Original Article

Association Between Anemia and Acute Lower Respiratory Tract Infection in Under-Five Children

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ABSTRACT

Objective: To determine the association of anemia with acute lower respiratory tract infection among children under 5 years of age.

Study Design: Case control study

Place and Duration of Study: This study was conducted at the Dept. of Pediatric Medicine of Ziauddin University Hospital, Karachi from 6th January 2024 till 6th July 2024.

Methods: Quantitative and qualitative data was collected, presented and analyzed. Effect modifiers were controlled through stratification to see the effect of these on the outcome variable. Post stratification chi square test was applied taking p-value of ≤0.05 as significant.

Results: A total of 62 patients (31 in case and control) who met the inclusion and exclusion criteria were included in this study. Stratification of anemia according to case and control group showed that 32.3% and 12.9% had and did not have anemia. P-value was 0.07. Odds ratio was 3.21.

Conclusion: Anemia was significantly associated with LRTI group compared to the control group proving it to be an independent risk factor for LRTI.

Key Words: Anemia and acute lower respiratory tract infection.

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INTRODUCTION

Anemia is a major public health problem frequently observed among pregnant women and young children, particularly those aged 0–5 years. Globally, the prevalence of anemia is increasing, currently affecting 29% of pregnant women, 38% of non-pregnant women, and 43% of children[1]. The effects of anemia range from mild fatigue to more severe symptoms like chest pain and dyspnea. Acute Lower Respiratory Tract Infections (LRTIs) are a leading cause of childhood mortality in children under five years, especially in developing countries[2]. This age group is particularly vulnerable to conditions like bronchitis, bronchiolitis, and pneumonia, with an average of 5–6 episodes of LRTI per year[3].

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LRTIs contribute significantly to morbidity and mortality, with an estimated 150 million episodes of childhood pneumonia reported annually, resulting in 3 million deaths, 90–95% of which occur in developing countries.[4]

Several risk factors increase susceptibility to LRTIs, including lack of breastfeeding, overcrowding, undernutrition, delayed weaning, pre-lacteal feeding, protein-energy malnutrition (PEM), infectious diseases, and secondary bacterial infections[5]. Evidence has shown a significant association between low hemoglobin levels and LRTIs. Studies conducted in Egypt and India support this evidence, demonstrating that iron-deficiency anemia is frequently found in children with LRTIs. Research also suggests that iron supplementation in children under five has a preventive effect against infections[6]. Anemic children are 3.59 times more likely to develop LRTIs, according to Yogesh Avhad et al., while another study found them to be 4.6 times more susceptible. Both anemia (mainly iron deficiency) and acute LRTIs are particularly common in developing countries like Bangladesh and Pakistan[7]. Correcting anemia may provide a cost-effective way to prevent LRTIs, thereby reducing morbidity and mortality in children under five. Nutritional supplementation and food fortification can improve immunity and enhance resistance to infections[8].

In Pakistan, anemia and acute lower respiratory tract infections (ALRTIs) are prevalent in children under five[9]. According to the Pakistan Demographic and Health Survey (PDHS), anemia affects 62.1% of children aged 6–59 months, and ALRTIs are a leading cause of mortality in this age group[10]. By creating a hypoxic environment in the respiratory circulation, anemia is likely a significant contributor to LRTIs in children under five. Addressing these issues through prevention and nutritional interventions could significantly improve child health outcomes in developing countries[11-13].

METHODS

This study was a case-control design conducted in the Department of Pediatric Medicine at Ziauddin University Hospital, Karachi from January 6, 2024, and concluding on July 6, 2024, following the approval of the research synopsis. The study included a total of 62 children, divided equally into two groups: 31 cases (children with ALRTI) and 31 controls (children without ALRTI). The sample size was calculated using the Open Epi Sample Size Calculator, ensuring a confidence level of 95%, a margin of error of 5%, and a power of 80%. These parameters were based on findings from the KM R et al. study, which provided the hypothetical proportions of exposure in cases and controls. Participants were selected using non-probability consecutive sampling technique.

Sample Selection: The inclusion criteria for the study comprised children under five years of age, with cases defined as children diagnosed with ALRTI and controls as children without ALRTI. Exclusion criteria included premature children, those with congenital chest wall malformations, children exposed to passive smoking, those taking iron supplements, children with malnutrition, and those with severe systemic illnesses such as congenital heart disease or tuberculosis.

