breathing at any time in the last 2 weeks? (NAME) কি গত 2 সপ্তাহে কোন সময়ে দ্রুত, ছোট, দ্রুত শ্বাস নেওয়া বা শ্বাস নিতে অসুবিধা হয়েছে?	No না……………0 Yes হ্যাঁ………..1		

54.	Was the fast or difficult breathing due to a problem in the chest or to a blocked or runny nose? বুকে সমস্যা বা নাক বন্ধ বা সর্দির কারণে কি দ্রুত বা কঠিন শ্বাস নেওয়া হয়েছিল?	No না……………0 Yes হ্যাঁ………..1		
55.	Have you heard about respiratory diseases among the children? আপনি কি শিশুদের মধ্যে শ্বাসযন্ত্রের রোগ সম্পর্কে শুনেছেন?	No না……………0 Yes হ্যাঁ………..1		
##	**We will define Acute Respiratory Infection as any combine of the following:** **A.** A cough accompanied by had deleted fast, short, rapid breaths or difficulty breathing. **B.** A cough accompanied by difficult breathing due to a problem in the chest or to a blocked or runny nose **আমরা তীব্র শ্বাসযন্ত্রের সংক্রমণকে নিম্নলিখিতগুলির সমন্বয় হিসাবে সংজ্ঞায়িত করব:** **ক.**এটি কাশির সাথে, কম বা দ্রুত শ্বাস নিতে অসুবিধা. **খ.** সর্দির কারণে শ্বাসকষ্টের সাথে কাশি বা বুকে সমস্যা বা অবরুদ্ধ			
56.	Has your child had an ARI in last 2 weeks (15 days)? আপনার সন্তানের কি গত 2 সপ্তাহে (15 দিনে) ARI হয়েছে?	No না………..0 if No যদি, না Yes হ্যাঁ………..1	**64 এ চলে যান**	
57.	If, yes how long did the ARI last ? যদি, হ্যাঁ, ARI কতদিন স্থায়ী ছিল?	Number of days দিনের সংখ্যা		
58.	Did you seek advice or treatment for the illness from any source? আপনি কোন উৎস থেকে অসুস্থতার জন্য পরামর্শ বা চিকিত্সা চেয়েছিলেন?	No না………..0 যদি, না Yes হ্যাঁ………..1	**64 এ চলে যান**	
59.	Where did you seek advice or treatment from? আপনি কোথা থেকে পরামর্শ বা চিকিত্সা চেয়েছিলেন?	Public Health Facility সরকারি স্বাস্থ্য কেন্দ্র………1 Private Health Facility বেসরকারি স্বাস্থ্য কেন্দ্র……...**2** Medicine shop ওষুধের দোকান……3		
60.	How many days after the illness began did you first seek advice or treatment for (NAME)? অসুস্থতা শুরু হওয়ার কত দিন পর আপনি প্রথমে (NAME) এর জন্য পরামর্শ বা চিকিৎসা চেয়েছিলেন?	No. of Days দিনের সংখ্যা		
61.	At any time during the illness, did (NAME) take any drugs for the illness? অসুস্থতার সময় কোন সময়ে, (NAME) অসুস্থতার জন্য কোন ওষুধ খেয়েছিলেন?	No না……………0 যদি, না Yes হ্যাঁ………..1	**63 এ চলে যান**	
62.	How long after the illness started, did (NAME) first take DRUG? অসুস্থতা শুরু হওয়ার কতদিন পর, (NAME) প্রথমে DRUG খেয়েছিলেন?	Same day একই দি(ন…….1 Next day পরের দিন………2 Two days and after দুই দিন এবং তার পরে ……….3		
63.	Total expenditure on child's health in last 2 weeks (including traveling cost) গত 2 সপ্তাহে শিশুর স্বাস্থ্যের জন্য মোট ব্যয় (ভ্রমণ খরচ সহ)	টাকায় খরচ		
64.	Frequency of Respiratory episode in last year? গত বছর শ্বাসযন্ত্রের পর্বের ফ্রিকোয়েন্সি?	পর্বগুলি		

বিঃদ্রঃ:Q43 থেকে Q48 তথ্য AWC কর্মীদের কাছে পাওয়া যাবে।

SECTION 5: MOTHER'S KNOWLEDGE ATTITUDE AND PRACTICES FOR (ARI-এর জন্য মায়ের জ্ঞানের দৃষ্টিভঙ্গি এবং অনুশীলন)

