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Contributing Risk Factors to Pneumonia in Children Under Five Years in Madhesh Province of Nepal

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Abstract:-

➢ ***Introduction:***

Pneumonia is the significant cause of morbidity and mortality in under five year children worldwide. In Nepal, pneumonia is the second most common cause of childhood mortality. Exclusive breastfeeding and basic immunization in preventing pneumonia cannot be underestimated. This study aims to assess the contributing risk factors associated with childhood pneumonia among children aged 16 months to under-5 year.

➢ ***Methods:***

A case-control study was conducted from January to July 2022 including children under 5 years visiting the pediatric out-patient department of JMCTH. A total of 200 subjects aged 16–59 months were enrolled, in which 'cases' included 100 patients diagnosed with pneumonia and 'controls' included 100 patients with non-pneumonia illnesses, matched by age and setting. The WHO guideline was followed for the diagnosis of pneumonia. The data on contributing risk factors were collected from both cases and controls via interview method from their parents.

➢ ***Results:***

The study showed non-exclusive breastfeeding [odds ratio (OR) =7.82 in 95% confidence interval (CI)], indoor air pollution [OR=7.47 in 95% CI], incomplete basic immunization [OR= 4.44 in 95% CI], low birth weight [OR=3.11 in 95% CI] and severe acute malnutrition i.e. high degree of wasting [OR=2.70 in 95% CI] were the major contributing factors of pneumonia in children under age five in the Madhesh Province of Nepal. However, nutritional status (height-for-age z score), age, sex, and educational status of mother did not appear to be contributing risk factors for pneumonia.

➢ ***Conclusion:***

This study highlights non-exclusive breastfeeding, indoor air pollution, incomplete basic immunizations, low birth weight, and severe acute malnutrition significantly increase the risk of childhood pneumonia. Exclusive breastfeeding plays a vital role, while gender seems to influence the relationship between exclusive breastfeeding and pneumonia incidence.

Keywords:- *Breastfeeding; Immunization; Nutritional Status; Pneumonia.*

I. INTRODUCTION

Pneumonia is a significant contributor to the morbidity and mortality among infants and young children in both developed and developing nations. It stands out as a major public health concern for children below age of 5. WHO reports that annually, there are over 150 million cases of pneumonia, constituting more than 95% of all new cases worldwide.[1]

Among the leading causes of infant mortality, pneumonia ranks within the top 5. According to the United Nations Children's Fund (2015), pneumonia-related causes claimed the lives of 100 children per hour, with a death rate of 20% in developing countries, in contrast to 4% in developed countries.[2,3]

Contributing risk factors associated for pneumonia include malnutrition, indoor air pollution (arising from cigarette smoke within the household, use of mosquito coils, and firewood stoves for cooking), high population density within the dwelling, zinc deficiency, the educational level of the mother, her previous experience in childcare, presence of comorbidities, day care attendance, humidity, cold weather, inadequate vitamin A intake, birth sequence, and low birth weight (LBW).[4,5] Key factors deemed crucial for pneumonia prevention are exclusive breastfeeding until the age of 6 months and completion of basic immunizations (Expanded Program on Immunization [EPI] coverage.[6,7]

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The exclusive breastfeeding coverage in Dhanusha District, Province 2, Nepal, falls below the national target rate. Additionally, the completeness of basic immunization, or EPI coverage, Dhanusha has not reached the goal set for Universal Child. Despite the accomplishments in immunization, the incidence of pneumonia continues to be elevated in this region, with a noticeable increase in new cases. Consequently, targeted research is essential to identify risk factors linked to the high occurrence of childhood pneumonia in Dhanusha.

II. METHODS

As case-control study conducted in JMCTH, Province 2, Nepal, from January to June 2022, this research contains a case group consisted of children aged 16–59 months who were diagnosed with pneumonia; and control group included healthy or sick children of the same age who sought treatment at the health facility during the same period but were not diagnosed with pneumonia.

The internal independent variables considered were breastfeeding-nonexclusive and exclusive (for the first 6 months of age) and the basic immunization-incomplete and complete in extended programme on immunization (EPI) schedule, and the dependent variable was the incidence of child pneumonia. External independent variables included age, sex, mother's education, nutritional status (stunting height-for-age <-2.0 z score and wasting body weight-for-height < -2.0 z score), history of low birth weight (LBW), and indoor air pollution (caused by cigarette smoke, use of mosquito coils, firewood stoves for cooking).

