Section: Pediatrics

Original Research Article

A PROSPECTIVE CASE CONTROL STUDY OF MODIFIABLE RISK FACTORS FOR ACUTE LOWER RESPIRATORY TRACT INFECTIONS IN CHILDREN AGED LESS THAN FIVE YEARS

Dr. Ahlaam Arif[1], Mohammad Fahad Mohiuddin[2], Fatima. Nasir[3], Mohd Muthiuddin Muzammil[4]

[1]Assistant Professor, Department of Pediatrics, Princess ESRA Hospital, DCMS, Hyderabad, India.
[2]Senior Resident, Department of Pediatrics; Princess ESRA Hospital, DCMS, Hyderabad, India.
[3]Assistant Professor, Department of Pediatrics, Princess ESRA Hospital, DCMS, Hyderabad, India.
[4]Senior Resident, Department of Pediatrics, Princess ESRA Hospital, DCMS, Hyderabad, India.

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Corresponding Author:
Dr. Ahlaam Arif,
Email: drahlaam@gmail.com

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Abstract

Background: Acute Lower Respiratory Tract Infections (LRTIs) are a significant global health concern, particularly prevalent in overcrowded and under-resourced regions. In India, they rank among the leading causes of illness and death, affecting vulnerable populations like children and the elderly. Challenges such as air pollution and limited healthcare access compound the problem. Urgent measures are needed to improve prevention, diagnosis, and healthcare infrastructure to mitigate the impact of LRTIs both worldwide and in India. **Aims and Objectives:** The aim of the present study was to identify various modifiable risk factors for acute lower respiratory tract infections (ALRTI) in children aged 2 month to 5 years. **Materials and Methods:** 100 ALRTI cases fulfilling WHO criteria for pneumonia, in the age group of 2 month to 5 year were interrogated for potential modifiable risk factors as per a predesigned proforma. 100 healthy control children in the same age group were also interrogated. **Results:** Socio-demographic risk factors like overcrowding, partial immunization and low socioeconomic status were potential risk factors similarly nutritional risk factors like administration of prelacteal feeds, late weaning, anemia, rickets and malnutrition were associated with ALRTI. Significant environmental risk factors were biomass fuel pollution, lack of ventilation, family history of smoking, and not having separate kitchen. **Conclusion:** The present study has identified various socio-demographic, nutritional and environmental modifiable risk factors for ALTRI which can be tackled by effective health education of the community and leading to a healthy community and a healthy nation as a whole.

INTRODUCTION

Acute Respiratory Infection.

Acute lower respiratory infections affect the airways below the epiglottis and Acute Lower Respiratory Tract Infection (LRTI) refers to infections affecting the airways below the larynx, including bronchi and lungs and include severe infections, such as pneumonia, bronchiolitis, croup etc. Common types include bronchitis and pneumonia, often caused by viruses or bacteria. Pathophysiology involves inflammation of the airways, leading to symptoms like cough, chest pain, and difficulty breathing. Clinical features vary but may include fever, productive cough, and wheezing. Management typically involves supportive care, including rest, hydration, and over-the-counter medications for symptom relief. Antibiotics may be prescribed for bacterial LRTIs, while antiviral drugs are used for viral cases. Severe cases may require hospitalization for oxygen therapy or intravenous fluids. Prevention strategies include vaccination, hand hygiene, and avoiding exposure to known respiratory pathogens.

As per data gathered in 2010, 7.6 million children who died in first 5 years of their life, 64% (4.8 million) died of infectious causes. Of all infectious disorders, pneumonia, diarrhoea and malaria were the leading cause of death worldwide- of all deaths in children younger than 5 years, pneumonia alone caused- 1.396 million deaths (Data as per year 2010).[1] Present UNICEF data estimated that pneumonia is killing 2,500 children a day.