	Questions প্রশ্ন	**Response প্রতিক্রিয়া**	**Skip**	**Code**
#	**Question on Knowledge জ্ঞানের উপর প্রশ্ন**			
65.	The illnesses (ARI) caused by:অসুস্থতা (ARI)_______দ্বারা সৃষ্ট:	Viruses ভাইরাস……….1 Bacteria ব্যাকটেরিয়া……….**2** Allergies এলার্জি……….3		
66.	What are the symptoms of ARI? ARI এর লক্ষণগুলো কি কি?	Cold and Cough with fever জ্বরের সাথে সর্দি-কাশি………………………………..**1** Only Fever শুধু জ্বর……….২ Vomiting বমি……….৩ Pain in ear, nose, throat কানে, নাকে, গলায় ব্যাথা......4		
67.	**What do you think, how does a child get infection of respiratory diseases? আপনি কি মনে করেন, কিভাবে একটি শিশু শ্বাসযন্ত্রের রোগের সংক্রমণ হয়?**			
67_A	Clean Air পরিষ্কার বাতাস	Yes হ্যাঁ ……1 No না …….**2** Don't know জানি না…..3		
67_B	Smoky Air ধোঁয়াটে বাতাস	Yes হ্যাঁ ……1 No না …….**2** Don't know জানি না…..3		
67_C	Eating old or rotten food পুরানো বা পচা খাবার খাওয়া	Yes হ্যাঁ ……1 No না …….**2** Don't know জানি না…..3		
67_D	Cooking inside with fire বাড়ির ভিতরে আগুন দিয়ে রান্না করা	Yes হ্যাঁ ……1 No না …….**2** Don't know জানি না…..3		
67_E	Cooking outside বাইরে রান্না	Yes হ্যাঁ ……1 No না …….**2** Don't know জানি না…..3		
68.	What are the complications of ARI? ARI এর জটিলতাগুলো কি কি?	Bronchitis ব্রংকাইটিস……….1 Pneumonia নিউমোনিয়া……….**2** Ear discharge কানের ব্যথা……..3 Multi-organ failure মাল্টি-অর্গান ফেইলিউর…….4		
#	**Questions on Attitude মনোভাব নিয়ে প্রশ্ন**			
69.	Do you consider ARI as a Serious Illness? আপনি কি ARI কে গুরুতর অসুস্থতা হিসাবে বিবেচনা করেন?	Not important and Serious গুরুত্বপূর্ণ এবং গুরুতর নয়……………………...**1** Important and Serious গুরুত্বপূর্ণ এবং গুরুতর …………….……**2** Very important and Serious অত্যন্ত গুরুত্বপূর্ণ এবং গুরুতর………………**3**		
70.	How important do you think it is for your child to breath clean air? আপনার সন্তানের জন্য পরিষ্কার বাতাসে শ্বাস নেওয়া কতটা গুরুত্বপূর্ণ বলে আপনি মনে করেন?	Not important and Serious গুরুত্বপূর্ণ এবং গুরুতর নয়……………………...**1** Important and Serious গুরুত্বপূর্ণ এবং গুরুতর …………………….……**2** Very important and Serious অত্যন্ত গুরুত্বপূর্ণ এবং গুরুতর………………**3**		

71.	How serious do you think it is if your child is having difficulty in breathing, they have a sever cough, or have problem with their chest? আপনার সন্তানের যদি শ্বাস নিতে অসুবিধা হয়, তার তীব্র কাশি হয় বা তার বুকে সমস্যা হয় তবে এটি কতটা গুরুতর বলে আপনি মনে করেন?	Not important and Serious গুরুত্বপূর্ণ এবং গুরুতর নয়……………………...**1** Important and Serious গুরুত্বপূর্ণ এবং গুরুতর ………………………..……**2** Very important and Serious অত্যন্ত গুরুত্বপূর্ণ এবং গুরুতর………………**3**		
72.	How serious do you think it is if your child has a runny or blocked nose ? আপনার সন্তানের সর্দি বা অবরুদ্ধ নাক থাকলে এটি কতটা গুরুতর বলে আপনি মনে করেন?	Not important and Serious গুরুত্বপূর্ণ এবং গুরুতর নয়……………………...**1** Important and Serious গুরুত্বপূর্ণ এবং গুরুতর ………………………..……**2** Very important and Serious অত্যন্ত গুরুত্বপূর্ণ এবং গুরুতর………………**3**		
73.	How important you consider building immunity of your child against ARI? এআরআই-এর বিরুদ্ধে আপনার সন্তানের রোগ প্রতিরোধ ক্ষমতা গড়ে তুলতে আপনি কতটা গুরুত্বপূর্ণ বলে মনে করেন?	Not important and Serious গুরুত্বপূর্ণ এবং গুরুতর নয়……………………...**1** Important and Serious গুরুত্বপূর্ণ এবং গুরুতর ………………………..……**2** Very important and Serious অত্যন্ত গুরুত্বপূর্ণ এবং গুরুতর………………**3**		
#	**Question on Practice** **অনুশীলনের উপর প্রশ্ন**			
74.	What is the frequency of air ventilation of your home in winter season? শীতকালে আপনার বাড়ির বায়ুচলাচলের ফ্রিকোয়েন্সি কত?	Never কখনই না………**1** Daily দৈনিক……….**2** Weekly সাপ্তাহিক……….**3** Occasionally মাঝে মাঝে……….**4**		
75.	From where do you seek treatment of your children during ARI illness? এআরআই অসুস্থতার সময় আপনি কোথা থেকে আপনার সন্তানদের চিকিৎসা চান?	No treatment কোন চিকিৎসা নেই……….**1** Home Treatment ঘরোয়া চিকিৎসা…….**2** Homeopathy হোমিওপ্যাথি……….**3** Medical Care চিকিৎসা সেবা……….**4** Medicine shop ওষুধের দোকান………**5**		
76.	Do you maintain eating utensils or drinking containers separately for children ? আপনি কি খাওয়ার পাত্র/ পানীয়ের পাত্র বাচ্চাদের জন্য আলাদাভাবে ব্যবহার করেন ?	No না……0 Yes হ্যাঁ……1		
77.	Do you maintaining distancing from your child when you suffering from cold and cough? আপনি যখন সর্দি এবং কাশিতে ভুগছেন তখন কি আপনি আপনার সন্তানের থেকে দূরত্ব বজায় রাখেন?	No না…………..0 Yes হ্যাঁ……………1		
78.	Duration of desensitize/cleaning room during child illness শিশুর অসুস্থতার সময় ঘরের ঘর পরিষ্কার করার সময়কাল	Not at all মোটেও না... 0 Every day প্রতিদিন… 1 2 days interval 2 দিনের ব্যবধান …..**2** >2 days interval দুই দিনের বেশি ব্যবধান…………. 3		
79.	When do you visiting the doctor after the symptom of our child আমাদের সন্তানের লক্ষণ দেখা দেওয়ার পর আপনি কখন ডাক্তারের কাছে যান	Not al all মোটেও না.........**0** অবিলম্বে ……..1 0-2 দিন………**2** >2 days interval দুই দিনের বেশি ব্যবধান…………. 3		
80.	What do you do to prevent a child from getting a cold? (Multiple choice question) বাচ্চাকে ঠান্ডা লাগা থেকে বাঁচাতে আপনি কী করবেন? (মাল্টিপল চয়েস প্রশ্ন)	Honey with Tulshi তুলশীর সাথে মধু……….1 Turmeric with honey মধুর সাথে হলুদ……2 Hot water and milk গরম জল এবং দুধ…….3		

