# ASSESSING INDOOR AIR POLLUTION EXPOSURES AND ACUTE RESPIRATORY INFECTION IN CHILDREN UNDER 5 IN URBAN SLUM AREAS OF GANDHIDHAM CITY: A COMMUNITY-BASED STUDY

Dissertation Submitted to

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By

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Under the Supervision and Guidance of

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IPA International Pediatric Association

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1st July, 2024

## Organization Certificate

This is to certify that **Dr Madhumita Singh** pursuing **MBA (Hospital and Health Management)** from Institute of **Health Management Research (IIHMR)** has completed her dissertation with the International Pediatric Association from **1st April to 30th June, 2024.**

As part of her dissertation, she studied " **Assessing Indoor Air Pollution Exposures and Acute Respiratory Infection in Children Under 5 in Urban Slum Areas of Gandhidham City: A Community-Based Study".**

Dr. Naveen Thacker
President, IPA

## DECLARATION BY STUDENT

I hereby declare that this dissertation is titled "Assessing Indoor Air Pollution Exposures and Acute Respiratory Infection in Children Under 5 in Urban Slum Areas of Gandhidham City: A Community-Based Study" is the bonafide record of my original research work. I declare that it has not been submitted toany other university or institution for the award of any degree or diploma. Information derivedfrom the published or unpublished work of others has been duly acknowledged in the text.

(Signature)

Name of Student: Dr. Madhumita Singh

Date: 20th June, 2024

## CERTIFICATE

This is to certify that the dissertation titled "Assessing Indoor Air Pollution Exposures and Acute Respiratory Infection in Children Under 5 in Urban Slum Areas of Gandhidham City: A Community-Based Study" is a record of the research work undertaken by Dr. Madhumita Singh in partial fulfillment of the requirements for the award of the degree of MBA (Hospital and Health Management) from IIHMR University, Jaipur under my guidance and supervision and her approach to the researchstudy has been sincere, scientific, and analytical.

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# ABSTRACT

**TITLE:** Assessing Indoor Air Pollution Exposures and Acute Respiratory Infection in Children Under 5 in Urban Slum Areas of Gandhidham City: A Community-Based Study

**Author Name:** Dr. Madhumita Singh

**Advisor Name:** Dr. Naveen Thacker

**Keywords:** Indoor Pollution, Solid Fuel Combustion, Children Under-5 years, Acute respiratory infection

**Background:** The use of inefficient and solid fuels within the home produces household air pollution, which is composed of a variety of health-damaging pollutants, including small particulates that can enter the bloodstream and deeply infiltrate the lungs. Typically, the fuels are burned ineffectively, and on unvented household cook stoves, which, along with inadequate ventilation, produce a lot of smoke indoors. 1.1 billion individuals are exposed to high amounts of respirable particles due to indoor air pollution, which ranks eighth among risk factors for all diseases and deaths in developing nations. With two million deaths globally, acute respiratory infections are the leading cause of morbidity and mortality among children under five.

**Objective:** To determine the prevalence of Acute respiratory infection in children under 5 years of age in households using solid fuel combustion in Gandhidham city. To determine the association between indoor air pollution and prevalence of Acute respiratory infection in children under the age of 5.

**Methodology:** Community-based cross-sectional study design was conducted to examine the association of acute respiratory infections with biomass fuel exposure among under-five children in the Slum area of Gandhidham Gujrat, from Apr 01 to June 30, 2024

**Findings:** The overall prevalence of the ARI is 46.7%. Most of the mothers were literate and their educational status was not associated with the prevalence of ARI. Overcrowding has existed in 43% of the households. A majority, i.e., 91% of the households were inadequately ventilated. The prevalence of indoor smoking was 3%. Out of the total households, 15% used unclean fuel. The use of unclean fuel and parental smoking is significantly associated with the higher prevalence of ARIs. Inadequate ventilation did have a positive association with ARI.

**Conclusions**: The findings of this study also affirm that Acute Respiratory Infections (ARI) are common among under-five children; the weighted prevalence rate for ARI was 46.7%, which is consistent with the previous studies. Like other studies, poor ventilation and smoke from unclean fuels are identified as ARI risk factors. This study is among the few that did not find a relationship between maternal education and an increased risk of ARI. There was also no

significant sex difference in the prevalence of ARI**.**

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# ABBREVIATIONS

| ABBREVIATIONS | MEANING |
|---|---|
| ARI | Acute Respiratory Infection |
| ASHA | Accredited Social Health Activist |
| AWW | Anganwadi Workers |
| SPSS | Statistical Package for Social Sciences |

