

Community-Acquired Pneumonia (CAP) in Children under 5 Years of Age

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ABSTRACT

BACKGROUND

In India epidemiological and social changes occurred concomitantly with the universal introduction of the 10-valent pneumococcal conjugate vaccine. This study identified risk factors for pneumonia following the implementation of a pneumococcal vaccination program. Objective of the present study was to analyse the risk factors for community-acquired pneumonia in children under 5 years of age.

METHODS

A community based cross-sectional study was undertaken between January and December 2019. Hospitalised children aged 2 – 59 months with chest-radiography-confirmed CAP were enrolled for whom vaccination cards were available. We included child-related factors and sociodemographic factors.

RESULTS

The study included 160 children - 80 cases and 80 controls. There were more male children and more children over 1 year of age in the control group. Variables that were significantly different between groups were age < 1 year, low / very low weight for age, and not having been vaccinated against the influenza virus. There was no significant difference in birth weight, prematurity, previous respiratory diseases, breast feeding, and any other diseases and regarding the use of 10-valent pneumococcal vaccine when comparing cases and controls. Sociodemographics like household crowding, maternal age, smoking, lower socio-economic condition, and maternal education are significantly associated with pneumonia.

CONCLUSIONS

Effective community-based interventions like health education, generating awareness amongst the people living in the slums may go a long way in addressing the risk factors as well as reducing the burden of pneumonia in these areas.

KEYWORDS

Pneumonia, Influenza Vaccine, Pneumococcal Conjugate Vaccine

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BACKGROUND

Pneumonia is the inflammation of lung parenchyma due to pathogenic micro-organisms such as bacteria, viruses and fungi. Clinically, it is also defined as a condition typically associated with fever, respiratory symptoms, and evidence of parenchymal involvement, either by physical examination or the presence of infiltrates on chest radiograph. CAP is defined as pneumonia in a previously healthy child who acquired the infection outside a health facility or develops the illness within 48 hours of admission into a health facility. Community acquired pneumonia (CAP) is the leading cause of mortality of under-five children in developing countries, including India. Annually there are 151.8 million new cases of CAP.¹ Among these 8.7 % (13.1 million) cases are severe enough to require hospitalization.¹

WHO has defined severe pneumonia as CAP with presence of certain danger signs such as not able to drink, persistent vomiting, convulsions, lethargy or unconsciousness, stridor in a calm child or severe malnutrition. Children with fast breathing, with or without chest in-drawing are classified as "pneumonia" and children with pneumonia and with any danger signs are classified as severe pneumonia.

The presence of comorbidities as risk factors for CAP in childhood has been well defined in previous studies, and these comorbidities are accepted as the main risk factors.² In our study, we intended to verify risk factors in previously healthy children. Therefore, the objective of the present study was to analyze the risk factors for community-acquired pneumonia in children under 5 years of age, excluding neonates. This study intended to describe the clinical characteristics of CAP and explore the risk factors of severe CAP among children.

METHODS

A community based cross-sectional study was undertaken from January to December 2019. Hospitalised children aged between 2 to 59 months with chest radiography-confirmed CAP were enrolled for whom a vaccination card was available. We included child-related factors (birthweight, breastfeeding, nutritional status, previous respiratory disease and / or allergy, previous hospitalization, 10-valent pneumococcal conjugate vaccine, influenza vaccine) and sociodemographic factors. Exclusion Criteria: Concomitant primary disease, such as heart, liver, or kidney disease; chronic lung disease; neuropathy; diagnosis of immunodeficiency.