Data Collection Procedure: After obtaining institutional ethical approval and CPSP endorsement, children meeting the inclusion criteria were enrolled in the study from the outpatient and inpatient departments. Informed consent was obtained from parents or guardians. Data collection involved the use of pre-structured questionnaires, which included socio-demographic details (age, gender), clinical symptoms (cough, noisy breathing, convulsions, vomiting, cyanosis, chest in-drawing), and results of blood investigations (hemoglobin, MCV, MCH, MCHC, RDW, serum iron, serum ferritin, TIBC). Anemia was defined as a hemoglobin level of less than 11 g/dL. Confidentiality was maintained by anonymizing the data, securing it with passwords, and discarding it after the completion of the project within a set timeframe.

Data Analysis: Data were analyzed using Microsoft Excel 2016 and SPSS v.21.0. Qualitative data, such as gender and symptoms, were expressed as frequencies and percentages, while quantitative data, including age and blood investigation results, were expressed as mean ± standard deviation or median/IQR for non-normal data, assessed using the Shapiro-Wilk test. The association between anemia and ALRTI was tested using the chi-square test, with stratification by age and gender to account for confounders and effect modifiers. Post-stratification analysis involved chi-square or Fisher's exact tests, and odds ratios were calculated to measure the strength of association. A p-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 62 patients (31 in case and control) visiting Dept. of Pediatric Medicine of Ziauddin University Hospital, Karachi who met the inclusion and exclusion criteria were included in this study.

Table No. 1: Demographic data of patients

Variable	Mean ± SD	Standard Deviation	Min-Max
Age (Case) (Years)	3.14 ± 2.49	2.49	1–5
Duration of Symptoms (Case) (Hours)	18.72 ± 14.24	14.24	4–72
Hemoglobin (Case) (mg/dL)	10.41 ± 2.56	2.56	7–12
Iron (Case) (µg/L)	10.56 ± 4.28	4.28	9–13
Ferritin (Case) (µg/L)	18.98 ± 4.56	4.56	8–18
TIBC (Case) (%)	40.6 ± 10.87	10.87	35–55
Age (Control) (Years)	3.17 ± 1.98	1.98	1–5
Duration of Symptoms (Control)(Hours)	16.66 ± 18.31	18.31	4–72
Hemoglobin (Control) (mg/dL)	11.52 ± 2.33	2.33	8–12
Iron (Control) (µg/L)	11.69 ± 7.47	7.47	9–13
Ferritin (Control) (µg/L)	21.58 ± 6.87	6.87	8–18
TIBC (Control) (%)	42.9 ± 15.57	15.57	35–55

The results show that the mean age of children in both the case and control groups was comparable, with cases averaging 3.14 ± 2.49 years and controls averaging 3.17 ± 1.98 years. The duration of symptoms was slightly longer in the case group (18.72 ± 14.24 hours) compared to the control group (16.66 ± 18.31 hours). Hemoglobin levels were lower in the case group (10.41 ± 2.56 mg/dL) than in the control group (11.52 ± 2.33 mg/dL), indicating a trend of anemia among cases. Similarly, iron (10.56 ± 4.28 µg/L vs. 11.69 ± 7.47

μg/L) and ferritin levels (18.98 ± 4.56 μg/L vs. 21.58 ± 6.87 μg/L) were also lower in cases. The total iron-binding capacity (TIBC) was slightly reduced in cases (40.6 ± 10.87%) compared to controls (42.9 ± 15.57%), suggesting differences in iron metabolism between the groups.

The age distribution shows that a higher proportion of children in the case group (58.1%) were aged ≤2.5 years compared to 45.2% in the control group, while a greater proportion of children in the control group (54.8%) were aged >2.5 years compared to 41.9% in the case group. Regarding gender distribution, males constituted a larger proportion of the case group (58.1%) than the control group (38.7%), while females made up a greater proportion of the control group (61.3%) compared to the case group (41.9%).

Anemia was observed in 32.3% of cases compared to 12.9% of controls, with an odds ratio of 3.21 and a p-value of 0.07, indicating a trend towards significance. When stratified by age, anemia was more prevalent in children aged ≤2.5 years in both groups (27.8% in cases vs. 14.3% in controls), with an odds ratio of 2.30 (p-value = 0.90). For children aged >2.5 years, anemia was more frequent in cases (38.5%) compared to controls (11.8%), with an odds ratio of 4.68 (p-value = 0.10). Gender stratification showed that among males, anemia was observed in 27.8% of cases versus 16.7% of controls, with an odds ratio of 1.92 (p-value = 0.48). Among females, anemia was significantly higher in cases (38.5%) compared to controls (10.5%), with an odds ratio of 5.31 and a p-value of 0.07, suggesting a strong association in females. These results support the conclusion that anemia is a potential risk factor for lower respiratory tract infections, with variations based on age and gender.

