

Nutritional risk factors for acute lower respiratory tract infection among infants and children 2-60 months old in Basra, Southern Iraq

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ABSTRACT

Objectives: A case-control study was carried out to identify nutritional risk factors for acute lower respiratory tract infections among infants and children under 5 years.

Methods: Children who have been admitted to the pediatric wards at Basra Maternity and Children Hospital and those who have visited Al-Razie Primary Health Center over the period from the 4th of November 2007 till the end of May 2008 were recruited. A total of 110 patients with pneumonia according to the WHO criteria and 207 apparently healthy infants and children, their age ranged from 2 months-5 years were included.

Results: The study has revealed that formula feeding in early life, duration of breast feeding of less than 6 months, time of introduction of weaning foods before 6 months, anemia, rickets and malnutrition are significant risk factors for acute lower respiratory tract infection. In addition, a significant correlation was found between the severity of the acute lower respiratory tract infection and rickets, malnutrition, serum calcium level, and hemoglobin level

Conclusion: Presence of anemia, rickets and malnutrition are significant risk factors for acute lower respiratory tract infections and also for a more severe disease.

Key words: Acute lower respiratory tract infections, nutrition, children

عوامل الخطورة التغذوية المؤدية إلى عدوى المجاري التنفسية السفلى أُلحاد عند الأطفال من عمر 2-60 شهر في البصرة- جنوب العراق

الاهداف: أجريت هذه الدراسة المقارنة باستخدام العينة الضابطة لتحديد عوامل الخطورة التغذوية المسببة لعدوى المجاري التنفسية السفلى للأطفال دون سن الخامسة .

طريقة البحث: شملت الدراسة الاطفال الذين تم ادخالهم إلى ردهات الأطفال في مستشفى البصرة للنسائية والأطفال وكذلك ممن راجعوا مركز الرازي للرعاية الصحية الأولية للفترة من الرابع من شهر تشرين الأول 2007 ولغاية نهاية شهر أيار 2008.

تضمنت الدراسة مئة وعشرة مرضى مصابا بعدوى المجاري التنفسية السفلى اعتمادا على مبادئ منظمة الصحة العالمية وكذلك مائتان وسبع من غير المصابين تراوحت أعمارهم ما بين شهرين إلى خمس سنوات.

النتائج: أثبتت هذه الدراسة ان الرضاعة الاصطناعية في الأشهر الأولى من العمر، قصر مدة الرضاعة الطبيعية لفترة اقل من ستة أشهر ووقت بداية إطعام الطفل قبل الستة أشهر، فقر الدم، الكساح و سوء التغذية كلها عوامل خطورة للإصابة بعدوى المجاري التنفسية السفلى عند الأطفال دون سن الخامسة. كما بينت الدراسة وجود ترابط معتد إحصائيا بين شدة المرض والإصابة بالكساح وسوء التغذية وفقر الدم، نسبة الكالسيوم في الدم ونسبة الهيموغلوبين.

الاستنتاجات: الإصابة بفقر الدم، الكساح، و سوء التغذية هي عوامل خطورة مهمة للإصابة بعدوى المجاري التنفسية السفلى عند الأطفال دون سن الخامسة وكذلك لشدة المرض.

INTRODUCTION

It was estimated that more than 10 million children die each year in developing countries before they reach their fifth birthday. Seven in ten of these deaths are due to acute respiratory infections (mostly pneumonia), diarrhea, measles, malaria, or malnutrition-and often to a combination of these conditions. Providing quality care to sick children is a serious challenge. In response to this challenge, WHO and UNICEF developed

the Integrated Management of Childhood Illness (IMCI) strategy, which combines improved management of childhood illness with aspects of nutrition, immunization, and other important disease.^[1] Based on a simple approach to pneumonia detection, WHO developed and established a programme in 1984 which became the basis for reduction of mortality due to acute lower respiratory tract infection, it includes health education to promote appropriate child