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Pneumonia accounts for 16 per cent of all under-five deaths and killed 922,000 children in 2015. Most of its victims were less than 2 years old.[2] Acute lower respiratory tract infection is responsible for 19% of all deaths in children below 5 years globally and 82% of all disabilities and premature mortality as measured by disability adjusted life years (DALY).[3] The annual worldwide incidence of pneumonia is estimated at 151 million new cases per year. Latest UNICEF data also show annual child deaths from pneumonia decreased by 47 per cent from 2000 to 2015—from 1.7 million to 920,000—but many more lives could be saved. Mortality due to childhood pneumonia is strongly linked to poverty-related factors such as under-nutrition, lack of safe water and sanitation, indoor air pollution and inadequate access to health care. As per recent UNICEF estimates it was believed that 6 out of 10 deaths due to pneumonia were concentrated in 10 countries and India being one of the 10 countries2. 1 in 6 deaths were due to pneumonia in 2015 accounting to 9,22,000 per year, 2,500 per day or 100 per hour deaths.

According to WHO estimates, respiratory infections caused about 987, 000 deaths in India, of which 969,000 were due to acute lower respiratory tract infection.[4] The burden that pneumonia places on families and health system in low resource countries in turn exacerbates inequalities; overwhelmingly, children who are poor, hungry and living in remote areas are most likely to be visited by this "forgotten killer".[5] Apart from infectious agent, child's genetic and immunological status, certain other factors like malnutrition, low birth weight, and duration of breast feeding have been identified as pneumonia risks. Some other inciting factors are smoking habit of parents, parental literacy, household crowding, indoor smoke pollution.[6,7]

Many of these risk factors are amenable to corrective measures. Therefore, knowledge of these risk factors related to acquisition of ALRI will help in its prevention, through effective health education of community and appropriate initiative taken by the government, leading to a healthy community and healthy nation as a whole. However, evidence on the association between these factors and pneumonia in children is scarce in this region. Therefore it was prudent to undertake this study to identify various modifiable risk factors for ALRTI in underfive children admitted to Princess Esra Hospital, Hyderabad, Telangana.

MATERIALS AND METHODS

Setting: The present study was carried out at Department of Pediatrics, Princess Esra Hospital, Hyderabad.

Design: The present study was a hospital based prospective case control study

Sample Size: 100 children suffering from ALRI as ascertained by WHO criteria, of age below five years, of both genders, admitted in paediatrics wards or paediatric intensive care unit of Princess Esra Hospital will be taken as 'cases'. An equal number of age matched healthy children who were normal siblings of admitted children for non-respiratory complaints as well as those attending immunization clinic and OPD for non-respiratory complaint to the same hospital during study period without previous history of severe or very severe pneumonia were taken as "controls".

Inclusion Criteria

- Cases of ALRTI as defined by WHO from 2 months to 60 months of age of both genders.
- Matched children without previous history of severe or very severe pneumonia as Controls.

Exclusion Criteria

- Children less than 2months and more than 60 months
- Children with clinical diagnosis of bronchial asthma
- Children with congenital heart disease.
- Children with pulmonary tuberculosis, cystic fibrosis, immunodeficiency, aspiration pneumonia, foreign body inhalation and any other chronic illness.
- Parents not willing to co-operate.

Methodology

A Verbal, informed consent of the child's care taker was obtained in both cases and controls. For both cases & controls a detailed history and physical examination was done according to a predesigned proforma to elicit various potential risk factors. Age of the child was recorded in completed months and age of parents in completed year. A detailed history of relevant symptoms like fever, cough, rapid breathing, chest retraction, refusal of feeds, lethargy, wheezing etc., was taken. Past history of similar complaints was also taken. History of immunization was elicited from parents and verified by checking the documents wherever available. History of breastfeeding and weaning was recorded. Dietary intake of child prior to current illness was calculated by 24 hour Dietary recall method. History of upper respiratory tract infection in the family members in the preceding 2 week was recorded. History of smoking by various family members and details of cooking fuel used was recorded. Details of the housing conditions were also obtained. Socioeconomic status grading was done according to Modified Prasad's classification. A detailed clinical examination of each child was carried out. Respiratory rate and heart rate were measured for one minute, when the child was quiet. A detailed anthropometry was done and malnutrition was graded according to Indian academy of Pediatrics classification. Severity of respiratory distress was assessed in each child. Anemia and other signs of vitamin deficiencies were recorded. A detailed systemic examination was done in both cases and controls. Routine haematological investigations were done in all cases, Chest x ray was done in all

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cases to know the type of ALRTI and other specific investigations were done as per individual case requirement and all the cases were treated as per the standard protocol depending on the type of ALRTI.

