

# Clinical profile of acute lower respiratory tract infections in children aged 2–60 months: An observational study

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## ABSTRACT

**Background:** Assessment of risk factors and clinical profile for acute lower respiratory tract infections (ALRIs) with severe and very severe pneumonia in children <5 years age is obligatory. **Objective:** To study the clinical profile, risk factors, and clinical outcomes associated with ALRIs in children aged 2–60 months. **Methodology:** In total, 130 children of either gender, diagnosed with ALRIs, admitted in a tertiary care hospital were enrolled. Demographic data and clinical history was collected. Clinical profile data such as respiratory and heart rate, oxygen supplementation, ventilator use, and lab investigation such as erythrocyte sedimentation rate, hemoglobin, total leucocyte count, differential leucocytes count, and blood culture were analyzed and noted. **Results:** The study findings demonstrated male gender predominance for ALRIs with 1.3:1 male to female ratio. Around 16% of them had pneumonia, 61% had severe pneumonia, and 23% had very severe pneumonia. The birth weight of child, maternal and paternal literacy, socioeconomic status, overcrowding at home, immunization status of children, type of kitchen and fuel used for cooking, malnutrition, anemia, and need for oxygen supplementation were found to be associated with the occurrence of ALRIs ( $P < 0.05$ ). Most of the presented symptoms were cough (100%), breathlessness (96.92%), and fever (92.31%). Bronchiolitis (63%), bronchopneumonia (27%), and lobar pneumonia (25%) were the major clinical outcomes. **Conclusion:** The study identified various sociodemographic, environmental, and nutritional risk factors for ALRIs along with the clinical profile, which can be managed by effective peripheral health personnel's training and persuasive community health education.

**Keywords:** Birth weight, bronchopneumonia, cough, infant, risk factors

## Introduction

Acute lower respiratory tract infections (ALRIs) are the substantial cause of morbidity and mortality in children, especially in developing countries.<sup>[1,2]</sup> Pneumonia and bronchiolitis are most common among children.<sup>[3]</sup> Worldwide, around 18% of annual deaths in children below 5 years of age occur due to pneumonia. Around 20% pneumonia deaths occur in developing countries and 4.3% occur in developed countries.<sup>[4]</sup> In India, 0.21% pneumonia deaths occur among children per year.<sup>[5]</sup>

Severe and very severe pneumonia are its most virulent forms and are characterized by the presence of central cyanosis, chest in-drawing, convulsions, and lethargy.<sup>[5]</sup>

On an average, about five episodes of ALRIs occur per year in children below 5 years and most of the recurrences are self-limiting and mild. Yet, they cause about 20–40% hospital admissions and 30–50% of visits to health facilities.<sup>[6]</sup>

ALRIs are a group of infections with different risk factors and are affected by sociodemographic, environmental, and sociocultural factors in terms of morbidity and mortality.<sup>[7,8]</sup>

Most of the population-based studies have focused on studying the clinical profile, risk factors, and outcomes of ALRIs in adults.<sup>[9]</sup> Hence, there is a dearth of literature in pediatric groups,

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especially in the first 5 years of life.<sup>[8]</sup> Thus, this study was aimed to perform an observational study on the clinical profile, risk factors, and outcomes of ALRIs in children aged 2–60 months.

## Materials and Methods

With the institutional ethics committee's approval and written informed consent from their parents, this single-centered, hospital-based, prospective, observational study was conducted in the Department of pediatrics at a private medical college in Karad for 2 years (2017–2019). To show a medium difference as statistically significant, we needed to choose a medium effect size (Cohen's- $w$ ). With a medium effect size ( $w = 0.8$ ), 80% power at 95% confidence level, we required a sample size of  $\sim 12$  for Chi-square test of independence with  $df\ 2\ (2-1 \times 3-1)$ . Based on the availability of the patient pool, the final sample size was made up to 130.

In total, 130 children of either gender, aged between 2 and 60 months, diagnosed with ALRIs (viz., pneumonia [P], severe pneumonia [SP], and very severe pneumonia [VSP] as per WHO criteria)<sup>[10]</sup> were included in the study. Children with underlying pulmonary tuberculosis or heart diseases were excluded from the study.