# CHAPTER I
# INTRODUCTION

The use of inefficient and solid fuels within the home produces household air pollution, which is composed of a variety of health-damaging pollutants, including small particulates that can enter the bloodstream and deeply infiltrate the lungs (1). Typically, the fuels are burned ineffectively, and on unvented household cook stoves, which, along with inadequate ventilation, produce a lot of smoke indoors (2). 1.1 billion individuals are exposed to high amounts of respirable particles due to indoor air pollution, which ranks eighth among risk factors for all diseases and deaths in developing nations (3). With two million deaths globally, acute respiratory infections are the leading cause of morbidity and mortality among children under five (4). Children under five exposed to polluted air due to the combustion of unprocessed biomass fuel are most vulnerable to health hazards. They are more affected than adults as they inhale large amounts of polluted air compared to their body size due to increased minute ventilation as they are more active (5). The sub-Saharan African nations and Southeast Asia have the highest incidence of ARI, accounting for about 80% of all cases worldwide (6). ARI accounts for more than two-thirds of all pediatric diseases in Indian slum regions (7). Although reliable epidemiological data on the frequency of childhood ARI are not readily available, it remains a serious public health concern in India. Young newborns, malnourished children, children who aren't exclusively breastfed, and those who have been exposed to solid biomass combustion are also at higher risk (8). Acute respiratory infections (ARIs) account for 14.3% of fatalities in infants and 15.9% of deaths among children aged 1 to 5 in India, with the majority of these deaths being preventable. Because of the high rates of morbidity and mortality associated with ARIs, the healthcare system still faces significant challenges in controlling them (9). ARI is the cause of 20–30% of hospital admissions and 30–60% of pediatric outpatient visits globally (9). Malnutrition, diarrheal illnesses, and ARI are the three most common causes of illness and mortality in children under five in developing countries like India. There are connections between environmental risk factors (such as air pollution, overcrowding, etc.) and childhood risk factors (such as low birth weight (LBW), malnutrition, etc.), according to the December 1991 International Consultation on Control of ARI. Corrective actions are possible for many of these risk factors (10). Since the majority of the research on ARI so far has concentrated on the burden of disease in the vicinity of urban slums, it lacks representative and reliable information, which causes the prevalence of ARI to be underestimated (6). Several respiratory illnesses, including acute respiratory infections, chronic obstructive pulmonary disease, lung cancer, pulmonary tuberculosis, and asthma, are linked to exposure to biomass fuels(11). Among children under five, exposure to smoke from biomass fuel stoves is one of the factors leading to acute respiratory illnesses (12) Acute respiratory infections are the leading cause of illness and mortality for children under five globally, accounting for 2 million deaths and 94,037,000 disability-adjusted life years(13). Around 400,000 children under the age of five in India die from ARI-related illnesses every year. This percentage represents 13–16% of all child fatalities among hospital admissions for pediatric patients(14). While there has been much research on the consumption of biomass fuels and acute respiratory infections (ARI), the focus of these studies was confined to determining the correlation between respiratory infection incidence and biomass fuel exposure. The prevalence of ARI in India was estimated by the National Family Health Survey-4 (NFHS-4) to be 2.7% in 2015–2016. This is a ~50% drop from the 5.6% recorded by the NFHS-3 in 2005–2006(15). India has not met the Millennium Development Goal 4 of lowering child death by two-thirds between 1990 and 2015, despite a roughly 50% decline in ARI mortality of children under the age of five (16).

## 1.1 OBJECTIVES

1. To determine the prevalence of Acute respiratory infection in children under 5 years of age in households using solid fuel combustion in Gandhidham city.
2. To determine the association between indoor air pollution and prevalence of Acute respiratory infection in children under the age of 5.

## 1.2 Purpose of the Study

The purpose of this study is to identify the prevalence of ARI among children residing in the slum area of Gandhidham below the age of 5 years old. The study also focuses on the association between indoor pollution caused by the combustion of the solid fuel used for cooking and the prevalence of the ARI. As ARI is a major determinant of child mortality, understanding its etiological factors is necessary. This study aims to find the prevalence of ARI in children under 5 years of age in households using solid fuel combustion as well as the association between indoor pollution and the prevalence of ARI.

# CHAPTER III

## 3.1 REVIEW OF LITERATURE

| S.No | Title | Author | Purpose | Findings |
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| 1. | Respiratory involvement among women exposed to the smoke of traditional biomass fuel and gas fuel in a district of Bangladesh | Alim, Md Abdul; Sarker, Mohammad Abul Bashar; Selim, Shahjada; Karim, Md Rizwanul; Yoshida, Yoshitoku; Hamajima, Nobuyuki; | The main objective of the study on respiratory involvements among women in Bangladesh was to investigate the association between the type of cooking fuel used (biomass fuel vs. gas fuel) and respiratory symptoms and diseases among women in rural and urban areas of Bogra district, Bangladesh. | Prevalence of Respiratory Involvement: Women using biomass fuel had a higher prevalence of respiratory involvement (29.9%) compared to those using gas fuel (11.2%) in Bangladesh. Age and Respiratory Involvement: The adjusted odds ratio for respiratory involvement was highest among women aged 36–58 years. |
| | Prevalence and risk factors of acute lower respiratory infection among children living in biomass fuel using households: a community-based cross-sectional study in Northwest Ethiopia | Adane, Mesafint Molla; Alene, Getu Degu; Mereta, Seid Tiku; Wanyonyi, Kristina L | The objective of the study is to determine the prevalence of childhood acute lower respiratory infection (ALRI) and associated factors among children living in households that use biomass fuel for cooking in Northwest Ethiopia. The study aims to identify the factors contributing to | Prevalence: The prevalence of childhood acute lower respiratory infection was found to be 19.2% (95% CI: 18.2–20.2) among the 5830 children included in the study |

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| | | | ALRI in this specific population to inform public health interventions and strategies for reducing the burden of respiratory infections among children in the region | |
| | Impact of domestic air pollution from cooking fuel on respiratory allergies in children in India | Kumar, Raj; Nagar, Jitendra K; Raj, Neelima; Kumar, Pawan; Kushwah, Alka S; Meena, Mahesh; Gaur, SN | The objective of the study on the Impact of Domestic Air Pollution from Cooking Fuel on Respiratory Allergies in Children in India was to investigate the association between indoor air pollution from cooking fuel and respiratory allergies in children.<br>The study aimed to assess the prevalence of respiratory symptoms and diseases in children exposed to indoor air pollutants, particularly focusing on the use of different types of cooking fuels and their impact on respiratory health | 1.Levels of indoor SO2, NO2, and SPM were significantly higher in households using biomass fuels for cooking compared to those using liquefied petroleum gas (LPG).<br>2. Diagnoses of asthma, rhinitis, and upper respiratory tract infections were made in a percentage of children examined, with varying prevalence rates.<br>3. Children with symptoms of respiratory allergy experienced cough, phlegm production, shortness of breath, and wheezing. Additionally, a percentage of children had a family history of respiratory disease.<br>4. A significant proportion of children's families predominantly from upper |