Statistical Analysis: Data was managed on Microsoft® Excel spreadsheet, all the entries were double checked and analysis was performed using SPSS version 15 software package.

RESULTS

The various risk factors for ALRTI were broadly classified under 3 headings – socio-demographic variables, nutritional variables and environmental variables. The age and sex distributions were comparable between cases and controls. [Table 1]

SOCIO DEMOGRAPHIC VARIABLES

In our study, we found that the incidence of ALRTI among the infants was 47%. P value being 0.740 it was statistically not significant. (see table 2)

Sex distribution

In our study, we found that 62% of male children and 38% of female children were suffering from ALRTI. The sex wise distribution in control group was 52% as male children and 48% as female children. (see table 2)

Of the studied 100 cases with ALRTI, 39 children had bronchiolitis, 25 children had bronchopneumonia, 30 children had Lobar pneumonia and 5 children had Wheeze associated with lower respiratory infection (WALRI). Croup was diagnosed in 1 child. (see table 3)

Unfortunately, in our entire study one child died due to severe pneumonia associated with severe malnutrition. The other patients improved before discharge from the hospital.

Socio demographic variables when compared between the two groups, there were significantly higher number of illiterate mothers in cases as compared to controls 22% vs. 8% with a p value of 0.006 which was significant. Mother's literacy was quite high in control group which shows that education is an important contributing factor for a child's well-being in terms of mother's having relevant knowledge of care seeking at earliest with early signs of infection. [Table 4]

Similarly more fathers were illiterate in test group as compared to controls (4% vs. 2%) with a 'p' value of 0.001 which was statistically significant. Father's literacy like mother's literacy is also an important criteria for a healthy development of a child in a safe and a healthy environment.

Inappropriate immunization for age was significantly associated as a risk factor in 32% of children in test group with ALRTI as compared to 10% of children in control group without ALRTI. It is highly significant with a 'p' value of 0.000 and Chi square (X2) of 14.587.

Similar to earlier studies, we also found a similar correlation with number of under 5 years of age children dwelling at the same time affecting with increased incidence of ALRTI. It was noted that families having more than two under five children at home, were significantly associated with ALRTI in test as compared to controls (36% vs. 14%) with a 'p' value of 0.001 it is statistically very highly significant.

Similarly, overcrowding is significantly associated with ALRTI in test group when compared to controls (60% vs. 15%) and the results were statistically highly significant with a 'p' value of 0.000 and a Chi square of 43.20.

Our hospital caters to more of lower middle class and other lower class families. In our study we found that ALRTI cases were more from upper lower and lower classes (class 3-37%, class 4-50%, class 5 -13%). The results were found to be statistically significant with a 'p' value of 0.003 and a chi square value of 11.625.

We found that 35% children who presented to us with confirmed ALRTI had a positive family history of upper respiratory tract infection in the preceding two weeks. The control group gave no such history. The 'p' value of 0.000 was considered statistically highly significant and we had a chi square value of 42.424.

NUTRITIONAL VARIABLES

We found that 15% of children in test group received prelacteal feeds as compared to 2% in controls. With a 'p' value of 0.001 and a Chi square of 10.86 it was considered statistically significant.

Among the nutritional variables compared between the test group and control group early (11% vs. 6%) and late weaning (49% vs. 14%) had a significant association with ALRTI ('p' value of 0.000). It is statistically highly significant.