Subjects were selected from the age of 16 months onwards to facilitate the identification and classification of children who received complete basic immunization, as the limit for the last basic immunization EPI schedule in children in Nepal is 15 months of age. This approach enabled a clear assessment of the relationship between complete basic immunizations in EPI and the incidence of childhood pneumonia.

Data collection employed a nonprobability sampling technique using consecutive and convenient sampling for both case and control groups. The samples were evenly taken from the outpatient department (OPD) with a total of 200 subjects, including 100 children in each group. The case group was selected based on medical record data, with children diagnosed with pneumonia according to the Integrated Management of Childhood Illness (IMCI) approach, which is a reference for health workers to classify pneumonia in children aged 2 months to 5 years.

To choose the control group, age and seasonal (setting) matching techniques were used to avoid bias. Controls were selected from children of corresponding same age groups, who were not diagnosed with pneumonia but suffered from influenza, tonsillitis, or the common cold during the same time frame as the case samples. If the number of eligible children for the control group exceeded that of the case group, random selection was employed.

Data were collected from patient medical records and through interviews with the children's parents using a valid questionnaire. Anthropometric examinations were also noted. Surveys of the respondents' home conditions were conducted directly asking questions during collecting data with parents.

The study received ethical clearance from the Medical and Health Research Ethics Committee of JMCTH (approval no. IRB-JMC/2020/36), and written informed consent was obtained from parents and guardians of the children after providing detailed information about the study.

In the analyses, description of sample was done by calculating frequencies and percentage. Analytic study was done by using bivariate analytic method such as chi-square test and multivariate analytic method such as logistic regression if required. Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS) version 22. Bivariate analysis was performed through a 2-stage chi-square(χ^2) analysis. In the first stage, the relationship between the independent variables and the dependent variable was examined where the odds ratio is 1 when there is no relationship, while the second stage involved determining the odds ratio (OR) to assess the relative risk. We can test the null hypothesis that the odds ratio is 1 by the usual χ^2 test. A p-value of < 0.05 was considered significant in discussions of factors related to the odds of having pneumonia.

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III. RESULTS

A. Attribute of Study Population:

Table 1: Attribute of Study Population (Children of 16–59 Months of Age)

Variable		No.	%
Age(Months)	16 to 36	108	53.98
	37 to 59	92	46.02
Sex	Male	98	48.86
	Female	102	51.14
Breastfeeding	Non-exclusive	127	63.64
	Exclusive	73	36.36
Basic immunization	Incomplete	80	39.77
	Complete	120	60.23
Vitamin A supplementation	Incomplete	50	25
	Complete	150	75
Nutritional status (Height for age *z* score)	Stunted	49	24.43
	Non-stunted	151	75.57
Nutritional status (Weight for height *z* score)	Wasting	27	13.64
	Normal	173	86.36
Low Birth weight (LBW)	LBW	26	13.07
	No LBW	174	86.93
Mother's education	Low	111	55.68
	Middle-high	89	44.32
Household air pollution	Yes	141	70.45
	No	59	29.55

*Note: Vitamin A Supplementation-

- Complete: Got complete bi-annual Vitamin A supplementation till the date (as much as 10 times according to the government schedule for 6 months to 5 years of age).
- Incomplete: Got if less than bi-annual schedule and less than 10 times for age of 5 year according to the specified schedule.

B. Association of Contributing Risk Factors with Child Pneumonia:

Table 2: Association of Contributing Risk Factors with the Incidence of Pneumonia in Children Aged 16–59 Months

Variables		Incidence of pneumonia		Total	OR of pneumonia in respect to independent variable(in 95% CI)	P value
		Yes	No			
Age(months)	16-36	58	50	108	1.37	0.291
	37-59	42	50	92	1	
Sex	Male	47	51	98	1.19	0.547
	Female	53	49	102	1	
Breastfeeding	Non-exclusive	85	42	127	7.82	0.001
	Exclusive	15	58	73	1	
Basic immunization	Incomplete	57	23	80	4.44	0.001
	Complete	43	77	120	1	
Vitamin A supplementation	Incomplete	31	19	50	1.91	0.08
	Complete	69	81	150	1	
Nutritional status (Height for Age *z* score)	Stunted	30	19	49	1.82	0.115
	Not stunted	70	81	151	1	
Nutritional status (Weight for Height *z* score)	Wasting	19	8	27	2.70	0.028
	Normal	81	92	173	1	
LBW history	LBW	19	7	26	3.11	0.014
	No LBW	81	93	174	1	
Mother's education	Low	60	51	111	1.44	0.226
	Middle-high	40	49	89	1	
Household air pollution	Yes	89	52	141	7.47	0.001
	No	11	48	59	1	

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- Interpretations: Odds of pneumonia were 7.82 times higher (OR=7.82 at 95% confidence interval [CI] and P value=0.001) in children who were not exclusively breastfed.