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| | | | | and middle classes were using LPG fuel for cooking |
| | Cooking fuels and children respiratory health: Evidence from Nigeria | Devi, Boishakhy; Maina, PM; | The objectives of the study on cooking fuels and children's respiratory health in Nigeria are as follows:<br>1. To investigate the impact of different fuel types on the respiratory health of children under 5 years old.<br>2. To analyze the association between household fuel choices (conventional vs. modern fuels) and the occurrence of Acute Respiratory Infections (ARI) symptoms in children.<br>3. To explore the potential benefits of transitioning to modern cooking fuels in reducing respiratory health risks for children.<br>4. To consider the role of various control variables, such as gender, age, and education of the household head, in influencing the | Impact of Fuel Type: Modern cooking fuels were found to be significantly safer for children's respiratory health compared to conventional fuels when considered collectively. Transitioning to modern fuels, such as electricity and biogas, was associated with a reduced probability of Acute Respiratory Infection (ARI) symptoms among children under 5 years old in Nigerian household.<br>2. Individual Fuel Types: While the overall trend favored modern cooking fuels, the study noted some inconclusive results when analyzing the impact of specific fuel types on children's respiratory health. This ambiguity was attributed to limitations in data observations for certain fuel types.<br>3. Household Factors: The study highlighted the importance of household factors, such as the gender, age, and education |

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| | | | likelihood of children experiencing ARI symptoms due to household fuel emissions | level of the household head, in influencing the likelihood of children experiencing ARI symptoms due to household fuel emissions. Highly educated female household heads were identified as potentially playing a significant role in reducing the probability of ARI symptoms among children |
| | Health Effect of Biomass Fuel Pollutants to Women and Children in Kieni East Constituency Nyeri County, Kenya | Addisu, Abebaw; Getahun, Tesfalem; Deti, Mulunesh; Negesse, Yilkal; Mekonnen, Besufekad; | To determine the health effects of biomass pollutants on women and children.<br>2. To establish attitudes and perceptions based on cook stove adaptation concerning efficiency and affordability.<br>3. To understand in depth the household cooking characteristics of vulnerable rural communities.<br>4. To determine policy interventions at the county level that can help reduce morbidity and mortality associated with indoor pollution. | 1.Eighty percent of rural women cooked indoors using biomass fuel without ventilation.<br>2. There was a positive correlation between the use of ordinary cook stoves and an increase in respiratory diseases.<br>3. Forty percent of women interviewed reported cases of respiratory complications, eye infections, asthma, and lung problems affecting them and their children |

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| | Association between household air pollution and pneumonia among children under five years old admitted at the Indira Gandhi children's hospital in Kabul, Afghanistan | Safi, Helah; Venkat, Padma; Prakash, Muthuperumal; | The objective of the research paper is to examine the association between acute respiratory infections (ARIs) in under-five children and indoor air pollution (IAP) from biomass fuel exposure in Jimma Town, Southwestern Ethiopia. The study aims to investigate the prevalence of ARIs, the concentration of particulate matter in households using biomass fuel compared to clean fuel, and the influence of household and kitchen characteristics on the prevalence of ARIs. Additionally, the research seeks to provide recommendations for improving kitchen environments, reducing indoor air pollution, and implementing effective strategies to decrease | Prevalence of Acute Respiratory Infections (ARIs): The prevalence of acute respiratory infections in the study area was 16% among under-five children.<br>2. Biomass Fuel Usage: 67.5% of the under-five children in the study were living in households that predominantly used biomass fuel.<br>3. Risk Factors for ARIs: Children living in households using biomass fuel were four times more likely to develop acute respiratory infections compared to those in households using clean fuel.<br>4. Household size was significantly associated with the prevalence of acute respiratory infections, with larger families having increased risk. The absence of a separate kitchen in households was associated with a fourfold increased risk of acute respiratory infections in children.<br>5. Particulate Matter Concentration: Indoor particulate matter concentration was higher in households using biomass |

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| | | | biomass fuel usage in the study area | fuel compared to clean fuel.<br>Particulate matter concentrations were significantly higher in kitchens than in living rooms.<br>Households with parental smoking had significantly higher particulate matter concentrations.<br>These findings highlight the significant association between biomass fuel usage, indoor air pollution, and the prevalence of acute respiratory infections among under-five children in the study area. The study underscores the importance of addressing indoor air pollution from biomass fuel exposure to reduce the burden of respiratory infections and ensure the well-being of children |
| | Effects of indoor air pollution due to solid fuel combustion on physical growth of children under 5 in Sri Lanka: A descriptive cross sectional study | Ranathunga, Nayomi; Perera, Priyantha; Nandasena, Sumal; Sathiakumar, Nalini; Kasturiratne, Anuradhani; Wickremasinghe, Ananda Rajitha | To assess the impact of indoor air pollution from solid fuel combustion on the physical growth of children under 5 years old.<br>2. To measure air quality levels, specifically PM2.5, Carbon Dioxide ($CO_2$), and | Prevalence of Wasting and Underweight: The prevalence of wasting was 19.7% and underweight was 20.4% in the entire study population, with 68% of children belonging to the high exposure group (using biomass fuel or kerosene for cooking).<br>2. Impact on Physical Growth: Children from |