Anemia as a risk factor was also significantly present in 40% of cases as compared to 5% of controls ('p'< 0.000). It is statistically very highly significant.

Malnutrition was significantly present in 53% of cases as compared to 2% of controls with a p value of 0.001 and was statistically very highly significant.

Infants with a history of low birth weight appeared to have significant association with ALRTI occurrence, in test group 16% vs. 3% as compared to controls with a 'p' value of 0.001. It is statistically very highly significant. 20% children in test group and 2% children in control group had unrecorded birth weight. These children were not taken for analysis with respect to birth weight as a risk factor for the study. However there were significant number of children with low birth weight who presented to us with ALRTI suggesting low birth weight as a significant risk factor. [Table 5]

ENVIRONMENTAL VARIABLES

Our study did not show a co relation of mud flooring to increased number of ALRTI. 13% of children affected with ALRTI had mud flooring when compared to 16%. Majority of the children lived in cement flooring houses. As a result we could not come to a conclusion that ALRTI was

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directly associated to type of flooring. The 'p' value for the study of this variable was 0.547, which was statistically not significant.

We noticed a poor/inadequate ventilation in dwellings of 61% of children in test group when compared to 8% in control group. The 'p' value is 0.001 and is highly significant.

We found that kerosene was used as a source of lighting in 12% of children suffering from ALRTI when compared to 4% of controls. The 'p' value being 0.037 it is statistically not significant.

We found that cooking fuel other than liquid petroleum gas was strongly associated with ALRTI. Our results were able to show that 77% children suffered from ALRTI where firewood, cow dung and kerosene was used as a fuel for cooking whereas the figures were at 66 % in the control group. This was statistically significant as the 'p' value was 0.0006.

62% of children in the test group suffering from ALRTI did not live in a house where they had a separate kitchen. Most of these children belonged to class 4 and class 5 socio economic class. The food was cooked in the living place where they were exposed to smoke. The control group showed a lesser percentage (37%) of children where they had no separate kitchen. The 'p' being 0.000 this result was considered statistically highly significant.

Family history of smoking was seen in 30% of children who were admitted with ALRTI as compared to 8% of controls. The 'p' value being 0.002 it is statistically very highly significant. [Table 6]

Table 1: Number of children as per age group

Age	Test	Control	P Value
< 1 year	47	56	0.740
1 – 5 years	53	44	

Table 2: Sex distribution in both the study group

Sex	Control	Test	P Value
Female	48 (48%)	38 (38%)	0.153
Male	52 (52%)	62 (62%)	

Table 3: Final diagnosis of the children in the Test group

Diagnosis	Test
Bronchiolitis	39 (39%)
Broncho Pneumonia	25 (25%)
Croup	1 (1%)
Lobar Pneumonia	30 (30%)
WALRI	5 (5%)