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care practices (at both the community and family levels) and appropriate acute respiratory infection (ARI) case management within the framework of the primary health care.^[2] In Iraq, ARI control programme had been adopted since 1990. For success of such a programme, ARI epidemiology is needed to be known to improve methods of management of these illnesses. A recent meta-analysis study has demonstrated that risk factors significantly associated with severe acute lower respiratory tract infection (ALRI) in a consistent manner across studies were: low birth weight, lack of exclusive breastfeeding, crowding - more than 7 persons per household, exposure to indoor air pollution, incomplete immunization, undernutrition—weight-for-age less than 2 standard deviations, and HIV infection.^[3] Low birth weight (LBW) affects immune competence and increases vulnerability to infectious diseases in later life. Greater peripheral T-cell turnover due to immune activation (elevated C-reactive protein concentrations and bactericidal activity) may have resulted in a greater need for replenishment from the thymus, these events may cause lower immune functional reserve in preschool-age children born with LBW.^[4] Malnourished children have an impaired immunologic response and consequently more severe infections. Malnutrition impairs host immune responses, including cell-mediated immunity and secretory IgA production. Protein-calorie malnutrition is a major cause of secondary immune deficiency in the world.^[5] In developing countries, exclusively breast-fed babies are less likely to be exposed to contaminated foods and may have a better nutritional status in the first months of life, which may contribute to the reduction in incidence and the severity of infectious diseases.^[6] There is a strong positive effect of exclusive breastfeeding in the first months of life on infant survival. It was estimated that 27% of the monthly hospitalizations of lower respiratory tract infection can be prevented by exclusive breastfeeding and 25% by partial breastfeeding.^[7] Anemia is a significant risk factor for ALRTI. Anemic children were 5.75 times more susceptible to ALRTI compared to the non-anemic children, and it was concluded that prevention of anemia, due to whatever etiology, will reduce the incidence of ALRTI.^[8]

Lower vitamin D status was associated with early childhood ALRTI.^[9] Humoral immunodeficiency is known in rickets, mainly in the form of dysgammaglobinemia, poor antibody response, defective opsonization and bacterial killing.^[10]

Justification of the study

As prevention in the health care of infants, children, and adolescents is the core of pediatrics and many of the risk factors for ALRTI can be corrected including nutritional risk factors, this case-control study was carried out to assess the nutritional risk factors for acute lower respiratory tract infections among less than 5-year-old children in Basrah.

SUBJECTS AND METHODS

A case-control study has been carried out on infants and children, less than 5 years old with ALRTI and healthy children over the period from the 4th of November 2007 till the end of May 2008. Pneumonia is defined as the presence of cough with fast breathing of more than 50/min in infants between age group 3-12 months and more than 40/min in children aged 13-60 months.^[11] A total of 110 patients, their ages ranged from 2-60 months with ALRTI who have been admitted to pediatric wards at Basra Maternity and Children Hospital were recruited in this study. A total of 207 age-matched, apparently, healthy infants and children were randomly selected from children visiting the outpatient department of Basra Maternity and Children Hospital and Al-Razie Primary Health Center for vaccination, minor illnesses (other than respiratory diseases) and those accompanying their parents during their visits were included in the study.

Exclusion criteria

Children with previous history of wheezing, congenital heart disease, and patients with chronic underlying illnesses like cerebral palsy. Infants less than 2 months were excluded since the assessment of pneumonia and severe pneumonia is different in the young infant aged 7-59 days.^[2]

Data collection:

A verbal, informed consent was obtained from one of the parents or other caregiver (for patients and control group) before enrollment in

the study. A special questionnaire was designed for the purpose of the study. The following information were taken: Name, sex, age (in months), the type of feeding in early life (breast, bottle, mixed), its duration, and age of introduction of weaning foods. A detailed history of relevant symptoms like fever, cough, rapid breathing, refusal of feeds, lethargy, wheezing etc. was taken. Physical examination including anthropometric measurement was undertaken for all children with special emphasis on respiratory rate, chest in drawing, stridor in calm child, wheeze and signs of rickets. Weight for height was calculated according to the CDC/WHO normalized references, the child whose weight for height was less than -2 standard deviation (or 2 Z-scores) was considered to be seriously or acutely malnourished.^[12] In addition, classification of condition according to the WHO criteria (very severe disease, severe pneumonia, pneumonia, no pneumonia or cold) was recorded.^[2] A wrist X-ray was done for all children (patients and control group) recruited in the study. A sample of 0.5 ml of blood was taken for estimation of hemoglobin, serum calcium, and serum alkaline phosphatase. These tests were done for all patients and 140 children in the control group. For all children, anemia is defined when hemoglobin (Hb) is less than 10.5g/dl.^[13] Serum calcium (mmol/l) and

alkaline phosphatase were estimated by spectrophotometer in the wave length of 610 nm. Normal value for calcium (2.1- 2.6 mmol/l) and for alkaline phosphatase (14.5-42U/dl).^[14]

Statistical analysis

Statistical analysis was done using SPSS program(version 11), data were expressed and comparisons of proportions was performed using chi-square, P-value of < 0.05 was considered as statistically significant. Logistic regression analysis was also done for the analysis of different potential risk factors, and for each variable the adjusted odd ratio (OR) and 95% confidence interval (CI) were assessed.