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| | | | Carbon Monoxide (CO), in households using different types of cooking fuels.<br>3. To compare the physical growth indicators (such as weight and height) of children from households with high exposure to indoor air pollution (using biomass or kerosene) versus low exposure (using Liquefied Petroleum Gas or electricity).<br>4. To analyze the association between air pollution levels and anthropometric indices of children under 5.<br>5. To provide insights for public health interventions and policies aimed at reducing indoor air pollution and improving the physical growth of children in Sri Lanka. | the high exposure group had significantly lower mean z-scores for weight-for-height, height-for-age, and weight-for-age compared to the low exposure group (using Liquefied Petroleum Gas or electricity for cooking) after adjusting for confounders.<br>3. Association with Air Pollutants: Z-scores of weight-for-age, height-for-age, and weight-for-height were negatively correlated with Carbon Monoxide (CO) and PM2.5 concentrations, indicating a link between indoor air pollution levels and poor physical growth in children.<br>4. Implications: The study highlighted that indoor air pollution due to the combustion of biomass fuel leads to physical growth retardation in children under 5 in Sri Lanka, emphasizing the importance of addressing indoor air quality for child health and development. |
| | Prevalence of the acute respiratory infections and associated factors in the rural areas and urban slum areas of western Maharashtra, India: a community- | Murarkar, Sujata; Gothankar, Jayashree; Doke, Prakash; Dhumale, Girish; Pore, Prasad D; Lalwani, Sanjay; | Estimate the prevalence of ARIs among children under five years of age in the | 1.Prevalence of ARIs: The prevalence of ARIs among under-five children was 50.4%, with a higher prevalence in rural |

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| | based cross-sectional study | Quraishi, Sanjay; Patil, Reshma S; Waghachavare, Vivek; Dhobale, Randhir; | specified regions. Assess the association of selected sociodemographic and household environmental factors with the occurrence of ARIs in these children | areas (54.2%) compared to urban areas (46.7%). 2. Associated Factors: Living in rural areas and parental smoking were significantly associated with ARIs in under-five children. 3. Gender Prevalence: The study showed an equal prevalence of ARIs among boys and girls, with no significant difference observed. 4. Housing Environment: Overcrowding was present in 43% of households, and 94.4% of households were inadequately ventilated |
| | Childhood respiratory morbidity and cooking practices among households in a predominantly rural area of Ghana | Kwaku Poku Asante, Patrick Kinney, Charles Zandoh, Eleanne Van Vliet, Ernest Nettey, Livesy Abokyi, Seth Owusu-Agyei, Darby Jack | To assess the prevalence of acute lower respiratory infections (ALRI) among children in households using biomass fuel for cooking. 2. To investigate the association between household cooking practices, particularly the type of cook-stove and fuel used, and the occurrence of respiratory symptoms in children. | Prevalence of Respiratory Symptoms: The prevalence of symptoms of acute lower respiratory infections (ALRI) among children in the surveyed households was 13.7%. 2. Cooking Practices: The majority of households (77.8%) used wood as their primary fuel, with most obtaining wood from their neighborhood and using a 3-stone local stove for cooking. Charcoal use was less common, while LPG or |

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| | | | 3. To explore the socioeconomic and demographic factors influencing household cooking practices and their potential impact on respiratory health outcomes.<br>4. To provide insights for designing interventions, such as promoting improved cook-stoves, to mitigate the health risks associated with indoor air pollution from traditional cooking methods. | electricity use was rare. Female respondents were primarily responsible for gathering firewood and cooking in the household .<br>3. Cooking Areas: A majority of respondents cooked in open areas with no roofs and walls, while partially enclosed areas were the most common secondary cooking areas.<br>4. Association with Respiratory Symptoms: None of the cooking practice variables assessed were significantly associated with respiratory symptoms |
| | Effects of Cooking Fuels on Acute Respiratory Infections in Children in Tanzania | James H. Kilabuko and Satoshi Nakai | 1.To assess the association between different types of cooking fuels (biomass fuels, charcoal, and kerosene) and the prevalence of acute respiratory infections in children under five years old.<br>2. To investigate the potential impact of various factors such as nutritional status, birth order, household crowding, birth | Prevalence of ARI: The average prevalence of acute respiratory infections (ARI) among children under five years old in Tanzania was approximately 11%. The prevalence of ARI did not vary significantly across different types of cooking fuels used in households.<br>2. Association with Cooking Fuels: The study revealed that the effect of biomass fuels on ARI prevalence in children |

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| | | | weight, prenatal diseases, breastfeeding, and child care practices on the occurrence of acute respiratory infections in children.<br>3. To evaluate the limitations of the study, including the method of assessing acute respiratory infections through questionnaires and the potential underestimation or overestimation of ARI frequency.<br>4. To provide insights into the implications of the study findings for policy-making and public health interventions aimed at reducing the burden of acute respiratory infections in children associated with different cooking fuels. | was similar to the effect of charcoal or kerosene, as indicated by the odds ratio of 1.01 (95% CI: 0.78-1.42). This suggests that there was no significant difference in the impact of different cooking fuels on ARI.<br>3. Comparison with Other Studies: The prevalence of ARI in children using biomass fuels in Tanzania was lower than that reported in similar studies conducted in Zimbabwe and India. Positive associations between exposure to biomass smoke and ARI have been reported in many studies, while some studies have not established a clear relationship.<br>4. Policy Implications: The study implies that to reduce the risk of ARI associated with cooking fuels in children in Tanzania, a shift towards cleaner fuels such as gas and electricity may be essential. The findings suggest the importance of considering the health implications of different cooking fuels in public health policies and interventions |