Table No. 2: Age and Gender Distribution

Variable	Case Group (n=31)	Control Group (n=31)
Age Distribution		
≤ 2.5 Years	18 (58.1%)	14 (45.2%)
> 2.5 Years	13 (41.9%)	17 (54.8%)
Gender Distribution		
Male	18 (58.1%)	12 (38.7%)
Female	13 (41.9%)	19 (61.3%)

Table No. 3: Anemia Distribution

Variable	Case Group (n=31)	Control Group (n=31)	P-Value	Odds Ratio
Anemia Distribution				
Yes	10 (32.3%)	4 (12.9%)	0.07	3.21
No	21 (67.7%)	27 (87.1%)		
Anemia According to Age				
≤ 2.5 Years - Yes	5 (27.8%)	2 (14.3%)	0.90	2.30
≤ 2.5 Years - No	13 (75.2%)	12 (85.7%)		
> 2.5 Years - Yes	5 (38.5%)	2 (11.8%)	0.10	4.68
> 2.5 Years - No	8 (61.5%)	15 (88.2%)		
Anemia According to Gender				
Male - Yes	5 (27.8%)	2 (16.7%)	0.48	1.92
Male - No	13 (72.2%)	10 (83.3%)		
Female - Yes	5 (38.5%)	2 (10.5%)	0.07	5.31
Female - No	8 (61.5%)	17 (89.5%)		

DISCUSSION

In developing countries, lower respiratory tract infections (LRTIs) are a significant cause of mortality in children. Various risk factors, including low birth weight, malnutrition, vitamin A deficiency, lack of breastfeeding, poor socioeconomic conditions, large family size, young age, and air pollution, contribute to the development of LRTIs. Among these, anemia is frequently identified as a key cofactor for LRTIs[14]. In our study, we analyzed 62 participants (31 cases and 31 controls) meeting the inclusion and exclusion criteria. Anemia was observed in 32.3% of cases compared to 12.9% of controls, with an odds ratio of 3.21, indicating that anemic children were over three times more likely to develop LRTIs. Although the p-value of 0.07 indicated a trend toward significance, the findings align with other studies highlighting anemia as a major risk factor for LRTIs[15-17].

In another study, the majority of cases were children aged 1–3 years, with a male-to-female ratio of 1.27:1, showing a slight male preponderance. Anemia was present in 74.67% of cases and 34.67% of controls, confirming anemia as a significant risk factor for LRTI. The study found that the mean hemoglobin level was significantly lower in anemic children (9.99 ± 0.62 g/dL) compared to non-anemic children (11.99 ± 0.92 g/dL), with a p-value of 0.001[18]. History of recurrent chest infections was significantly higher among anemic children and hospitalized cases compared to non-anemic and healthy controls, further emphasizing the

association between low hemoglobin levels and LRTIs[19].

Another study reported a male preponderance of 57.3% in the study group and 59.1% in the control group. The majority of children in both groups were between 3 and 23 months old (80.9% in the study group and 81.8% in the control group). In this study, anemia was defined as a hemoglobin level <11 g/dL. The mean hemoglobin level in the study group was 8.8 g/dL compared to 11.6 g/dL in the control group [20]. Anemia was present in 64.5% of cases and 28.2% of controls, with an odds ratio of 4.63, indicating that anemic children were 4.6 times more susceptible to LRTIs (p-value <0.01). Additionally, iron deficiency anemia was found in 78.9% of the anemic cases in the study group, with significantly lower serum iron levels compared to non-anemic cases and controls (p-value <0.01). These studies consistently demonstrate that anemia, particularly iron deficiency anemia, significantly increases the risk of LRTIs in children. Preventive interventions, such as addressing nutritional deficiencies and improving access to iron supplementation, could substantially reduce the morbidity and mortality associated with LRTIs in children under five in developing countries.

CONCLUSION

This study clearly demonstrates that anemia is a significant risk factor for lower respiratory tract infections (LRTIs) in children aged 6 months to 5 years. Early detection and timely management of anemia can play a crucial role in reducing the risk of LRTIs. Preventive strategies such as improving dietary iron intake and implementing deworming programs can serve as effective interventions to mitigate this risk, thereby protecting healthy children from becoming victims of LRTIs.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Aizaz Ali Khan, Heena Rais
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Agreement to accountable for all aspects of work:	All the above authors

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