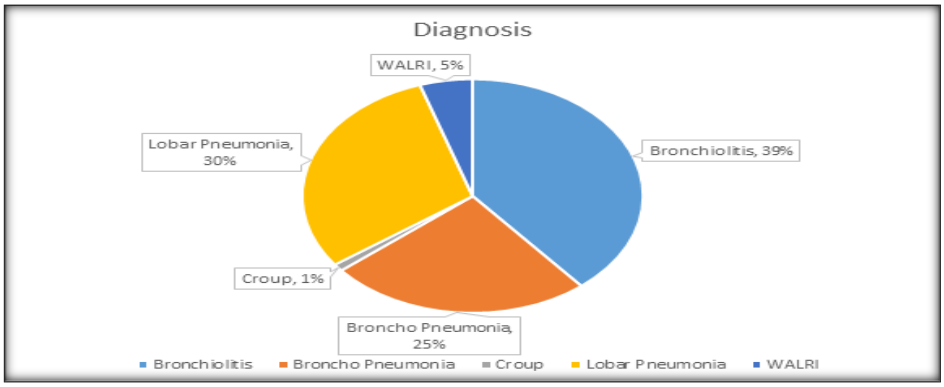

Figure 1: Final diagnosis of the children in the Test group

Table 4: Number of cases of Socio Demographic Variables

Socio Demographic Variables		Control	Test	P Value
Mother's Literacy	Illiterate	8	22	0.006*
	Literate	92	78	
Father's Literacy	No	2 (2%)	16 (16%)	0.001*
	Yes	98 (98%)	84 (84%)	
Immunization	Complete	90 (90%)	68 (68%)	0.000*
	Incomplete	10 (10%)	32 (32%)	
Children under 5 years of Age	< 2	86 (86%)	66 (66%)	0.001*
	> 2	14 (14%)	34(34%)	
Overcrowding	No	85 (85%)	40 (40%)	0.000*
	Yes	15 (15%)	60 (60%)	
Socioeconomic Class (SEC)	Class 3	54 (54%)	37 (37%)	0.003*
	Class 4	44 (44%)	50 (50%)	
	Class 5	2 (2%)	13 (13%)	

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Family h/o URTI	None	100 (100%)	65 (65%)	0.000*
	Father	0 (0%)	3 (3%)	
	Mother	0 (0%)	7 (7%)	
	Siblings	0 (0%)	25 (25%)	

Table 5: Nutritional Variables

Nutritional Variables		Control	Test	P Value
Prelacteal Feeds	Given	2 (2%)	15 (15%)	0.001*
	Not Given	98 (98%)	85 (85%)	
Weaning (Age in Months)	< 4	6 (6%)	11 (11%)	0.000*
	4 to 6	80 (80%)	40 (40%)	
	> 6	14 (14%)	49 (49%)	
Anemia	Absent	95 (95%)	60 (60%)	0.000*
	Present	5 (5%)	40 (40%)	
Malnutrition	Absent	98 (98%)	47 (47%)	0.001*
	Present	2 (2%)	53 (53%)	
Birth Weight	< 2.5 kgs	3 (3%)	16 (16%)	0.001*
	> 2.5 kgs	95 (95%)	64 (64%)	
	Not known	2 (2%)	20 (20%)	

Table 6: Environmental Variables

Environmental Variables		Control	Test	P Value
Flooring	Cement	84 (84%)	87 (87%)	0.547
	Mud	16 (16%)	13 (13%)	
Ventilation	Adequate	92 (92%)	39 (39%)	0.001*
	Inadequate	8 (8%)	61 (61%)	
Lighting	Electricity	96 (96%)	88 (88%)	0.037
	Kerosene Lamp	4 (4%)	12 (12%)	
Fuel Used	Cow dung	0 (0%)	1 (1%)	0.0006*
	Firewood	46 (46%)	63 (63%)	
	Kerosene	20 (20%)	13 (13%)	
	LPG	34 (34%)	23 (23%)	
Separate Kitchen	No	37 (37%)	62 (62%)	0.000*
	Yes	63 (63%)	38 (38%)	
Family h/o smoking	Absent	92 (92%)	70 (70%)	0.0002*
	Present	8 (8%)	30 (30%)	