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| | Cooking and Season as Risk Factors for Acute Lower Respiratory Infections in African Children: A Cross-Sectional Multi-Country Analysis | Hannes Buchner, Eva A. Rehfuess | 1. To investigate the association between main cooking fuel used in households and the prevalence of acute lower respiratory infections (ALRI) in children under five years of age in sub-Saharan Africa.<br>2. To examine how cooking location and stove ventilation impact the risk of ALRI in children.<br>3. To assess the potential effect modification of seasonality on the relationship between main cooking fuel and ALRI prevalence.<br>4. To provide insights that can guide the design of effective public health interventions to reduce household air pollution and mitigate the burden of respiratory infections in African children. | Main Cooking Fuel Impact: Main cooking fuel had a statistically significant impact on ALRI risk, with households using kerosene, coal and charcoal, wood, and lower-grade biomass fuels showing elevated odds of suffering from ALRI compared to clean fuels during the rainy season.<br>2. Seasonal Effect Modification: Seasonality acted as an effect modifier in the relationship between main cooking fuel and ALRI risk. During the rainy season, the odds of ALRI were higher for households using kerosene, coal and charcoal, wood, and lower-grade biomass fuels compared to clean fuels.<br>3. Cooking Location Impact: Cooking indoors without a separate kitchen was identified as an additional determinant of ALRI risk in children. This highlights the importance of considering cooking location as a risk factor for respiratory infections.<br>4. Implications for Public Health: The study demonstrated |

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| | | | | that large DHS datasets can be valuable for studying the impact of household air pollution on child health. It emphasized the need to address confounding factors and measurement imprecisions in future research on ALRI determinants. 5. Generalizability: While the study sample was not designed to be representative of the entire African continent, the findings are likely applicable across various geographical and climatic areas in South, East, and West Africa. This suggests the potential generalizability of the study results to different parts of the continent. |
| | Place of food cooking is associated with acute respiratory infection among underfive children in Ethiopia: multilevel analysis of 2005–2016 Ethiopian Demographic Health Survey data | Eric M. Foote, Laura Gieraltowski, Tracy Ayers, Ibrahim Sadumah, Sitnah Hamidah Faith, Benjamin J. Silk, Adam L. Cohen, Vincent Were, James M. Hughes, and Robert E. Quick | 1.To assess the prevalence of acute respiratory infections (ARI) among under-five children in Ethiopia. 2. To investigate the relationship between the place of cooking food (indoor, outdoor, or in a separate building) | 1.Prevalence of ARI: A total of 30,895 under-five children were included in the study, with 11.9% of children experiencing acute respiratory infections. The prevalence of ARI was 12.7% in 2005, 11.9% in 2011, and 11.1% in 2016. 2. Association with Cooking Place: The |

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| | | | and the risk of ARI in children.<br>3. To identify factors at the child, household, and survey levels that may influence the occurrence of ARI in under-five children.<br>4. To provide evidence-based recommendations for public health interventions aimed at reducing the burden of respiratory infections in this vulnerable population | risk of ARI in under-five children was 44% lower in households that cooked food outdoors compared to those cooking inside the house.<br>3. Variability Among Surveys: There was a statistically significant difference in the prevalence of ARI among children across the three survey periods (2005, 2011, 2016).<br>4. Recommendations: The study suggests that promoting the use of improved stoves and alternative energy sources, integrating health and energy sectors, and behavior change interventions can help reduce respiratory infections among children in Ethiopia. |
| | A Cross-Sectional Analysis of the Association between Domestic Cooking Energy Source Type and Respiratory Infections among Children Aged under Five Years: Evidence from Demographic and Household Surveys in 37 Low-Middle Income Countries | Zubaidah Al-Janabi, Katherine E. Woolley G. Neil Thomas, and Suzanne E. Bartington | 1.To assess the relationship between household cooking energy sources (cleaner vs. biomass fuels) and the prevalence of acute respiratory infections (ARI) and acute lower respiratory infections (ALRI) in children under five years old.<br>2. To investigate the potential | 1.Prevalence of Respiratory Infections: The study found that a significant proportion of children under five years old in the included countries lived in households using solid fuel for cooking, with varying prevalence rates of acute respiratory infections (ARI) and acute lower respiratory infections (ALRI) reported.<br>2. Cooking Energy Source Types: The |

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| | | | impact of cleaner cooking technologies on reducing the burden of respiratory infections in low-middle income countries.<br>3. To identify key risk factors associated with respiratory infections in children, including household characteristics, maternal factors, and contextual variables.<br>4. To provide evidence-based recommendations for public health interventions and policies aimed at promoting cleaner cooking practices to improve respiratory health outcomes in children. | majority of households used solid fuel (biomass) for cooking, while a smaller percentage utilized cleaner cooking energy sources such as electricity, LPG, natural gas, and biogas.<br>3. Respiratory Infection Cases: The study identified a notable number of ARI and ALRI cases reported in the two weeks prior to the survey, indicating a burden of respiratory infections among young children in the studied countries.<br>4. Variation Across Countries: There was variation in the use of cleaner cooking energy sources and the prevalence of respiratory infections across the 37 lowmiddle income countries included in the analysis.<br>5. Risk Factors: The analysis considered various factors such as child characteristics, maternal factors, household wealth, cooking location, and urban/rural residence to assess their influence on the association between cooking energy sources and respiratory infections. |

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| | | | | 6. Association Between Cooking Energy Sources and Respiratory Infections: The study likely found associations between the type of cooking energy source used in households and the risk of ARI and ALRI in children under five years old, providing insights into the potential impact of cleaner cooking technologies on respiratory health outcomes |
| | Effect of household air pollution due to solid fuel combustion on childhood respiratory diseases in a semi urban population in Sri Lanka | Nayomi Ranathunga, Priyantha Perera, Sumal Nandasena, Nalini Sathiakumar, Anuradhani Kasturiratneand Rajitha Wickremasinghe | 1. To investigate the association between household air pollution from solid fuel combustion and the incidence of respiratory symptoms and diseases in children under 5 years old. 2. To assess the impact of different types of cooking fuel (biomass fuel and kerosene vs. LPG or electricity) on the respiratory health of children. 3. To examine the relationship between household air pollution exposure and the | 1. Incidence of Infection-Induced Asthma: Children residing in households using biomass fuel and kerosene had a significantly higher incidence of infection-induced asthma compared to children in households using Liquefied Petroleum Gas (LPG) or electricity for cooking. The relative risk (RR) for infection-induced asthma was 1.77 (95% CI: 1.098–2.949) in children exposed to biomass fuel and kerosene. 2. Factors Associated with Respiratory Health: Maternal education was significantly associated with the incidence of infection |