Odds of pneumonia were 4.44 times higher (OR=4.44 at 95% CI and P value=0.001) in children who did not receive complete basic immunization (EPI coverage).

C. Interaction and Stratification Test

Table 3: Impact of Non-Exclusive and Exclusive Breastfeeding on Pneumonia Incidence among Children Aged 16-59 Months, Stratified by Gender

Variables		OR (95%CI)	P value
Male child with breastfeeding status	Male child; Non-exclusive breastfeeding	3.9	0.004
	Male child: Exclusive breastfeeding	1	
Female child with breastfeeding status	Female child: Non- exclusive breastfeeding	17.4	0.001
	Female child: Exclusive breastfeeding	1	

- Interpretation: Since odds ratio (OR) 0.083 in bivariate analysis increased to 3.94 for boys and 17.4 for girls, we can conclude that female children (aged 16-59 months) who are not exclusively breastfed are more likely to experience pneumonia.

IV. DISCUSSION

Children who were not exclusively breastfed for the first six months faced nearly eight times the risk of developing pneumonia compared to those who were exclusively breastfed. In our study, only 36% of the children were exclusively breastfed, a figure significantly below the World Health Organization's (WHO) target of 50%. Breast milk is rich in essential nutrients, hormones, growth factors, and elements that help protect against allergies, reduce inflammation, and boost the immune system. Recent studies from the United States and the United Kingdom have shown that children who were exclusively breastfed had notably fewer illnesses compared to those who were not.[8,9] Colostrum, the first form of breast milk, is particularly important as it contains about 16% protein and includes critical components like immunoglobulin-A, lactoferrin, and white blood cells, all of which are key in preventing infections.[10]

In our study, 60% of participants had received full basic immunization, although this figure remains below the national target. Our analysis shows that children who lacked complete basic immunizations had nearly five times the risk of developing pneumonia compared to those who were fully immunized. These findings align with Damanik et al., who found that children aged 12 to 24 months suffering from acute respiratory infections (ARIs) are 3.8 times more likely to be missing basic immunizations than those without ARIs, including pneumonia.[11] Similarly, Madhi et al. emphasized the crucial role vaccines play in preventing pneumonia.[7]

Our study found no significant relationship between the age of the children and the incidence of pneumonia among the participants. This lack of correlation may be due to differences in age distribution between the groups, with most children in the case group being over 2 years old. Similarly, Muhe et al. also concluded that there is no correlation between age and pneumonia in children under five.[12]

In our study, we found no association between gender and the incidence of pneumonia among children. This finding may be influenced by the differing proportions of males and females in the study sample. Although some studies suggest a higher occurrence of acute respiratory infections (ARIs) in boys under five compared to girls,[13] both Greenberg et al. and Sukamawa et al. reported no significant link between gender and the incidence of pneumonia in children (P=0.09).[14] Similarly, Nieminen et al. found no significant relationship between gender and pneumonia incidence in their research on toddlers.[15]

The interaction and stratification tests revealed a significant link between gender and exclusive breastfeeding in relation to the incidence of childhood pneumonia. This suggests that among infants and toddlers who are not exclusively breastfed, girls are at a higher risk of developing pneumonia compared to boys. Several factors could explain this trend in Dhanusha, Nepal. One possible reason is that girls in this region may spend more time indoors, which could lead to greater exposure to indoor air pollution.

In our study, we found no relationship between maternal educational status and the incidence of pneumonia in children. This finding is consistent with Budiati's study, which also reported no significant association between maternal education and pneumonia rates.[16] Similarly, Fatmi and White found no meaningful correlation between parental education and the occurrence of childhood pneumonia.[17] Tiewsoh et al.'s study produced comparable results.[18] However, these findings contrast with those of Nirmolia et al., who identified a significant link between lower maternal education levels and a higher incidence of pneumonia.[19]