Inclusion Criteria

The case group consisted of children admitted to the hospital wards or to the intensive care unit with a clinical and radiological diagnosis of CAP made in accordance with the following WHO diagnosis criteria:

1. Increased respiratory rate (rate > 60 breaths / minute if aged < 2 months, > 50 breaths / minute if aged 2 – 11 months, and > 40 breaths / minute if aged 12 – 59 months);
2. Lower chest wall in drawing (severe pneumonia); or
3. Cyanosis and / or inability to feed or drink (very severe pneumonia)

Chest X-rays were analysed independently by two radiologists according to the WHO criteria for epidemiological studies on vaccine effectiveness. To render the study feasible, a control group was selected from among members of the community served by the hospital. This group consisted of healthy children who had been admitted to the hospital for elective surgery and didn't have previous history or diagnosis of pneumonia by WHO criteria at the time of recruitment. The controls were recruited in accordance with the eligibility criteria on the same day or within 3 days of case allocation.

Overall, the study included children from 1 to 59 months of age for whom a vaccination card was available. Children were excluded if they had any concomitant primary disease, such as heart, liver, or kidney disease; chronic lung disease; neuropathy; hemoglobinopathies; congenital lung malformation; or a known diagnosis of immunodeficiency.

Allocation before starting data collection, the research assistants were trained for data collection methods. The laboratory technicians were trained on study-specific sample transportation, processing, and storage. The Statistical Package for Social Sciences software program, version 20.0, was used throughout the statistical analysis. Risk factors reaching a significance level of $p \leq 0.05$.

RESULTS

Study included 160 children: 80 cases and 80 controls. Frequency distribution of the variables related to the child's past and current health, comparing cases and controls are analysed.

Variables Cases (n = 407) N (%).

Controls (n = 407) N (%).

P-Value OR 95 % CI.

Sex Female 194 (47.7) 141 (34.6) 1.

Male 213 (52.3) 266 (65.4) < 0.01 0.58 0.44 - 0.77.

Age $\geq$ 1 year 241 (59.2) 324 (79.6) 1.

< 1 year 166 (40.8) 83 (20.4) < 0.01 2.68 1.97 - 3.67.

Birth weight a > 2500 g 327 (87.9) 329 (85.5) 1.

< 2500 g 45 (12.1) 56 (14.5) 0.32 0.80 0.53 - 1.23.

Prematurity b No 346 (91.0) 349 (89.3) 1.

Yes 34 (9.0) 42 (10.7) 0.40 0.82 0.51 - 1.31.

Respiratory disease / previous allergy No 367 (90.2) 374 (91.9) 1.

Yes 40 (9.8) 33 (8.1) 0.40 1.22 0.76 - 1.99.

Previous hospitalization c No 326 (81.7) 355 (87.2) 1.

Yes 73 (18.3) 52 (12.8) 0.03 1.53 1.04 - 2.24.

Exclusive Breastfeeding (4 – 6 months) d.

Yes 203 (49.9) 212 (52.8) 1 No 204 (50.1) 192 (47.2) 0.53
 1.09 0.83 – 1.44
 Nutritional status (Weight-for-age ratio) d
 (> - 2 z score) 362 (89.2.) 383 (94.1) 1
 (≤ - 2 z score) 44 (10.8) 24 (5.9) 0.01 1.93 115 – 3.23
 10-valent pneumococcal conjugated vaccine Vaccinated 254
 (62.4.) 258 (63.4) 1.
 Unvaccinated 153 (37.6.) 149 (36.6) 0.77 1.04 0.78 – 1.38.
 Influenza virus vaccine Vaccinated 172 (42.3) 289 (71.0) 1.
 Unvaccinated 235 (57.7) 118 (29.0) < 0.01 3.34 2.50 – 4.