A case of ALRI was defined according to the acute respiratory infection control program as, "presence of cough with fast breathing of more than 60 breaths/min at  $< 2$  months of age, more than 50/min at 2–12 months of age, and more than 40/min at 12–60 months (5 year) of age, the duration of illness being less than 30 days." The presence of lower chest wall in-drawing was taken as SP. The presence of central cyanosis, lethargy, refusal of feeds, or convulsions was taken as VSP.<sup>[11]</sup>

Data including detailed history of relevant symptoms, history of similar complaints, immunization, breastfeeding and weaning, family history of upper respiratory tract infection (URTI) in the preceding 2 weeks, smoking, and cooking fuel details were recorded. The dietary intake of the child prior to current illness was calculated by 24-h dietary recall method. Grading of housing conditions, socioeconomic status was done according to Modified Kuppaswamy classification.<sup>[12]</sup> Malnutrition was graded as per Indian Academy of pediatrics in the year 1972.<sup>[13]</sup>

## Clinical examination

During a detailed clinical examination, the respiratory, heart rates, and anthropometry measures were measured by standard techniques. Signs of pallor and vitamin deficiencies were also recorded.

Routine blood investigations such as erythrocyte sedimentation rate, hemoglobin, and total leucocyte count were performed. Chest X-ray was performed to examine the type and site of associated complications. Blood was collected from vein for culturing and isolation of the microorganisms. Based on the organisms isolated from the culture and their sensitivity reports,

an etiological diagnosis was established. Daily clinical monitoring and data recording were done until discharge or death.

Statistical analysis was performed using R software (Version. 3.6.0). The qualitative variables were analyzed using Chi-square test of independence. Ordinal logistic regression was used to predict an ordinal-dependent variable given one or more independent variables at 95% confidence interval.

## Results

The present prospective study was carried out in 130 children diagnosed with ALRIs, i.e., P (16%), SP (61%), and VSP (23%). Majority of them were 13–60 months old (60%) with a male predominance and male to female ratio of 1.3:1, stipulating that male children are more prone to ALRI as compared to female children.

No significant ( $P > 0.05$ ) association was observed between age, gender, smoking history in the family, and family history of URTI in the previous 2 weeks with the occurrence of ALRIs. However, birth weight of child, maternal and paternal literacy status, socioeconomic status of parents, overcrowding at home, and immunization status of children were found to be associated with the occurrence of ALRIs ( $P < 0.05$ ) [Table 1].

The type of kitchen and fuel used for cooking were significantly associated ( $P < 0.05$ ). However, the type of floor and cross ventilation had no association with the occurrence of ALRIs ( $P > 0.05$ ) as majority of the houses had pucca (solid) flooring and adequate cross ventilation [Table 2].

A significant ( $P < 0.05$ ) association was found between malnutrition, anemia status of the child, and the occurrence of ALRIs with SP mostly occurring in children with grade I and II malnutrition. Also, a significant ( $P < 0.05$ ) association was found between the occurrence of ALRIs and the need for oxygen supplementation as most of the children needed oxygen supplementation (80.6%). Ventilatory support was not required by majority of the children (81%) suffering from ALRIs. Most of the children were diagnosed with bronchiolitis (63%), bronchopneumonia (27%), and lobar pneumonia (25%). As most of the children showed an improved outcome (83%), no significant association was observed between occurrence of ALRIs and the type of outcome [Table 3]. Leucocytosis was observed in a small percentage (48%) of children, and no significant association with ALRI severity was noted. The blood culture status was mentioned in Table 3.

The birth weight contributed significantly as a risk factor in predicting the status of pneumonia ( $P < 0.05$ ) as when moving from a birth weight of  $\leq 2.5$  kg to a birth weight  $> 2.5$  kg; the odds of occurrence of pneumonia increased by 0.30 times. However, the weaning status did not contribute significantly ( $P > 0.05$ ) in the prediction of the pneumonia status [Table 4].

