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## ORIGINAL RESEARCH

# Acute Lower Respiratory Tract Infection in Children Under Five Years of Age: Anemia as a Risk Factor

**[1]GajananVenkatrao Surewad, [2]Bhaskar Reddy Dodda, [3]Radha Parisa, [4]Sahithi Chandarlapati**

[1]Department of Paediatrics, Government Medical College, Jalgaon, Maharashtra, India
[2]Department of Paediatrics, Mamata Medical College, Khammam, Telangana, India
[3]Department of Paediatrics, Nimra Institute of Medical Sciences, Jupudi, Vijayawada, Andhra Pradesh, India
[4]Department of Paediatrics, Ramesh Hospital, Guntur, Andhra Pradesh, India

**Corresponding Author**
GajananVenkatrao Surewad
Department of Paediatrics, Government Medical College, Jalgaon, Maharashtra, India
**Email:** gvsurewad@gmail.com

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**Abstract**

**Background:** It has been proposed that a number of risk factors, some of which are definite, some of which are possible, and just a few of which are conceivable, increase a child's risk of acute lower respiratory infections. Since lower respiratory tract infections are the primary cause of paediatric mortality and morbidity, controlling the risk factors would benefit children's healthy development and growth.

**Aim:** The purpose of our research was to ascertain if low Hb levels in kids with LRTI are related to.

**Methods and Materials:** The original sample size for the present research was 180 cases per group (control group and study group), however for convenience and better accuracy, we utilised 220 cases per group. A haemoglobin level of less than 11 gm% was considered inadequate in this investigation.

**Results:** For patients and controls, the mean haemoglobin levels were 9.25 g% and 10.44 g%, respectively. 143 children in the research group, or 64.6% of the overall study population, were anaemic in this investigation. 77 children, or 35.4% of the study population, were not anaemic in the research group. However, 64 children in the control group, or 28.4% of the overall control population, were anaemic. In contrast, 156 children in the control group, or 71.6% of the total, were not anaemic. Based on statistics, the variance was significant.

**Conclusion:** The risk of anaemia after an acute lower respiratory tract infection is significant. To reduce in frequency, acute lower respiratory tract infections need to be avoided and identified early. Further study is required to validate this significance, and other comorbidities such as low birth weight, unwillingness to bottle-feed, poor nutritional status, inadequate immunisation, and exposure to both household and ambient smoking should also be considered.

**Key words:** Acute lower respiratory tract infection, Children, Anaemia.

## Introduction

The most reliable method for determining a person's anaemia diagnosis is to take their haemoglobin (Hb) levels. Anaemia is a severe public health concern that may impact

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individuals at any stage of life; however, it is more prevalent in young children and iron-deficient pregnant women [1]. Approximately 75% of children in India between the ages of 1-3 who were assessed had anaemia, which puts them at risk for a variety of problems, including infections [2]. Lower respiratory tract infections (LRTIs) include all infections of the lungs and airways below the larynx, including bronchitis, pneumonia, croup syndromes, and bronchiolitis [3]. Acute lower respiratory tract infections (ALRTI), such as pneumonia, are the primary cause of mortality for children under the age of five in developing countries. Around the globe, there are 150 million cases of paediatric pneumonia reported annually, and 3 million children under the age of five die from the disease each year, with 90–95 percent of these fatalities taking place in developing countries [4-6]. Many risk factors have been proposed to increase the chance of lower respiratory infections; some are known to exist, others are likely to occur, and just a small number of them are even somewhat plausible [7]. Since lower respiratory tract infections are the primary cause of paediatric mortality and morbidity, controlling the risk factors would benefit children's healthy development and growth. The purpose of our research was to ascertain if low Hb levels in kids with ALRTI are related.

## Materials and methods

### Study setup and study group

The Nimra Institute of Medical Sciences and Hospital in Jupudi, Vijayawada Krishna (District), Andhra Pradesh, was the site of the present hospital-based prospective research, which was conducted in the paediatric wards. Over the course of a year, from December 2020 to November 2021, the research was conducted. The original sample size for this research was 180 participants each group (control group and study group), however for convenience and accuracy, we chose 220 cases and 220 controls.

### Study design

Observational Case-control study (Blinded).

### Inclusion criteria

The LRTI case group was selected using the WHO criteria, which included 220 children under the age of five who had fever, cough, rapid respiratory rate for age, chest indrawing, and Ronchi or crepitations on auscultation. The control group consisted of 220 age- and gender-matched children who had symptoms of illnesses other than ALTRI.

### Exclusion criteria

Children with bronchial asthma, immunodeficiency disorders, iron supplement use, severe systemic illness, congenital heart diseases, congenital malformations of the chest wall, tuberculosis (any evidence plus cases with positive Montaux tests), cardiac/lung parenchymal lesions, bronchial asthma, and children who had previously received antibiotics from outside sources were not included in the study.

### Consent

The institutional ethics committee (IEC) granted the study's ethical approval. Before the research began, the parent of an eligible kid was asked for their informed permission.