Variables		Controls N = 80	%	Cases N = 80	%	P- Value
Gender	Female	29	36.25	34	42.5	< 0.05
	Male	51	63.75	46	57.5	
Age	> 1 year	53	66.25	45	56.25	< 0.05
	< 1 year	27	33.75	35	43.75	
Birth Weight	> 2500 gms	64	80	63	78.75	> 0.05
	< 2500 gms	16	20	17	21.25	
Prematurity	No	68	85	67	83.75	> 0.05
	Yes	12	15	13	16.25	
Previous Respiratory Disease	No	63	78.75	61	76.25	> 0.05
	Yes	17	21.25	19	23.75	
Brest Feeding	No	37	46.25	39	48.75	> 0.05
	Yes	43	53.75	41	51.25	
Any other Diseases	No	69	86.25	70	87.5	> 0.05
	Yes	11	13.75	10	12.5	
Weight to Height Ratio	> - 2 z score	66	82.5	45	56.25	< 0.05
	< 2 z score	14	17.5	35	43.75	
10 Valent Pneumococcal Conjugated Vaccine	Vaccinated	58	72.5	56	70	> 0.05
	Unvaccinated	22	27.5	24	30	
Influenza Vaccine	Vaccinated	44	55	35	43.75	< 0.05
	Unvaccinated	26	32.5	45	56.25	

Table 1. Distribution of the Child-Related Factors for Risk of Acquiring Pneumonia

#Breastfeeding when the child had been exclusively breastfed for 4 months.

#Nutritional status according to z-score of -2, the weight-for-age ratio was classified into two categories: very low or low weight for age and normal weight for age.

#10-valent pneumococcal conjugated vaccine children were considered to have been vaccinated if they had received at least two doses prior to their first birthday or one dose after their first birthday.

#Influenza virus vaccine children who were immunized according to the immunization card received: a) At least one dose if they received the prime vaccination previously and had been immunized with two doses or

b) Two doses of the prime vaccination children under 6 months of age and those over 6 months of age who had not been immunized were classified as unvaccinated.

There were proportionally more male children and more children over 1 year of age in the control group. Variables that were significantly different between groups were age < 1 year, low / very low weight for age and not having been vaccinated against the influenza virus. There was no significant difference in birth weight, prematurity, previous respiratory diseases, breast feeding and any other diseases and regarding the use of 10-valent pneumococcal vaccine when comparing cases and controls.

Variables		Controls N = 80	%	Cases N = 80	%	P- Value
Household crowding	No	71	88.75	65	81.25	< 0.05
	Yes	9	11.25	15	18.75	
Maternal age	>19 years	71	88.75	69	86.25	< 0.05
	<19 years	8	10	11	13.75	
Smoking in the home	No	67	83.75	63	78.75	< 0.05
	Yes	13	16.25	17	21.25	
Socioeconomic status						
Upper Middle Class and above		16	20	14	17.5	< 0.05
Lower Middle class		24	30	24	30	
Upper Lower Class		36	45	37	46.25	
Lower Class		4	5	5	6.25	
Maternal education						
Illiterate		14	17.5	19	23.75	< 0.05
Up to primary		16	20	18	22.5	
Up to matric		40	50	39	48.75	
High school and above		10	12.5	4	5	
Table 2. Distribution of the Sociodemographic Factors for the Risk of Acaquiring Pneumonia						

Table 2. Distribution of the Sociodemographic Factors for the Risk of Acquiring Pneumonia

Monthly family income or total household income, i.e., considering the earnings of all individuals living in the household.

Categorized as ≤1 or > 1 minimum wage. (the minimum wage is the lowest remuneration that employers may legally pay to workers per month). During the period corresponding to the data collection the range was U\$ 210.00 to 230.00.

Maternal education 1) Did not finish high school (<11 years of schooling) 2) Finished high school (≥11 years of schooling).

Household crowding Defined as ≥2 individuals sleeping in the same room as the child.

Maternal age Based on the WHO concept of adolescence, maternal age was categorized into <19 years and ≥ 19 years.

Smoking in the home: Whether any members of the household smoked and whether the child's mother smoked.

Socio-economic status based on Kuppuswamy classification 2014.

According to the socio demographic factors evaluated. All the factors evaluated were found to significantly increase the risk for CAP.