**Table 1: Association between sociodemographic risk factors and occurrence of ALRIs**

Sociodemographic risk factors	Clinical diagnosis (n=130)			Total	P <sup>c</sup>
	P (21) n (%)	SP (79) n (%)	VSP (30) n (%)		
Age (months)					
2-12	8 (15.38)	37 (71.15)	7 (13.46)	52	0.080
13-60	13 (16.67)	42 (53.85)	23 (29.49)	78	
Birth weight (kg)					
<2.5	4 (7.55)	33 (62.26)	16 (30.19)	53	<b>0.010</b>
>2.5	17 (22.08)	46 (59.74)	14 (18.18)	77	
Maternal literacy					
G	2 (100)	0 (0)	0 (0)	2	<b>0.000</b>
H/S	8 (36.36)	10 (45.45)	4 (18.18)	22	
ILL	2 (8)	12 (48)	11 (44)	25	
P/M	9 (11.11)	57 (70.37)	15 (18.52)	81	
Paternal literacy					
G	3 (42.86)	1 (14.29)	3 (42.86)	7	<b>0.000</b>
H/S	13 (35.14)	18 (48.65)	6 (16.22)	37	
ILL	1 (5.88)	9 (52.94)	7 (41.18)	17	
P/M	4 (5.8)	51 (73.91)	14 (20.29)	69	
Socioeconomic status (class)					
II	9 (64.29)	3 (21.43)	2 (14.29)	14	<b>0.000</b>
III	6 (12)	32 (64)	12 (24)	50	
IV	6 (9.38)	43 (67.19)	15 (23.44)	64	
V	0 (0)	1 (50)	1 (50)	2	
Smoking history in the family					
Yes	5 (17.86)	14 (50)	9 (32.14)	28	0.373
No	16 (15.69)	65 (63.73)	21 (20.59)	102	
Overcrowding at home					
Yes	10 (11.63)	49 (56.98)	27 (31.4)	86	<b>0.003</b>
No	11 (25)	30 (68.18)	3 (6.82)	44	
Family history of URTI in the previous 2 weeks					
Yes	8 (16.67)	27 (56.25)	13 (27.08)	48	0.671
No	13 (15.85)	52 (63.41)	17 (20.73)	82	
Immunization status					
AFA	20 (30.3)	34 (51.52)	12 (18.18)	66	<b>4.782e<sup>-05</sup></b>
IFA	1 (1.56)	45 (70.31)	18 (28.13)	64	

AFA: Appropriate for age; C: Chi-square test of independence; G: graduate; H/S: High school; ILL: Illiterate; IFA: Inappropriate for age; P: Pneumonia; P/M: Primary/Middle School; SP: Severe pneumonia; URTI: Upper respiratory tract infection; VSP: Very severe pneumonia

**Table 2: Association between indoor environmental risk factors and occurrence of ALRIs**

Indoor environmental risk factors	Clinical diagnosis (n=130)			Total	P <sup>c</sup>
	P (21) n (%)	SP (79) n (%)	VSP (30) n (%)		
Type of fuel used					
Gas	17 (32.08)	26 (49.06)	10 (18.87)	53	<b>0.002</b>
Other	4 (5.19)	53 (68.83)	20 (25.97)	77	
Kitchen type					
Attached	9 (9.89)	63 (69.23)	19 (20.88)	91	<b>0.003</b>
Separate	12 (30.77)	16 (41.03)	11 (28.21)	39	

ADQ: Adequate; C: Chi-square test of independence; CWDNG: Cow dung; INDQ: Inadequate; P: Pneumonia; SP: Severe pneumonia; VSP: Very severe pneumonia

The risk factors such as type of fuel, ventilation, and flooring did not contribute significantly ( $P > 0.05$ ) in predicting the status of pneumonia [Table 5]. However, upon moving from adequate to inadequate ventilation, the odds of occurrence of pneumonia increased by 1.38 times.

Most of the symptoms presented by the children suffering from ALRIs were cough (100%), breathlessness (96.92%), and

fever (92.31%). Chest in-drawing (81.54%) and runny nose (69.23%) were also observed in some children. Two deaths due to VSP were recorded, and remaining children were recovered and were discharged.

## Discussion

The present prospective study was carried out to study the clinical profile, risk factors, and outcomes associated with ALRIs

