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

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ABSTRACT

Background: There are many risk factors in children that have been suggested to enhance the likelihood of developing acute lower respiratory infections, some of which are certain, some of which are likely, and only a few of which are conceivable. Gaining control of the risk variables will have a positive impact on the healthy development and growth of children because lower respiratory tract infections are the main reason for death and morbidity in children.

Aim: Our study's goal was to determine the relationship between low Hb levels in children suffering from LRTI

Methods and Materials: 180 cases in each group (study group and control group) were the intended sample size for the current study, however we used 220 cases in each group for convenience and greater accuracy. In this study, a haemoglobin level of less than 11 gm% was deemed poor.

Results: The mean haemoglobin level for patients and controls was 9.25 g% and 10.44 g%, respectively In this study 143 children in study group were anemic contributing 64.6 % of total study population. While 77 children were non anemic in study group contributing 35.4% of study population. On the other hand 64 children in control group were anemic contributing 28.4 % of total control population. While 156 children were non anemic in control group contributing 71.6 % of control population. The variation was relevant statistically.

Conclusion: Acute lower respiratory tract infection has a high risk of anaemia. Acute lower respiratory tract infections must be prevented and diagnosed early in order to be less common. This relevance needs to be confirmed by additional research, and other comorbidities such low birth weight, bottle-feeding refusal, nutritional status, insufficient immunization, and exposure to ambient and home smoking should also be taken into account.

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

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INTRODUCTION

The most accurate way to diagnose anaemia in people is by measuring their haemoglobin (Hb) levels. Anemia is a serious public health issue that can affect anyone at any phase of life, but it is more common among small children as well as pregnant women who are iron deficient [1]. In India, nearly 75 percent of the surveyed of kids between the ages of 1-3 are anaemic, putting them at risk for a number of complications, including infections [2]. All infections of the lungs and airways below the larynx are referred to as lower respiratory tract infections (LRTI), which also includes pneumonia, croup syndromes, bronchitis, and bronchiolitis [3]. The leading cause of death in children below the age of five in underdeveloped nations is acute lower respiratory tract infections (ALRTI) like (pneumonia). 150 million cases of paediatric pneumonia are recorded worldwide each year, and 3 million children under the age of 5 pass away from pneumonia each year, with 90–95 percent of these deaths occurring in underdeveloped nations [4-6].

There are many risk factors that have been suggested to

enhance the likelihood of developing lower respiratory infections, some of which are certain, some of which are likely, and only a few of which are conceivable [7]. Gaining control of the risk variables will have a positive impact on the healthy development and growth of children because lower respiratory tract infections are the main reason for death and morbidity in children. Our study's goal was to determine the relationship between low Hb levels in children suffering from ALRTI.

MATERIALS AND METHODS

Study setup and study group

The current study was a hospital-based prospective study performed in Paediatrics wards at Nimra Institute of Medical Sciences and Hospital, Jupudi, Vijayawada Krishna (District), Andhra Pradesh. The study was carried out from December 2020 to November 2021 during a 12-month period. 180 subjects in each group (study group and control group) were the intended sample size for the current study, however, we used 220 cases and 220 controls for convenience and greater accuracy.

Study design

Observational Case-control study (Blinded).

Inclusion criteria

A total of 220 children under the age group of 5 years with symptoms of fever, cough, fast respiratory rate for age, chest in-drawing, and Ronchi or crepitations on auscultation, were used to select the LRTI case group (According to WHO Criteria). 220 aged and gender-matched children with complaints of illness other than ALTRI were taken as the control group.

Exclusion criteria

The study excluded children with congenital malformations of the chest wall, severe systemic illness, congenital heart diseases, protein energy malnutrition PEM > Grade III as per Indian Academy of Paediatrics (IAP) Classification, tuberculosis (any evidence plus cases with positive Montaux tests), cardiac/lung parenchymal lesions, bronchial asthma, immunodeficiency disorders, and iron supplement use and children who had previously received antibiotics from outside sources.

Consent

The ethical approval for the study was obtained from institutional ethical committee (IEC). An informed consent was sought from parent of eligible child before the commencement of given study.

METHODOLOGY

In this study, a haemoglobin level of less than 11 gm% was deemed poor. All cases underwent investigations such as complete blood count (CBC), peripheral blood smear (PBF), blood culture and sensitivity test, X-ray chest, serum iron, and iron binding capacity. A phlebotomist with training took blood samples from each child's anti-cubital vein. The right tubes and sterile, disposable syringes and needles were used.

Methods used

The automatic blood cell analyser used the Cyanmeth Method to measure the haemoglobin amount in the blood samples. The Ferrozine method, which does not involve deproteinization, was used to quantify the iron content and TIBC.