DISCUSSION

I) SOCIO-DEMOGRAPHICAL VARIABLES

In our study most of ALRTI cases are infants constituting almost 47% of our test group, which goes in accordance with previous studies by Savitha et al13 and Thamer et al,[14] where infants with ALRTI constituted 62.5% and 58.4% respectively. A study done by Cunha et al,[15] reported that age less than one year was a risk factor for respiratory morbidity. The next age group, which had higher numbers, was 15 patients belonging to the age group of 21 months to 30 months. ALRTI was more commonly seen in males constituting 62% of the test group than female sex who were the rest 38%. Similar results were also found in Savitha et al,[13] Thamer et al,[14] and Broor et al,[16] studies. Their studies showed figures of 64.42%, 65.8% and 73.1% respectively. A study done by Hamid et al in Pakistan showed that there was a significant association between low parental education status and occurrence of ALRI.[17] Low educational level in mothers was found to be associated with increased risk of ALRI hospitalizations and mortality in a study in Brazil.[18] In our study 22% of mothers were illiterate which was in the range of Thamer et al,[14] and Broor et al,[16] studies. They showed an illiteracy rate of 16.2% & 34.8% respectively. Savitha et al,[13] study shows a strong association between the mother's illiteracy (63.49%) and the occurrence of ALRTI. Victora CG et al18 in a case control study showed that father's education was more strongly correlated than the mother's education. In our study only 16% of father's were illiterate, similar to Thamer et al,[14] & Broor et al 16 studies who showed father's illiteracy rate of 16.2% & 17.4% respectively. Savitha et al,[13] study showed (59.6%) strong association between the father's illiteracy and the occurrence of ALRTI. In our study 32% children were partially/incomplete immunized, these figures were similar to Savitha,[13] & Thamer,[14] et al studies which showed that 21.15%& 38.2% respectively. Broor et al,[16] study showed that more 69% children were partially immunized and suggested that these unimmunized or partially immunized children are at a high risk of development of ALRTI. In present study 34% of cases families were having more than two under five children at home similar to Savitha,[13] Broor et al,[16] studies, who showed that 39.2% & 30.77% of their study group lived in homes with more than two children. Compared to our cases only 14% of controls had more than 2 under 5 children at home. The results we obtained were statistically significant. In our study 60% cases are associated with overcrowding. Whereas Savitha,[13] Sikolia,[12] & Thamer et al,[14] studies showed slightly more cases are associated with overcrowding which were

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91.35%, 80.87% and 71.6% respectively. With a p value of 0.000 these results were also statistically significant. In a study by Rahman MM et a1,[19] in Bangladesh observed that poverty was significantly associated with occurrence of pneumonia in children. Savitha et al,[13] study showed significantly more (93.27%) children are belonging to low socioeconomic status. In present study 63% of children are living under low socioeconomic status (class 4 and class5). Similar results were found by Cunha AL et al.[15] In our study only 46% of controls belong to low socioeconomic status, when compared to 61% of families.

The present study finding was similar to above study findings. These results probably explain that low socio-economic status leads to less access to social, human and material resources leading to more ignorance and more prone for infections.

We found that 35% children admitted had a positive family H/O upper respiratory tract infection (<2week). Similar results were found in Broor (40%) et al,[16] study. However, study done by Savitha et al,[13] shows fewer (9%) cases associated with family H/O upper respiratory tract infection. Our control group did not have any positive family H/O upper respiratory tract infection.

II) NUTRITIONAL VARIABLES

In our study 15% of test group had history of administration of prelacteal feed as compared to 2% in control group. Savitha et al,[13] and Broor et al,[16] studies showed a higher rate of 31.73% & 27.4% prelacteal feeds administration respectively. Among children hospitalized with pneumonia in Rwanda, breast feeding was associated with a 50% reduction in case fatality. Savitha,[13] Broor,[16] et al studies showed that early weaning 37.5% & 39.4% before 4 months of age and late weaning 20.19% & 27.4% after 6 months of age were significantly associated with ALRTI. But our study differs from these studies wherein we showed that 49% of children in test group had late weaning and was significantly associated with ALRTI and only 11% of children in the test group had early weaning (< 4 months). Anemia was a very significant risk factor for ALRTI in Savitha,[13] (79.92%), Ramakrishnan 20 (74%) and Shah 21 (55.5%) et al studies. They observed that low haemoglobin level as a risk factor and found that anemic children were 5.75 times more susceptible to ALRI. Similarly, Malla T et al,[22] study showed that anemic patients were 3.2 times more susceptible. We were able to show in our study that 40% of children in test group were associated with anemia, which is less when compared to other studies. In the control group only 5% children had anemia, when compared to 42% in cases. This finding was statistically found to be significant. A study in New Delhi by Sehgal et al,[23] revealed severe malnutrition as the predictor of mortality in ALRI in underfive children. Similar study conducted by Broor S et al,[16] observed that children with severe malnutrition were at 1.85 times (OR 1.85; 95% CI 1.14-3.0) greater risk of developing ALRI as compared to children with mild or normal nutritional status. Overall, malnutrition is associated with a two to three fold increase in mortality from ALRI. Presence of malnutrition was also significantly associated with ALRTI in our study with 53% children in the test group were found to be malnourished, similar to Broor et al,[16] (40.1%). Savitha et al 13 in her study showed higher number (62.71%) of children who were suffering from ALRI were associated with malnutrition. We noted that only 2% of children in the control group are associated with malnutrition when compared to test group cases where it is 53%. The results were statistically significant as the p value was 0.001. Children with a history of low birth weight appeared to have more risk of severe pneumonia with an odds of 1.74. This result is in agreement with Taylor et al,[24] Chan et al.[25] This might be due to poor pulmonary function and low immunity in low birth weight babies which makes them more liable to have ALRI mainly in its severe form. We in our study found an association of 16% of children with low birth weight with ALRTI. Similar results were also seen in a study by Thamer et al,[14] (17.2%). But in Savitha et al,[13] showed only 9% of ALRTI children had low birth weight.