**Table 3: Association between nutritional and clinical risk factors and the occurrence of ALRIs**

Nutritional and clinical factors	Clinical diagnosis (n=130)			Total	P <sup>c</sup>
	P (21) n (%)	SP (79) n (%)	VSP (30) n (%)		
Weaning (months)					
<4	5 (12.5)	21 (52.5)	14 (35)	40	0.676
4-6	4 (14.29)	19 (67.86)	5 (17.86)	28	
>6	12 (19.35)	39 (62.9)	11 (17.74)	62	
Malnutrition (grade)					
Not known	15 (20.83)	39 (54.17)	18 (25)	72	0.010
I	4 (22.22)	14 (77.78)	0 (0)	18	
II	2 (12.5)	13 (81.25)	1 (6.25)	16	
III	0 (0)	12 (54.55)	10 (45.45)	22	
IV	0 (0)	1 (50)	1 (50)	2	
Anemia					
Present	2 (3.64)	37 (67.27)	16 (29.09)	55	0.003
Absent	19 (25.33)	42 (56)	14 (18.67)	75	
Leucocytosis					
Yes	10 (15.38)	38 (58.46)	17 (26.15)	65	0.706
No	11 (16.92)	41 (63.08)	13 (20)	65	
Blood culture					
No growth	21 (16.8)	78 (62.4)	26 (20.8)	125	0.173
<i>Staphylococcus aureus</i>	0 (0)	1 (25)	3 (75)	4	
<i>Streptococcus pneumoniae</i>	0 (0)	0 (0)	1 (100)	1	
Oxygen supplementation					
Present	5 (4.46)	77 (68.75)	30 (26.79)	112	0.000
Absent	16 (88.89)	2 (11.11)	0 (0)	18	
Ventilatory support					
Present	0 (0)	3 (30)	7 (70)	10	0.003
Absent	21 (17.5)	76 (63.33)	23 (19.17)	120	
Clinical outcome					
ALTB	0 (0)	4 (80)	1 (20)	5	0.071
BRCHPN	5 (18.52)	16 (59.26)	6 (22.22)	27	
BRNCHIO	11 (17.46)	41 (65.08)	11 (17.46)	63	
LOBPNE	2 (8)	11 (44)	12 (48)	25	
WLRI	3 (30)	7 (70)	0 (0)	10	
Outcome					
EXP	0 (0)	0 (0)	2 (100)	2 (7%)	0.073
IMP	21 (16.41)	79 (61.72)	28 (21.88)	128 (83%)	

ALTB: Acute Laryngotracheobronchitis; BRCHPN: Bronchopneumonia; BRNCHIO: Bronchiolitis; C: Chi-square test of independence; EXP: Expired; IMP: Improved; LOBPNE: Lobar pneumonia; P: Pneumonia; SP: Severe pneumonia; VSP: Very severe pneumonia; WLRI: Wheeze-associated lower respiratory infection

**Table 4: Logistic regression coefficient data for the prediction of pneumonia based on birth weight and weaning**

	Estimate	Std. Error	P
Intercept	2.606	0.5586	3.09e-06
Birth weight (>2.5 kg)	-1.1942	0.5956	0.044
WNG (>6 months)	-0.2614	0.4952	0.597

WNG: Weaning

in children aged 2–60 months. Most children with SP were reported in the age group of 2–12 months and with VSP being reported in 13–60-month-old children, and similar observations were made by Champatiray *et al.*<sup>[8]</sup> This major occurrence of SP in the age group of less than 1 year could be attributed to the fact that infants aged less than a year have low immunity,

poor nutritional status, narrower and smaller airways, frequent exposure to infections, and more susceptibility to general and viral infections.<sup>[7,14]</sup>

The male to female ratio in this study was in accordance with previous studies in which it is ranged between 1.4:1 and 1.5:1.<sup>[15,16]</sup> This could be due to the preferential treatment usually being given to the male child in families. Furthermore, as per a study by Libert *et al.*,<sup>[17]</sup> the lower incidence of ALRIs in girls could be due to their inherent immunity due to the presence of extra “X” chromosome in their genotype.<sup>[17]</sup>

Majority of the children suffering from SP and VSP in our study had a low birth weight (<2.5 kg). Birth weight as a risk factor significantly contributed in predicting the status of pneumonia, as

**Table 5: Logistic regression coefficient data for the prediction of pneumonia based on fuel, ventilation, and flooring type**

	Estimate	Std. Error	P
Intercept	33.7535	4380.351	0.994
Gas fuel	-18.811	1462.977	0.99
Kerosene fuel	-16.4245	1462.977	0.991
Inadequate ventilation	0.3225	0.6898	0.64
Mud floor	-16.0417	4128.822	0.997
Pucca (solid) floor	-14.2069	4128.822	0.997

the odds of occurrence of pneumonia increased when the birth weight increased from  $\leq 2.5$  to  $>2.5$  kg. This is in accordance with a previous study which reported that 84% of SP cases had a low birth weight.<sup>[7]</sup> A previous study has also shown that low birth weight increases the vulnerability to infectious diseases and has implications for immunocompetence.<sup>[18]</sup>