RESULTS

The total number children included in the study were (317); 110 children with acute lower respiratory tract infection and (207) children as a control group. The ages of patients with ALRTI range from 2 months to 60 months, with a mean age 12.31 ± 2 months while those of the control group is 14.71 ± 1.2 months, (**Table-1**). The majority of children in this study were infants 226 (71.3%) with a male: female ratio of 1.7:1 in cases and 2:1 in controls, (Table-1). There is no significant difference between cases and controls concerning age and sex of children.

Table 1. Selected socio-demographic variables among cases and control group

Variable	Cases No. (%)	Control No. (%)	P value
Age (months)			
<12	86 (78%)	140 (68%)	0.199
12-35	16 (15%)	46 (22%)	
36-60	8 (7%)	21 (10%)	
Sex			
Male	69 (63%)	139 (67%)	0.157
Female	41 (37%)	68 (33%)	

The nutritional status of infants and children in this study were assessed in both cases and control group, (**Table-2**). Among nutritional variables, there is a statistically significant higher number of infants and children with ALRTI consuming formula feeding as compared to control group (45% vs. 27%), P 0.000. Similarly, early weaning from breast

feeding less than 6 months of age is significantly associated with ALRTI (59% vs. 14%), P < 0.01. In addition, introduction of weaning foods before age of 6 months, presence of anemia, rickets, and malnutrition are significant risk factors for ALRTI, P 0.000, (**Table-2**).

Table 2. Nutritional variables among cases and control groups

Variable	Cases No.(%)	Control No.(%)	OR	CI 95%		P value
				Lower	Upper	
Feeding pattern						
Breastfeeding	60(55%)	152 (73%)	0.167	0.092	0.293	0.000
Formula feeding	50(45%)	55 (27%)				
Duration of breastfeeding						
< 6 months	65(59%)	29 (14%)	0.308	0.214	0.443	0.000
≥ 6 months	45(41%)	178 (86%)				
Age of introduction of weaning food						
< 6 months	32(29%)	158 (76%)	0.375	0.240	0.587	0.001
≥ 6 months	20(18%)	22 (11%)				
Anemia						
Present	58(53%)	28 (14%)	0.103	0.048	0.221	0.000
Absent	52(47%)	179 (86%)				
Rickets						
Present	70(64%)	29 (14%)	0.429	0.327	0.562	0.000
Absent	40(38%)	178 (86%)				
Malnutrition						
Present	54(49%)	17 (8%)	8.55	2.312	31.246	0.000
Absent	56(51%)	190 (92%)				

The level of hemoglobin, serum calcium, and alkaline phosphatase in all patients and in control group (140) were measured. Serum calcium level and hemoglobin level were significantly lower in children with ALRTI compared to the control group, $P < 0.05$ and < 0.01 respectively, (Table-3).

According to the WHO classification, 96 > (87%) children were with pneumonia and 14(13%) with severe pneumonia. None of patients has been classified as having very severe disease. The association between nutritional risk factors and severity of disease was assessed.

Table 3. Selected hematological and biochemical variables

Variable	Group of children	No.	Mean ± SD	T-test	P-value
S.Ca (mmol /l)	Cases	110	2.164 ± .286	2.499	0.045
	Controls	140	2.231 ± .191		
S. Alkph (U/dl)	Cases	110	18.436 ± 6.254	0.101	0.35
	Controls	140	18.372 ± 4.923		
Hb (g/dl)	Cases	110	10.174 ± 1.557	10.851	0.01
	Controls	140	11.787 ± 1.07		

Table-4, demonstrates that there is a significant association between the severity of the ALRTI and male sex, and rickets, $P < 0.05$. In addition, there is a significant association between severity of the disease and age of child, serum

calcium, and hemoglobin level, and malnutrition $P < 0.05$. However, severity of malnutrition shows a significant association with the severity of ALRTI.

Table 4. Correlation of different modifiable risk factors with the severity of the disease

Risk factors	B*	SE**	P-value
Male sex	23.2	8.411	0.013
Age	-4.9	8.170	0.044
Rickets	69.6	8.149	0.01
S.Ca	-6.4	6.129	0.41
Hb	-32.1	6.963	0.011
Malnutrition	-32.1	6.963	0.011

*B: Regression coefficient

**SE: Standard error

The whole variables included in the study were subjected to logistic regression analysis to know which variables are significantly associated with ALRTI. Independent risk factors associated

with ALRTI were early weaning from breast feeding before 6 months, malnutrition, anemia, low serum calcium level, $P < 0.05$, (Table-5).