		Warm water/ with salt and ghee গরম পানি/ লবণ ও ঘি সহ….4 Clean nose regularly নিয়মিত নাক পরিষ্কার করেন...4 Give hot water for drinking only খাওয়ার জন্য শুধুমাত্র গরম জল ব্যবহার করেন... ….6 Use room heater রুম হিটার ব্যবহার করেন...7 Use warm cloths গরম কাপড় ব্যবহার করেন.............8 Others অন্যান্য……. 9		

Thank you very much for the information

আপনার প্রতিক্রিয়ার জন্য আপনাকে অনেক ধন্যবাদ

ANNEXURE-III

Data collection Approval

Gokhale Institute of Politics and Economics

(Founded by Rao Bahadur R. R. Kale, Satara)

(Deemed to be University u/s 3 of the UGC Act, 1956)

846, Shivajinagar, B.M.C.C. Road

PUNE - 411 004 (INDIA)

August 1, 2022

TO WHOM IT MAY CONCERN

This is to certify that Mr. Koustav Ghosh is a bonafide student of Gokhale Institute of Politics and Economics (Deemed University), BMCC Road, Pune-411004, registered in February 3, 2020 for Ph.D. programme in Population Studies on the topic "Spatial clustering and its contextual determinants of Acute respiratory infections (ARI) and its association with mother's knowledge & Environmental condition: A study of rural part of West Bengal and India" under the guidance of Dr. Atreyee Sinha Chakraborty.

This certificate is issued at his request to avail the following data. He will use this data for academic purpose only.

Name of the State: West Bengal
Name of the District: Purba Bardhaman
Block/ Taluka: Monteswar (Shushuni and Baghason Panchayat)
Data collection duration: 10th August 2022 to 10th September 2022

Sl. No	Name of the Village	Selected Anganwadi (AWC) centre	Anganwadi (AWC) Teacher
1	Shushuni	Susunia F P School	Lipika Basu Mallik
2	Ataspur	Atashpur Muslimparal AWC	Minati Bayen
3	Hosenpur	Hassainpur AWC	Chintamani Dey
4	Ghoradanga	Ghoradanga Dharabahik Shikha Kendra AWC	Chhaya Garai
5	Shushuna	Tara Susuna AWC	Bani Mondal
6	Jaypur	Jaypur F P School AWC	Mina Bhattacharya
7	Panbarea	Panbaria Masjidtala	Subarna Roy
8	Kalui	Kalui AWC	Golsonara Malik
9	Kuli	Kuli AWC	Champa Das
10	Budhpur	Budpur F P School	Madhabi Dey
11	Kalswar	Kalswar F P School	Aruna Kayal
12	Bhojpur	Vojpur 1 No F P School	Tapasi Dey

GOKHALE INSTITUTE OF POLITICS & ECONOMICS DEEMED UNIVERSITY PUNE-4

Offig. Registrar

Officiating Registrar
Gokhale Institute of Politics and Economics
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