### Methodology

A haemoglobin level of less than 11 gm% was considered inadequate in this investigation. Investigations included peripheral blood smears (PBF), blood cultures, sensitivity tests, X-rays of the chest, serum iron, and iron binding capacity were performed in all patients. Blood

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samples were obtained from each child's anti-cubital vein by a trained phlebotomist. We utilised sterilised, disposable syringes and needles along with the appropriate containers.

**Methods used**

The quantity of haemoglobin in the blood samples was determined by the automated blood cell analyzer using the Cyanmeth Method. To calculate the iron concentration and TIBC, the non-deproteinizationFerrozine technique was used.

**Statistical analysis**

To characterise the data, the mean, SD/SE, and percentages were used. The least significant difference for intergroup variance was computed using the 95% confidence range. The Man-Whitney U-test and Fisher's exact test were used to evaluate the non-parametric data, while the Student's t-test was used to investigate the metric data. The P-value was expressed to three decimal places. The data analysis tools that were used were Excel and SPSS 19.0.

**Results**

158 children in the research group, or 63.2% of the overall study population, were anaemic in this investigation. 92 children, or 36.8% of the study population, were not anaemic in the research group. However, 79 children in the control group, or 31.6% of the overall control population, were anaemic. In contrast, 171 children in the control group, or 68.4% of the total, were not anaemic. Based on statistics, the variance was significant.

In the study population, 74.8% of participants had hypochromic microcytic condition, while 25.1% had normocytic normochromic condition. The results show that 37.0% of the control population had hypochromic microcytic condition, whereas 62.9% had normocytic condition. Table 1.

For patients and controls, the mean haemoglobin levels were 10.21 g% and 11.42 g%, respectively. Serum Iron Levels in Anemic LRTI were 36.2 ± 15.1 mcg/ dL in the study group while Serum Iron Levels in non- Anemic LRTI were 54.4 ± 17.1 mcg/dL in the study group. The variation was relevant statistically (Tables 1 and Table 2).

**Table 1: Anemia in the studied subjects**

| | Study (250) | | Control(250) | | Odds Ratio | p-value |
|---|---|---|---|---|---|---|
| | n | % | n | % | | |
| Anemic | 158 | 63.2 | 79 | 31.6 | 5.61 | 0.002 |
| Non-Anemic | 92 | 36.8 | 171 | 68.4 | 1 | |
| PBFSmear | | | | | | |
| (HypochromicMicrocytic) | 247 | 74.8 | 63 | 37.0 | 8.83 | 0.002 |
| Normocytic Normochromic | 83 | 25.1 | 107 | 62.9 | 1 | |
| Serum Iron Levels in Micrograms(mcg/dL) | | | | | | |
| Anemic LRTI | 36.2 ±15.1 | | 58.1 ±14.6 (42, 99) | | | 0.003 |
| Non-AnemicLRTI | 54.4 ±17.1 | | 63.5 ±17.4 (43, 104) | | | 0.007 |

**Table 2: Mean haemoglobin levels in the study group.**

| Parameter | Cases | Controls |
|---|---|---|
| Mean Hb level | 10.21g% | 11.42g% |

**Discussion**

Anaemia is the most common illness harming people's health, ability to progress socioeconomically, and ability to better mankind as a whole. An iron deficiency, or