III) ENVIRONMENTAL VARIABLES

A study conducted by Sikolia et al,[12] in Nairobi (Kenya) observed that poor housing conditions of family was associated with increased risk of ALRI in children. Similar results were reported by Savitha et al.[13] But studies conducted by Broor S et a1,[16] have shown that there was no significant association between housing conditions and respiratory infections. In our study we found that 13% of children admitted with ALRTI were living in houses whose flooring was made up of mud, which was similar (12.9%) to Broor et al,[16] Savitha et al,[13] in her study showed 61. 54% of children suffering from ALRTI had mud & cow dung as a flooring in their house. Mud floorings were found to be less in our study and did not find even single case with cow dung flooring. Children living in houses that are well ventilated have lesser chances for development ALRTI. In our study we found that 61 % of children suffering from ALRTI did not have adequate ventilation in their houses. However the results of study done by Savitha et al,[13] differ from our results wherein only 32.7% children with ALRTI had inadequate ventilation. The results were statistically highly significant. In a systematic review and meta-analysis of 24 studies by Mukesh et al 26, it has been shown that risk of pneumonia in young children is increased by exposure to unprocessed solid fuels by a factor of 1.8. Our results showed 76% of children in the test group used biomass fuels like firewood, cow dung and kerosene as a fuel for cooking, which was similar to the studies of Sikolia (71.2%) et al,[12] study. In our study we found that electricity was the main source for lighting in 88% of families of test group, kerosene lamp was used in 12% of families of the

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test group. Savitha et al,[13] study showed slightly higher number of people using kerosene lamp. The emission from these lamps leads to a condition called as "Chemical Pneumonitis" About 62% of families of children in the test group suffering from ALRTI did not have a separate kitchen and cooking was done in the living place, leading to bulk emissions being released into the living area, this was also seen in 69.85% cases in a study conducted by Sikolia et al.[12] In the present study family history of smoking is seen in 30% of test group when compared to 8% in control group. Broor et al,[16] also showed similar finding (32.8%). But studies conducted by Savitha et al,[13] in India have shown there was no significant association between parental smoking and respiratory infections.

CONCLUSION

In our study, we were able to identify many modifiable risk factors for ALRI in children under five. The significant socio demographic risk factors were Parental illiteracy, families having more than two underfive children at home, low socioeconomic status, overcrowding and partial immunization. The significant nutritional risk factors were administration of pre lacteal feeds, late weaning, anemia, and malnutrition. The significant environmental risk factors were biomass fuel pollution and lack of ventilation, family history of smoking, and not having a separate kitchen. The above risk factors can be tackled through effective health education of the community and appropriate initiatives taken by the government leading to a healthy community and a healthy nation as a whole.

Ethical Clearance: Ethical clearance was obtained from the institutional ethical committee prior to commencement of study.

Conflict of Interest: Nil

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