Statistical analysis

Mean, SD/SE, and percentages were used to describe the data. The 95% confidence interval was used to calculate the least significant difference for intergroup variance. Student's t-test was employed to analyse the metric data, while Man-Whitney U-test and Fisher's exact test were applied to the non-parametric data. Three decimal places were used to express the P-value. The data analysis tools utilized were SPSS 19.0 and excel.

RESULTS

The mean haemoglobin level for patients and controls was 9.25 g% and 10.44 g%, respectively In this study 143 children in the study group were anaemic contributing 64.6 % of the total study population. While 77 children were non-anaemic in the study group contributing 35.4% of the study population. On the other hand, 64 children in the control group were anaemic contributing 28.4 % of the total control population. While 156 children were non-anemic in the control group contributing 71.6 % of the control population. The variation was relevant statistically.

Hypochromic Microcytic condition was observed in 79.1% of the study population while Normocytic Normochromic condition was observed in 20.9% of the study population. Hypochromic Microcytic condition was observed in 32.4% of the control population while Normocytic Normochromic condition was observed in 67.6% of the control population, as observed in Table 1.

Serum Iron Levels in Anemic LRTI were 35.4 ± 14.5 mcg/

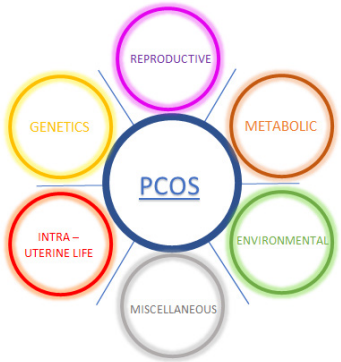

Figure 1: Factors contributing towards the high prevalence of PCOS disorder in reproductive women.

dL in the study group while Serum Iron Levels in non-Anemic LRTI were 53.5 ± 16.2 mcg/dL in the study group. Serum Iron Levels in Anemic LRTI were 53.5 ± 16.2 mcg/dL in the control group while Serum Iron Levels in non-Anemic LRTI were 53.5 ± 16.2 mcg/dL in the control group. The variation was relevant statistically (Tables 1 and Table 2).

DISCUSSION

The most prevalent disease hurting people's health, socioeconomic advancement, and general improvement of humanity is anaemia. Nutritional malnutrition, namely an iron deficiency, is the most frequent cause of anaemia [8]. With 616 million individuals at risk, Southeast Asia has the greatest percentage of anemic persons worldwide [9]. Reduced cognitive and physical maturation, as well as enhanced mortality and morbidity linked to the incidence of infections, are severe health effects in children [10]. For the growth and maturation of immunity, as well as the ensuing emergence of resistance against illnesses, balanced and enough nutritional supplementation is of utmost importance for growing children. Thus, iron deficiency among other nutritional deficiencies is a secondary risk factor for developing acute LRTI (ALRTI) [11]. Most commonly affected age group was 3 months to 23 months, which is quite comparable with the study conducted by Malla, et al. [12]. The common involvement of this age group could be because, supplementary and complementary feeding practices that might be inadequate and inappropriate, are practised and advocated widely in this age, due to which Hb could touch the nadir.

Numerous risk elements were found, including low birth weight, low socioeconomic level, unhygienic living circumstances, below-par nutrition, and an absence of exclusive breastfeeding. One of the risk variables has also been listed as anaemia or low haemoglobin levels [13-15]. Children with weakened immune systems are more likely to contract illnesses, even though most healthy kids can battle the illness with their own defences. Through a weakened state of the body's natural defences, anaemia amplifies this effect. The age range most frequently affected was three months to 23 months; there was a strong correlation between this age range and the occurrence of both LRTI with anaemia [16-19].

Notably, Hb functions as a buffer for compound nitric oxide (NO) and some other bodily abnormalities in addition to facilitating the movement of oxygen (O2) gas and carbon dioxide (co2) gas. Therefore, a drop in Hb, either quantitatively or qualitatively, may negatively impact the normal functions. Alveolar macrophages receive iron predominantly via RBC metabolism and the plasma pool, and because they may function less effectively in iron-deficient situations, this link between ALTRI and an iron-deficiency anaemia may be explained. In children under the age of five, ALRTI infections are one of the main causes of death, accounting for 16% of all deaths in this age group globally [20]. This is more common in developing nations.

In this study (Table 1) 143 children in the study group were anaemic contributing 64.6 % of the total study population. While 77 children were non-anemic in study group contributing 35.4% of the study population. On the other hand, 64 children in the control group were anaemic contributing 28.4 % of the total control population. While 156 children were non anemic in control group contributing 71.6% of control population. The variation was relevant statistically.

In light of the fact that haemoglobin is a carrier of oxygen after the gaseous exchange that happens in the lungs, its absence may result in a low-oxygen environment, which can subsequently lead to infections. This provides the door for an LRTI therapy or preventive notion that may be investigated in future research [13,20].