Our study found no significant correlation between chronic nutritional status (measured by Height-for-Age Z-score, HAZ) and the incidence of childhood pneumonia. This lack of association may be attributed to the fact that most participants displayed normal growth patterns. While past nutritional status cannot be determined with certainty, the height measurements taken at the start of the study likely represented the nutritional status during the pneumonia incidence. Fatmi and White have noted that the effect of nutritionally-related short stature on lung function growth and development remains unclear.[17]

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The association between acute nutritional status (measured by Weight-for-Height Z-score, WHZ) and pneumonia incidence in our study is consistent with findings from Fonseca et al., who identified malnutrition related to weight and height as a critical risk factor for childhood pneumonia.[20] Similarly, Nurnajiah et al. reported a significant link between the nutritional status of hospitalized children (aged 13–59 months) and pneumonia in Padang.[21] These results support Caulfield et al.'s findings, which indicate that childhood malnutrition plays a significant role in the global burden of disease, with malnutrition being directly responsible for 52.3% of child deaths from pneumonia.[22]

Children with a history of low birth weight (LBW) are over three times more likely to develop pneumonia compared to those without LBW history. This finding aligns with Hadisuwarno et al., who also reported a significant link between LBW and an increased risk of pneumonia (P=0.005).[23] Although nutritional factors may primarily exert indirect effects, their long-term impact remains a crucial risk factor for pneumonia.

Children living in homes with high levels of indoor air pollution face over seven times the risk of developing pneumonia compared to those in homes with lower pollution levels. The main contributor to this indoor air pollution is cigarette smoking by family members. Indoor smoking, along with the use of mosquito coils and firewood stoves, significantly deteriorates air quality. In Dhanusha, many families use firewood for cooking, a common practice in rural areas. However, the combustion of biofuels such as firewood, charcoal, agricultural residues, and livestock manure has been associated with respiratory diseases in various developing countries.[24,25] Research highlights the increased risk of severe pneumonia due to the disruption of respiratory defenses caused by exposure to particles from biofuel combustion.

The use of mosquito coils inside homes, including in bedrooms where children sleep, remains widespread, exposing them to harmful chemicals. These coils emit substances that can damage the respiratory system. Research by Zhang et al. has shown that exposure to the smoke and by-products of burned mosquito coils poses significant acute and chronic health risks.[26] Remarkably, a single mosquito coil used indoors releases an amount of pollutants equivalent to that of 75 to 137 cigarettes, producing smoke that contains toxic carbonyl compounds like formaldehyde and acetaldehyde. These compounds not only irritate the respiratory tract but are also recognized carcinogens.

In a 2014 case-control study conducted in Nepal by Karki S, Fitzpatrick AL, and Shrestha S, two modifiable smoke-related risk factors were identified as significant contributors to pneumonia in young children.[27] The study found that the presence of a smoky stove (chulo) in the household and parental smoking were both associated with an elevated risk of pneumonia in children.

According to a hospital-based descriptive cross-sectional study conducted in Fishtail Hospital and Research Center (FHRC) in Pokhara, Nepal, during the peak period of November 2017 to February 2018, several risk factors were found to be significantly associated with Acute Respiratory Infection (ARI) in children.[28] The study identified malnutrition, exposure to wood smoke and mosquito coil, as well as contact with a person having ARI, as notable risk factors contributing to ARI in children.

In a case-control study conducted by Vivi Ninda Sutriana, MPH, et al. in Indonesia in November 2021, the researchers investigated risk factors for childhood pneumonia.[29] The study's results were found to be similar to those of our own study. Such concurrence in findings from different studies can add further support to the identified risk factors and their implications in pneumonia incidence among children.

In 2022, Ghimire P. et al. conducted a cross-sectional study at Nepal Medical College and Teaching Hospital and International Friendship Children's Hospital (IFCH) in Kathmandu, focusing on children aged 2–59 months who visited the Pediatric OPD.[30] The study, which included 286 children, found that over half (60.8%) suffered from Acute Respiratory Infection (ARI), with about one-fifth having severe or very severe pneumonia. The researchers identified several significant factors associated with ARI, including the child's presence in the kitchen during cooking, family members with respiratory tract infections, and the influence of religion within the family ($p < 0.05$).

V. CONCLUSION

These findings underscore the critical importance of promoting exclusive breastfeeding and ensuring complete basic immunizations to prevent childhood pneumonia, particularly in regions where the disease is prevalent. Additionally, the results highlight that nutritional status (WHZ), a history of low birth weight (LBW), and indoor air pollution are all significantly linked to the incidence of pneumonia in children aged 16 to 59 months, especially in Madhesh Province of Nepal.

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