The parents of most children suffering from severe pneumonia had completed primary or middle-school education in our study. Similar findings were observed by Gornale *et al.*<sup>[19]</sup> as most of the parents of SP children in their study were educated till primary or middle-school level.<sup>[19]</sup>

Majority of the children with severe pneumonia in the present study belonged to upper lower (IV) and lower middle (III) class. This is in accordance with the study conducted by Champatiray *et al.* in which most cases of SP belonged to those classes.<sup>[8]</sup>

In our study, most of the SP-affected children were immunized for age. In contrast, a study conducted by Debnath *et al.*<sup>[15]</sup> found that only 23.8% children were immunized as per NIS and 51.2% children had incomplete immunization.<sup>[15]</sup>

In developing countries like India, biomass fuels are used widely in households with attached kitchens, which affect the nonspecific and specific local defense mechanisms of the respiratory tract. Due to proximity of young children to their mother during cooking and longer indoor stays especially with attached kitchens, they are at greater risk.<sup>[20]</sup> Most of the children with SP (68.83%) and VSP (25.97%) in our study lived in houses where biomass fuels other than gas such as kerosene and firewood were used for cooking and had attached kitchens. This is in accordance with the study conducted by Sikolia *et al.*<sup>[21]</sup>

Early weaning (before 4 months of age) can weaken the immunity of the child and in study conducted by Savitha *et al.*<sup>[22]</sup> showed that weaning was significantly associated with occurrence of ALRIs.<sup>[22]</sup> However, in the present study, no significant association was observed between ALRI severity and weaning age.

In our study, majority of the SP-affected children had grade I and II malnutrition. This is in contrast with the study conducted by Debnath *et al.*<sup>[15]</sup> in which grade IV malnutrition was observed in 44.7%, grade III in 28.9%, and normal malnutrition in 9.5%

of the cases.<sup>[15]</sup> Malnutrition has been significantly associated with the occurrence of ALRIs, especially among children below 5 years of age. It predisposes a child to infection by defecting cell-mediated immune response.<sup>[3]</sup>

Anemia was a significant risk factor for SP and VSP in the present study. This is in accordance with a study done by Ramakrishnan *et al.*, who reported it as a significant contributing factor for ALRIs.<sup>[23]</sup>

In comparison to previous studies,<sup>[8]</sup> the present study showed a less positive blood culture. This discrepancy could be due to a smaller number of VSP children in the present study. Furthermore, the most common organism in both these studies was *S. aureus*, which was associated with malnutrition.

Regarding the laboratory findings, leucocytosis was observed in small percentage and reason could be that majority of the cases were on oral antibiotics before getting admitted to the hospital. This is in accordance with a previous study.<sup>[8]</sup> Respiratory support required by children in the present study substantiate with results obtained by Kannam,<sup>[24]</sup> as SP and higher cases required oxygen supplementation in their study. However, mechanical ventilation was required in VSP cases.<sup>[24]</sup>

The final diagnoses in our study indicated that most of the children had bronchiolitis, bronchopneumonia, and lobar pneumonia. This is in line with the study conducted by Kannam in which 40% cases were diagnosed with bronchopneumonia, 25% with lobar pneumonia, and 19% with bronchiolitis.<sup>[24]</sup>

Mortality observed in the study was in accordance with a previous study where the mortality rate among VSP cases was 1.2%.<sup>[24]</sup> However, these studies are in contrast with a study conducted by Tiewsoh *et al.*<sup>[25]</sup> in which the mortality rate due to VSP was 10.5%.<sup>[23]</sup> This difference in the mortality rate could be attributed to the fact that this comparative study by Tiewsoh *et al.* was conducted in an urban research institute where the probability of a greater number of positive cases is high.<sup>[25]</sup>

The study has limitations being a hospital-based, single-center study, and might not be presenting the true incidence of ALRIs and their different etiologies for the entire population. Also, due to diagnosis based on the case management protocol of WHO and PCR non-availability at our center, viral pathogens were not routinely identified. For the true rate of incidence, multicentric studies in future are recommended.

## Conclusion

The results elucidate that early referrals based on risk factors are of paramount importance as it will not only halt the progression of ALRI severity but lower the mortality rate as well. Parental literacy is important for acquiring health knowledge, as adequately literate parents have better health awareness as compared to their illiterate counterparts. Most of these recommendations

can be which can be educated in the early detection at primary care physicians.

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### Conflicts of interest

There are no conflicts of interest.

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