Comparable analyses by Malla, et al. as well as Ashraf M et al. were also done [7,12]. This age group's frequent involvement may be caused by low haemoglobin levels, which are frequently associated with insufficient or improper supplemental feeding habits. Their research found no conclusive evidence of a gender difference among the populations we looked at [7,12,14]. The larger proportion of male babies may be explained by the gender bias in our society that favours early hospitalisations. These results were in agreement with the research done by Malla, et al. and Roma, et al. and the patients in our report show the typical clinical presentation of ALRTI [7,14].

The mean haemoglobin level for patients and controls was 9.25 g% and 10.44 g% as seen in Table 2, respectively. These results were consistent with those of earlier research [7-14]. However, when compared with other research conducted by Malla et al. and Roma, et al. which found an increased prevalence of microcytic hypochromic anaemia, the peripheral smear did not show any significant association [7,14]. This might be explained by the contradictory results of the peripheral smear. An analysis of the iron profile may have provided a clear definition of the connection. In our study, anaemia was defined as haemoglobin levels below 10 gm%. Out of the 400 children patients, 216 had anaemia, with 132 ALRTI cases and 84 non-ALRTI controls, indicating a 2.681-fold increased risk of LRTI in anaemic children.

Hypochromic Microcytic condition (Table 1) was observed in 79.1% of the study population while Normocytic Normochromic condition was observed in 20.9% of the study population. Hypochromic Microcytic condition was observed in 32.4% of the control population while Normocytic Normochromic condition was observed in 67.6% of the control population.

Serum Iron Levels in Anemic LRTI were 35.4 ± 14.5 mcg/dL in the study group while Serum Iron Levels in non-Anemic LRTI were 53.5 ± 16.2 mcg/dL in the study group. Serum Iron Levels in Anemic LRTI were 53.5 ± 16.2 mcg/dL in the control group while Serum Iron Levels in non-Anemic LRTI were 53.5 ± 16.2 mcg/dL in the control

Table 1: Anemia in the studied subjects.

	Study (220)		Control (220)		Odds Ratio	p-value
	n	%	n	%		
Anemic	143	64.6	64	28.4	4.64	0.002
Non-Anemic	77	35.4	156	71.6	1	
PBF Smear						
(Hypochromic Microcytic)	224	79.1	40	32.4	7.86	0.002
Normocytic Normochromic	60	20.9	84	67.6	1	
Serum Iron Levels in Micrograms (mcg/dL)						
Anemic LRTI	35.4 ± 14.5		57.2 ± 13.9 (35, 91)			0.002
Non-Anemic LRTI	53.5 ± 16.2		62.7 ±16.8 (36, 96)			0.006

Table 2: Mean haemoglobin levels in the study group.

Parameter	Cases	Controls
Mean Hb level	9.25g%	10.44g%

group. The variation was relevant statistically (Table 1).

This result was in line with research from Malla, et al. and Roma K et al. (showing 4.99-time susceptibility) [7,13]. Other investigations, such as OR- 4.63 by Ashraf, et al. but also OR- 3.59 by Avhad, et al. also demonstrated similar significance [12,13]. As a result, there was a strong correlation between anaemia and LRTI when the current study was compared to other studies of a similar nature. Therefore, LRTI incidence can be significantly decreased by anaemia prevention and early diagnosis. Concerning the importance of low haemoglobin levels as a potential cause for acute LRTI, there aren't much data in the literature.

Nitric oxide is carried by haemoglobin and is both inactivated and controlled by it. Therefore, a quantitative or qualitative decrease in haemoglobin may negatively impact the processes that keep the body running normally. A possible explanation for the correlation between acute LTRI and a low iron state, and resultantly iron deficiency anaemia, is that alveolar macrophages, which obtain iron mainly from RBC metabolic activities and the plasma reserve, may be compromised in iron-deficient states [20].

Limitations of the study

The frequency in a community context and the impact of other covariates may have been overlooked because this study was retrospective in nature and hospital-based.

A prospective investigation of a bigger population is warranted because the study's sample size is insufficient to draw a firm conclusion.

The study did not examine the iron profile to figure out the frequency of iron deficiency anaemia, which plays a role in the pathogenesis of infection.

CONCLUSION

The study conclusively demonstrated that anaemia is a significant risk factor for lower respiratory tract infection in children below the age of 5 years. The optimum strategies to stop the significant risk factor turning healthy children into patients with LRTI include early detection of anaemia in children, treatment of the condition, or prevention of anaemia through improved dietary iron intake and deworming. This relevance needs to be confirmed by additional research, and other comorbidities such as low birth weight, bottle-feeding refusal, nutritional status, insufficient immunization, and exposure to ambient and home smoking should also be considered.

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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