Table 5. Independent risk factors associated with acute lower respiratory tract infection

Variable	B*	SE**	P-value
Breast feeding less than 6 months	182.0	5.773	0.019
Malnutrition	152.4	4.535	0.022
Hb	-46.4	9.208	0.032
S. Ca	-60.7	6.283	0.03

B: Regression coefficient

**SE: Standard error

DISCUSSION

Acute respiratory infections (ARI) are among the leading causes of childhood mortality. Of more than 10 million children who die annually from preventable diseases, pneumonia is responsible for 18.1%, while in low-income countries this percentage rises to 26%.^[15,16] and there is increasing evidence that underlying malnutrition is the reason for increasing frequency of respiratory infections. Thus, there is a need for better knowledge of ALRTI burden and risk factors data that requires introduction of interventions without delay. In this study the WHO definition of clinical pneumonia was used to assess the severity of acute respiratory tract infections, a more recent study have reported that the WHO classification of non-severe, severe and very severe pneumonia correlated well with disease severity, but poorly with the probability of definitive or probable bacterial etiology for infection. The category of severe pneumonia presenting with chest in drawing showed high specificity for lower respiratory infection.^[17] In this study infants (2-12 months) were at greatest risk of developing severe pneumonia, the same result was reported by Hassan et al in Basra,^[18] and Bhat et al in

India.^[19] Simoes EA reported that age less than 6 months is an independent risk factor for severe ALRTI^[20] This is probably due to small caliber of airways in young infants that makes them particularly susceptible to severe infection.^[21] In addition, male sex was also significantly associated with the severity of ALRTI; the same result was obtained in a previous study in Basrah.^[18] Exclusive breast feeding in the first 6 months is confirmed to be protective against ALRTI in the current study. This is due to the protective and anti-infective properties of the breast feeding, improvement of the nutritional status and the child will be less likely to be exposed to contaminated foods. This in agreement with results of other studies done by ParicioTalayero et al in Spain^[6], Quigley et al in UK^[7], and Hassan et al in Basra.^[18] At the same time the study has revealed that formula feeding was a significant risk factor for ALRTI, similar results were obtained by Savitha et al in India^[10], and Duijts et al in Netherlands.^[22] Thus, promotion of breast feeding is one of the important strategies integral to the WHO programme for the control of ARI. Age of introduction of weaning food before six months

of age was a significant^[10], as early introduction of weaning foods is associated with interruption of breast feeding. This study has confirmed that anemic children, whatever the etiology, are more prone for ALRTI and increased severity of disease as compared to non-anemic children. Similar results were obtained by Hassan et al in Basra^[18], Savitha, et al in India^[10] and Ramakrishnan, et al in India.^[8] Hemoglobin facilitates O₂ and CO₂ transport, carries and inactivates nitric oxide (NO), and plays the role of buffer. Hemoglobin in the blood is mainly responsible for stabilizing the oxygen pressure in the tissues. Quantitative and/or qualitative reduction in hemoglobin, may adversely affect the normal function.^[8] Presence of rickets is a significant risk factor for ALRTI and increased severity in the present study. In addition, children with low serum calcium present with more severe respiratory illness. Similar results were reported by other studies by Savitha et al in India,^[10] and Najada et al.^[23] Oduwole et al have reported that Vitamin D insufficiency, and deficiency, may play an important role in the immune and hemopoietic system and therefore affect the response of a child to infections especially pneumonia. In addition, hypocalcaemia was more frequent among subjects with low of vitamin D compared with those who had normal levels.^[24] Efforts to prevent vitamin D deficiency or calcium supplementation may result in significant reductions in morbidity and mortality from pneumonia in the children.^[10] Malnutrition is significantly associated with increased severity of ALRTI disease similar results were obtained by other studies.^[10,18] Overall malnutrition is associated with a two to three fold increase in mortality from ALRTI, and improvements in the quality of complementary foods may reduce the risk of ALRTI incidence or mortality.^[25] It is well known that malnourished children have multiple immune system abnormalities, including lymphoid organ atrophy, profound T-cell deficiency, altered ratios of T-cell subsets, and decreased natural killer (NK) cell activity and cytokine production. In addition, malnutrition decreases T-cell function, cytokine production and the ability of lymphocytes to respond appropriately to cytokines.^[5]

CONCLUSIONS

From this study it can be concluded that formula feeding, early weaning from breast feeding before 6 months and administration of weaning food before the age of 6 months are significantly associated with ALRTI. Presence of anemia, rickets and malnutrition are significant risk factors for ALRTI and also for a more severe disease.

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Conflicts of Interest: None

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