DISCUSSION

Community-Acquired Pneumonia (CAP) causes great morbidity and mortality as well as enormous economic burden worldwide. In our study it was found males are more likely to develop lower respiratory tract infections. The greater resistance found in females can be explained by their enhanced immune response.³ In the present study, female gender constituted a protective factor against pneumonia. Few studies suggest that parents are more likely to bring their male children to the hospital for pneumonia than their female children and that female children suffer from more severe pneumonia than male children when they are admitted to the hospital.⁴

Studies reporting a protective effect of the influenza vaccine against pneumonia also referred to its protective role against co-infections by bacteria traditionally related to CAP, which support present study. As a means of preventing CAP,

the WHO recommends that immunization programs include vaccines against measles, pertussis and influenza as well as haemophilus influenzae type b and pneumococcal conjugate vaccines. The majority of case-control studies published in the literature were conducted prior to the introduction of the pneumococcal conjugate vaccine or were carried out in countries in which the vaccine was not routinely used.⁵

In the present study, household crowding was defined as two or more individuals sleeping in the same room as the child, as this was the situation that most closely reflected the conditions reported by the parents or guardians of the children included in the study. Following the improvement in economic conditions in the country, living conditions in homes with few rooms may reduce the transmission of respiratory pathogens.

Among the environmental risk factors of CAP, smoke due to use of biomass fuel for cooking has been extensively studied. Ambient air pollution resulted in two to four fold increased risk of CAP proven by Bhat and Manjunath, Broor et al, Mahalanabis et al.^{6,7,8} Still in rural India, 61.7 - 65.4 % of households use coal and wood as source of fuel for cooking [NFHS III 2007; DLHS III 2010].⁹ Other important environmental risk factors are overcrowding, in studies done by Tiewsoh et al.¹⁰ and Shah et al.¹¹ Upper or lower respiratory infection in a family member in study by Broor et al.⁷, Bhat and Manjunath,⁶ poor housing and indoor parental smoking by Acharya et al.¹² Despite statutory warning against tobacco, smoking by parents is prevalent in India.

In our study lower socio-economic status is significantly associated with occurrence of pneumonia. Lower income is cited as a risk factor for ARI (Acute Respiratory Infection).¹³ Similar result was shown in another study done in Hooghly district of West Bengal.¹⁴

Nutritional risk factors for CAP were lack of exclusive breast feeding for first 6 months of life,¹⁰ inappropriate timing and content of complimentary feeding,^{6,11} iron deficiency anaemia⁶ and malnutrition.^{6,7} This can also translate into 30 - 42 % increased incidence of respiratory infections in children in underdeveloped countries.¹⁵

Parents' educational level, particularly maternal schooling, is inversely related to morbidity and mortality from pneumonia in childhood, as mothers with more years of schooling are presumably more capable of taking care of their children.¹⁶ The variable, whether the mother had completed high school was used in the present evaluation in an attempt to make it as unlikely as possible that the positive variable would conceal cases of functional illiteracy, which, for healthcare-related purposes, is the same as complete illiteracy. Similar to what was found in the present study, other investigators have also failed to find any association between these factors. Educated mothers recognize the signs and symptoms of pneumonia early and so access health care earlier and so their children have a better outcome than others.¹⁷ A study conducted in Nigeria reveals that poor parental educational status is significantly associated with ARI.¹⁸

The possible protection offered by the influenza vaccine, as shown in this study, must be evaluated in etiological studies to assess role of virus in incidence of pneumonia.

Further studies on a wide range of possible risk factors that have not yet been evaluated in the community are required to clarify this question.

CONCLUSIONS

In a developing country like India, pneumonia is a common childhood illness. Risk factors include very low weight for age and not having been vaccinated against the influenza virus. Also, household crowding, maternal age, smoking, lower socio-economic condition, and maternal education. Effective community-based interventions like health education, generating awareness amongst people living in the slums may go a long way in addressing the risk factors as well as reducing the burden of pneumonia in these areas.

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