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| | | | incidence of infection-induced asthma in children.<br>4. To analyze the socioeconomic factors, parental education, parental occupation, and other household characteristics that may influence the respiratory health of children in a semi-urban population in Sri Lanka. | induced asthma, even after adjusting for confounders.<br>Male children had a significantly higher incidence of asthma compared to female children (RR = 1.17; 95% CI 1.01–1.37).<br>Risk factors for rhinitis included having an industry causing air pollution near the home and cooking inside the living area, while spending less time on cooking was a protective factor. |
| | Indoor air pollution in developing countries and acute lower respiratory infections in children | Kirk R Smitha, Jonathan M Sametb, Isabelle Romieuc, Nigel Bruced | 1. Conduct a critical review of the quantitative literature linking indoor air pollution from household use of biomass fuels with acute respiratory infections in young children.<br>2. Focus on acute lower respiratory infections and pneumonia in children under two years in less developed countries.<br>3. Assess the consistency and strength of the association between indoor air pollution from biomass fuels and | 1. Consistent Risk Increase: The studies reviewed show a strong and significant increase in the risk of acute respiratory infections in young children exposed to indoor air pollution from biomass fuels compared to those in households using cleaner fuels or having lower exposure levels.<br>2. Public Health Implications: The relative risks associated with indoor air pollution from biomass fuels are likely significant, considering that acute lower respiratory infections are a leading cause of death in children in less developed countries |

| | | | | |
|---|---|---|---|---|
| | | | the risk of respiratory infections in young children.<br>4. Determine the public health implications of the increased risk of respiratory infections in children exposed to indoor air pollution from biomass fuels.<br>5. Highlight the need for interventions and strategies to reduce the risks associated with household use of biomass fuels in less developed countries | and impose a substantial burden of disease globally.<br>3. Importance of Interventions: Even small additional risks due to air pollution from biomass fuels have important public health implications, highlighting the need for interventions and strategies to reduce exposure to indoor air pollution in households using biomass fuels.<br>4. Study Consistency: While not all studies were able to adjust for confounders, most that did so found strong and significant risks remained, indicating a consistent association between indoor air pollution from biomass fuels and respiratory infections in young children. |
| | Indoor Cooking Practices and Associated Health Factors Among Participants in the Dominican Republic and Nicaragua: A Collabor Collaborative Study Between Respir e Study Between Respiratory Therapy | Rachel Culbreth, Rachel Trawick, Jon Thompson, Douglas S. Gardenhire | The objective of the study on Indoor Cooking Practices and Associated Health Factors among participants in the Dominican Republic and Nicaragua was to determine factors associated with indoor cooking practices and specific vital | Differences in Indoor Cooking Practices: Variations were observed in indoor cooking practices, peak flow measurements, average heart rate, and SpO2 measurements between participants in Nicaragua and the Dominican Republic.<br>2. Factors Associated with Carbon Monoxide |

| | | | | |
|---|---|---|---|---|
| | | | signs across these two middle-income countries. The study aimed to investigate the relationship between indoor cooking practices, such as stove characteristics and smoking behavior, and health outcomes like carbon monoxide levels and systolic blood pressure | Levels: In Nicaragua, age and being male were predictors of higher carbon monoxide levels. This finding was contrary to the hypothesis that females, who traditionally perform cooking duties, would have higher carbon monoxide levels 3.Smoking Behavior: A small percentage of participants reported smoking, with a higher proportion of males reporting smoking. Future research should explore the interactions between smoking and indoor air pollution, particularly regarding gender differences. 4. Improved Cookstoves: The study found no association between improved cookstoves and carbon monoxide or systolic blood pressure levels. While improved cookstoves generally have health benefits, more research is needed to identify optimal interventions for specific cultures and regions. |

# CHAPTER IV
# METHODOLOGY

## 3.1 RESEARCH QUESTION

Is there an association between exposure to indoor air pollution from burning firewood for cooking and the incidence of acute respiratory infection in children under 5 years old living in the slums of Gandhidham City?

## 3.2 STUDY DESIGN

Community-based cross-sectional study design was conducted to examine the association of acute respiratory infections with biomass fuel exposure among under-five children in the Slum area of Gandhidham Gujrat, from Apr 01 to June 30, 2024.

## 3.3 SETTING

The study site is in Gandhidham city of the Kutch district of Gujrat. There are 10 slum colonies in Gandhidham city i.e. Sapna Nagar, Sector 5, Sector 6, Sector 7, Apna Nagar, Cargo, GDIC, PSL Cargo, Khodiyal Nagar, and Vava Jhodu.

## 3.4 STUDY POPULATION

A total of 100 households make up the study population for this investigation. These individuals were residing in the urban slum area of Gandhidham city. The slums of Gandhidham city are home to 88100 people, amongst which 9,624 are children under 5 years old.

## 3.4 INCLUSION CRITERIA

- Urban slum population of Gandhidham city
- Children under the age of 5 years
- Participants who consent to be part of the study.
- Households use solid fuel for cooking.
- Households without separate kitchen

## 3.5 EXCLUSION CRITERIA

- Children above the age of 5 years.
- Children with chronic respiratory diseases.
- Households use clean fuel for cooking.
- Children below the age of 2 months
- Households with separate kitchens and proper ventilation (windows, exhaust )
- Children whose guardians or parents withheld their consent were not included in the study.