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nutritional malnutrition, is the most common cause of anaemia [8]. Southeast Asia has the highest rate of anaemic people globally, with 616 million people at risk [9]. Severe health impacts in children include impaired physical and cognitive development, as well as increased mortality and morbidity associated with infection incidence [10]. For developing youngsters, adequate and balanced nutritional supplementation is critical for the development and maturation of immunity as well as the subsequent formation of resistance to diseases. Thus, among other dietary inadequacies, iron deficiency is a secondary risk factor for acute lung injury (ALRTI) [11]. The age range most often impacted was 3 months to 23 months, which is quite similar to the findings of the Malla, et al. research [12]. This age group's shared engagement may result from the widespread use and advocacy of supplemental and complementary eating methods, which may be insufficient or unsuitable and might bring Hb closer to the lowest point. Many risk factors were discovered, such as low birth weight, poor socioeconomic status, unclean living conditions, inadequate nutrition, and non-exclusive breastfeeding. Anaemia, or low haemoglobin levels, has also been identified as one of the risk factors [13–15]. Even while the majority of healthy children are able to fight off infections with their own defences, children with compromised immune systems are more susceptible to sickness. Anaemia magnifies this impact by weakening the body's natural defences. Three months to 23 months was the age range most often affected; there was a substantial association found between this age range and the incidence of both LRTI and anaemia [16–19]. Notably, in addition to aiding the passage of oxygen (O2) and carbon dioxide (co2) gases, haemoglobin also serves as a buffer for compound nitric oxide (NO) and some other physiological disorders. Consequently, a decrease in Hb might have a detrimental effect on the normal functioning, both quantitatively and subjectively. The primary ways that alveolar macrophages get iron are via the plasma pool and RBC metabolism. This may account for the relationship between ALTRI and iron-deficiency anaemia, since they may perform less well in iron-deficient environments. ALRTI infections account for 16% of mortality worldwide in children under the age of five, making them one of the leading causes of death in this age group [20]. This is more typical in underdeveloped countries. 143 children in the study group, or 64.6% of the overall study population, were anaemic in this research (Table 1). 77 children, or 35.4% of the study population, were not anaemic in the research group. However, 64 children in the control group, or 28.4% of the overall control population, were anaemic. In contrast, 156 children in the control group—or 71.6% of the total—were not anaemic. Based on statistics, the variance was significant. Given that haemoglobin is a transporter of oxygen after gaseous exchange in the lungs, its absence may cause an atmosphere deficient in oxygen, which may then cause infections. This opens the possibility of an LRTI treatment or preventative idea that might be looked into in further studies [13,20]. Similar studies were also conducted by Malla et al. and Ashraf M et al. [7,12]. The high incidence of involvement in this age range may be attributed to low haemoglobin levels, which are often linked to inadequate or inappropriate supplementary feeding practices. Their investigation turned up no solid evidence that the populations we examined differed by gender [7,12,14]. The gender bias in our culture that encourages early hospitalisations might be the reason for the higher percentage of male births. The patients in our study exhibit the usual clinical presentation of ALRTI, and these findings were consistent with the studies conducted by Malla et al. and Roma et al. [7,14]. Table 2 shows that the mean haemoglobin levels for the patients and controls were 9.25 g% and 10.44 g%, respectively. These findings aligned with those of previous studies [7–14]. Nevertheless, there was no discernible correlation between the peripheral smear and earlier studies by Malla et al. and Roma et al. that discovered a higher incidence of microcytic hypochromic anaemia [7,14]. The inconsistent findings of the peripheral smear might help to explain this. A precise specification of the link may have been obtained by an examination of the iron

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profile. Anaemia was defined in our research as haemoglobin levels less than 10 gm%. With 216 anaemic patients out of 400 paediatric patients, 132 instances of ALRTI and 84 non-ALRTI controls, the data show that anaemic children had a 2.681-fold higher risk of LRTI. Thirty-nine percent of the study group had normocytic Normochromic state, whereas seventy-nine percent had hypochromic microcytic condition (Table 1). The control population showed signs of normocytic normochromic condition in 67.6% of cases, and hypochromic microcytic condition in 32.4% of cases. The study group's serum iron levels for anaemic LRTI were 35.4 ± 14.5 mcg/dL, while those for non-anemic LRTI were 53.5 ± 16.2 mcg/dL. Serum iron levels in the non-anemic LRTI group were 53.5 ± 16.2 mcg/dL, while those in the anaemic LRTI group were 53.5 ± 16.2 mcg/dL. According to statistics, the variation mattered (Table 1). This result was consistent with studies by Malla et al. and Roma K et al. [7,13], which demonstrated 4.99-time susceptibility. Similar importance was also shown by other studies, including OR- 4.63 by Ashraf et al. and OR- 3.59 by Avhad et al [12,13]. When the present research was contrasted with previous comparable investigations, a high link was found between anaemia and LRTI. Therefore, early detection and control of anaemia may greatly reduce the occurrence of LRTI. There are little data in the literature about the significance of low haemoglobin levels as a possible cause for acute lower respiratory tract infections. Haemoglobin is responsible for both the inactivation and regulation of nitric oxide. Therefore, the systems that maintain the body functioning properly may be adversely affected by a quantitative or qualitative drop in haemoglobin. Alveolar macrophages, which primarily get their iron from RBC metabolic processes and the plasma reserve, may be hampered in iron-deficient situations, which might account for the association between acute LTRI and low iron levels and iron deficiency anaemia [20].

**Limitations of the study**

The retrospective nature of this research and its hospital-based design may have obscured the influence of other factors and the frequency in a community setting.

Because of the study's small sample size, a more comprehensive analysis of a larger population is necessary before drawing any definitive conclusions.

In order to determine the frequency of iron deficiency anaemia, which contributes to the pathophysiology of infection, the iron profile was not examined in this investigation.

**Conclusion**

The research findings unequivocally indicate that anaemia is a noteworthy risk factor for lower respiratory tract infections in children under the age of five. The best ways to avoid the substantial risk factor that turns otherwise healthy kids into LRTI patients are to cure the illness, prevent anaemia in the first place by increasing dietary iron intake, and deworm kids. Further study is required to validate this significance, and other comorbidities such as low birth weight, unwillingness to bottle-feed, poor nutritional status, inadequate immunisation, and exposure to both household and ambient smoking should also be taken into account.

**Author contributions**

GS: Conceptualization, supervision; writing- original draft, review & editing. BD: writing-review & editing. RP: writing- original draft; conceptualization. SC: Conceptualization, supervision; resources.

**Conflict of interest**

The authors declare there is no conflict of interest.

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