## 3.7 DATA COLLECTION TOOL/ PROCEDURE

Data were collected through house to house visit with assistance of ASHA and AWW. Interviews lasted approximately 10-15 minutes. All the household with at least 1 child under age of 5 were enrolled. We obtained written informed consent from the mother of under-five children. To ensure a representative sample, the Taluka Health Office was contacted to obtain data on the census of children under five and slum colonies within Gandhidham City. The population of children under 5 years old in Gandhidham city is 9624, a total of 100 participants were interviewed who have consented to be part of the study. Information was collected on the sociodemographic characteristics and environmental aspects of the home, such as ventilation, cooking fuel type, parental smoking behaviors, and overcrowding.

## 3.8 DATA ANALYSIS TECHNIQUE/TOOL

Data collected was checked for any incompleteness or partial filling, and data cleaning andanalysis were done using Microsoft Excel and SPSS.

The analysis methodology encompasses the following key steps:

Data Cleaning: Carefully gathered data is cleaned to find and fix any inconsistencies, missing numbers, or anomalies. This guarantees that the dataset is ready for legitimate and correct analysis.

Descriptive Analysis: Key features of the study population and variables of interest are summed up and presented using descriptive statistics. A comprehensive summary is given by metrics likemeans, frequencies, and percentages.

Multivariate logistic Regression Analysis: The multivariate logistic regression analysis was carried out to identify the determinants of ARI. $p < 0.05$ was considered as statistically significant.

Statistical Software Utilization: Advanced statistical testing and modeling are supported by SPSS, whereas Microsoft Excel is useful for managing preliminary data and exploratory analysis. This two-pronged software strategy guarantees a solid study that can produce insightful results.

Interpretation and Reporting: The research questions and objectives of the dissertation are taken into consideration while interpreting the findings. Tables, charts, and narrative summaries are used to clearly explain the results, allowing for thorough comprehension and supporting the suggestions that are supported by the available data.

## 3.9 ETHICAL CONSIDERATIONS

Informed written consent was obtained from all the study participants. Before beginning the interview, all the participants were informed about the purpose of the study and obtained their consent. If anyone was not willing to be a part of the study, they were not forced by any means.All the participants were explained about how their data would be collected, stored, and used, and they were assured of the confidentiality of their data. Storage of the data was done on a secured server with password protection and restricted access.

## CHAPTER V

## RESULTS

The mothers' mean age was 24.25 years (±SD 6.37), while the children's mean age was 2.38 years (±SD 1.36).

***Table 5.1: Socio-demographic details of Children***

| **Demographic Details** | **N=100** | **%** |
|---|---|---|
| **Sex of Children** | | |
| Female | 49 | 49% |
| Male | 51 | 51% |
| **Age of Primary Caregiver** | | |
| <24 | 53 | 53% |
| >24 | 47 | 47% |
| **Occupation of Primary Caregiver** | | |
| Skilled Employee | 18 | 18% |
| Unskilled Employee | 10 | 10% |
| Self Employed | 18 | 18% |
| Housewife | 54 | 54% |
| **Maternal Education** | | |
| <6$^{th}$ std | 47 | 47% |
| >6$^{th}$ std | 51 | 51% |

Most of the houses in the study area were overcrowded and the majority of the households used clean fuels for cooking. Most of the children who had ARIs were exposed to parental smoke

**Housing Environment**

The overall prevalence of the ARI is 46.7%. Most of the mothers were literate and their educational status was not associated with the prevalence of ARI.

Overcrowding has existed in 43% of the households. A majority, i.e., 91% of the households were inadequately ventilated. The prevalence of indoor smoking was 3%. Out of the total households, 15% used unclean fuel.

The use of unclean fuel and parental smoking is significantly associated with the higher prevalence of ARIs. Inadequate ventilation did have a positive association with ARI.

***Table 5.2: Household Environmental Factor***

| **Variables** | | **N=100** | **%** |
|---|---|---|---|
| Type of Fuel | Clean | 83 | 83% |
| | Unclean | 15 | 15% |
| Overcrowding | Yes | 66 | 66% |
| | No | 33 | 33% |
| Ventilation | Yes | 5 | 5% |
| | No | 91 | 91% |
| Parental Smoking | Yes | 3 | 3% |
| | No | 97 | 97% |

# Chapter VI
# DISCUSSION

Bangladesh, India, Indonesia, and Nepal have been reported to be accountable for 40% of all ARI deaths worldwide(17). ARI ranks third among the leading causes of death for children under 5 in both developed and developing nations(18). According to previous research, the prevalence of ARI varies between 20 and 30%(19). The study found the prevalence of the ARI is 46.7%, which is similar to the previous studies. Research conducted in the Indian state of Karnataka found that less than 10% of children under five had ARI (17). The prevalence of ARI varies according to differences in the social, cultural, and environmental factors found in the various geographical regions. The development of ARIs is more common in under-five children living in homes with poor ventilation than in under-five children living in well-ventilated homes because poor ventilation suggests that indoor smoke is trapped and that toxic materials build up in the homes, affecting the children's respiratory systems.
(20). Similarly, this study also suggested inadequate ventilation do have positive association with the ARI. Smoke builds up in houses with poor ventilation when unclean fuels like coal, wood, dung, and crop residue are burned. Because they spend so much time inside, children under the age of five are particularly vulnerable to the damaging effects of smoking on their lungs, increasing their likelihood of experiencing ARIs on a regular basis. The study shows that use of unclean fuel is not very common in urban slums, however, few households still use unclean fuel either solely or along with the LPG. The prevalence of ARI is higher in households with exposure to parental smoking. Insufficient ventilation could potentially exacerbate the impact of smoke on the incidence of ARI (21). This study demonstrated that the prevalence of ARIs in boys and girls was equal, which was consistent with research done in urban regions of Eastern Indonesia(22). Although according to some research, boys are more likely than girls to get ARIs (23). Although education generally contributes to improving maternal caregiving knowledge of the risk factors causing ARIs, this study found no difference in the occurrence of ARIs among children born to mothers with different levels of education.

## 6.2 STRENGTHS OF THE STUDY

House-to-House Survey: Instead of the head of the household self-reporting, information about the home environment was gathered and verified during the house-to-house survey.

Support of ASHA and AWW: Support of the ASHA and the AWWs (health workers of the government sector) was sought in the data collection. They help in overcoming the language barrier and smooth communication.

## 6.3 LIMITATIONS OF THE STUDY

Limited Generalizability: The findings may not be generalizable to other regions or populations outside of Maharashtra, India, due to the specific geographical focus of the study.

Self-Reporting: Some data, such as parental smoking habits, were self-reported and subject to social desirability bias, potentially impacting the validity of the results.

Small Sample Size- Due to time restrictions of dissertation duration, the sample size of the study is limited, which may limit the generalizability of the study. The sample size does not indicate the whole population.

# CHAPTER VII
# CONCLUSION AND RECOMMENDATIONS

## 7.1 CONCLUSION

The findings of this study also affirm that Acute Respiratory Infections (ARI) are common among under-five children; weighted prevalence rate for ARI was 46.7%, which is consistent with the previous studies. Like other studies, poor ventilation and smoke from unclean fuels are identified as ARI risk factors. This study is among the few that did not find a relationship between maternal education and an increased risk of ARI . There was also no significant sex difference in the prevalence of ARI.

## 7.2 RECOMMENDATIONS\

Look at effects of particular unclean fuel types on ARI: Study indicates restricted use on unclean fuels but provides a distinction between sole use and combined with LPG Moreover, examining the impact of various dirty fuels (e.g. coal and wood) or combinations on prevalence rates would likely enhance conclusions for ARI.

Develop rural based research: The study is about urban slums. Studying ARI pattern and its determinants among the rural population having a high prevalence of non-clean fuel use

Examine the future burden of childhood ARI: This research investigated existing prevalence for prompt illness. It would be interesting to study the effects of early childhood ARI on health outcomes with follow up studies that are conducted over time.

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# ANNEXURE

# Assessing Indoor Air Pollution Exposure and Acute Respiratory Infection in Children Under 5 in Urban Slum Areas of Gandhidham City: A Community-Based Study

* Indicates required question

## Demographic Details

1. **Name of primary caregiver** *

_____

2. **Age of the caregiver** *

_____

3. **Age of Child**

_____

4. **Sex of Child**

**Mark only one oval.**

- ◯ Male
- ◯ Female

5. **Address** *

6. **Occupation of primary caregiver** *

**Mark only one oval.**

- ◯ Skilled Employe
- ◯ Unskilled Employee
- ◯ Self Employed
- ◯ Unemployed
- ◯ Other: _____

7. **Number of household members**

_____

8. **Is their any child below 5 years old?**

**Mark only one oval.**

- ◯ Yes
- ◯ No

Household Characteristics

## 9. Type of Household

**Mark only one oval.**

- ◯ Pukka Makaan
- ◯ Kutcha Makaan

## 10. Number of rooms

**Mark only one oval.**

- ◯ 1
- ◯ 2
- ◯ Other: _____

## 11. Is the cooking usually done in the house, in a separate building, or outdoors?

*Check all that apply.*

- ☐ IN THE HOUSE
- ☐ IN A SEPARATE BUILDING
- ☐ OUTDOORS
- ☐ Other: _____

## 12. Do you have a separate room which is used as a kitchen?

**Mark only one oval.**

- ◯ Yes
- ◯ No
- ◯ Other

**Mark only one oval.**

- ◯ Yes
- ◯ NO

## 14. If yes, what type of ventilation

*Check all that apply.*

- ☐ Exhaust fan
- ☐ Windows
- ☐ Chimney
- ☐ Outside cooking
- ☐ Other: _____

Cooking Practice

## 15. In this household, is food cooked on a stove, a chullah, or an open fire?

*Check all that apply.*

- ☐ Stove
- ☐ Chullah
- ☐ Open fire

- [ ] Electricity
- [ ] LPG or Natural Gas
- [ ] Biogas
- [ ] Kerosine
- [ ] Coal/Lignite
- [ ] Charcoal
- [ ] Wood
- [ ] Straw/Shrubs/Grass
- [ ] Agricultural crop waste
- [ ] Dung cake
- [ ] Other: _____

17. **How many hour you spend in cooking in a day**

_____

Acute Respiratory infections

18. **Do the children suffer from any respiratory infection in last 1 year**

**Mark only one oval.**

- ◯ Yes
- ◯ No
- ◯ Other: _____

- [ ] Common cold
- [ ] Coughing without sputum
- [ ] Coughing with sputum
- [ ] Wheezing (Breathing making high pitched whistling sound) Fever
- [ ] Ear infection
- [ ] Skin rashes

20. **Do these symptoms last for more than 2 weeks**

**Mark only one oval.**

- ◯ Yes
- ◯ No
- ◯ Other: _____

21. If yes, which symptoms

_____

22. How often these symptoms occured in past 1 years

_____

23. Did the child require medical attention due to these symptoms

**Mark only one oval.**

- ◯ Yes
- ◯ No

24. **If yes, how often**

25. Did the child require hospital admission due to these symptoms

**Mark only one oval.**

- Yes
- No

26. **Do you have any medical history record for this**

**Mark only one oval.**

- Yes
- No

KAP

27. **Age of the mother**

28. Maternal Education

**Mark only one oval.**

- Less then 10th
- 10th Class
- 12 Class
- 12 Class and above

29. **Do you seek medical attention post the presentation of the symptoms**

**Mark only one oval.**

- Yes No
- Other:
- _____

30. **where do you seek medical guidance from the**

**Mark only one oval.**

- Doctors
- Chemists
- Quacks
- Home remedies
- Self medication
- Other: _____