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Relationship of Pre-Existing Maternal/Caregiver Acute Respiratory Infection in the Pattern and Risk of Acute Respiratory Infection among Infants in Rivers State, Nigeria

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Abstract

History of upper respiratory tract infection in the mother or siblings was associated with higher risk of acute lower respiratory tract infection in cases. Most upper respiratory tract infections were caused by viral pathogens and likely to occur in many members of the family. The study aimed to determine the existence and pattern of relationship between risk of acute respiratory infection (ARI) among infants and exposure to pre-existing maternal/caregiver acute respiratory tract infection. The study was designed as a community-based Nested case-control study of 1100 infants randomly selected from 12 communities out of 6 Local Government Areas of the 3 senatorial districts of Rivers State. A multistage random sampling technique was used in selecting the subjects up to the community level. Descriptive method was used to represent the characteristics of the subjects and the differences in ARI between exposed and unexposed infants were tested in a bivariate logistics regression at 5% level of significance. Odds ratio (OR) was used to interpret the size effect measures of ARI on exposure to pre-existing maternal/caregiver ARI differences. A total of 275 Cases of ARI and 825 controls were included in the study. Among exposed infants (N = 104), ARI cases were found to be higher n = 80 (76.9%) than in control n = 24 (23.1%). Whereas, among unexposed infants N = 991, ARI cases were found to be lower n = 195 (19.7%) than in control n = 796 (80.3%). For the exposed infants, the odds for ARI were 13.5 times significantly higher compared to those of their unexposed counterparts (OR-Unadjusted = 13.52, ($p < 0.0001$, 95% CI = 0.047 - 0.121)).

The findings will widen the horizon in the etiological consideration of ARI among infants vis-à-vis exposure potential to pre-existing maternal/caregiver ARI via nursing care. Therefore, community-based sensitization programme on barrier nursing care techniques and personal hygiene practices should be on focus.

Keywords

Acute-Respiratory-Infection, Pattern, Risk-Factor, Maternal/Caregiver, Pre-Existing, Barrier-Nursing

1. Introduction

Acute respiratory infection (ARI) is defined as an infection characterized by presence of cough with or without fever for less than two weeks [1]. According to [2], ARI is defined as "an episode of acute symptoms and signs resulting from infection of any part of respiratory tract or related structure, including nose, throat, larynx, trachea, bronchi, bronchioles, lungs, para-nasal and middle ear. A new episode is one occurring in an individual who had been free of symptoms for at least 48 hours".

Pattern in view of epidemiology refers to variation in the manifestation characteristics of health-related events in persons [3], while risk factor in our present discuss refers to factor related to the host and or environment that increases the chances of morbidity (ARI) in infants.

The study from [4], reported that mothers with pneumonia were more likely to deliver prematurely, and have infants of lower birth weight. It is quite possible that the cascade of mediators released by the active host inflammatory response to infection exerts distant effects on the uterus, leading to a high rate of preterm labor during the course of pneumonia. Literatures had equally reported low birth weight among infants as risk factor for ARI in young children; this implies that exposure to pre-existing maternal pneumonia may increase the potential for ARI in infancy from an epidemiological point of view, whose principle and theoretical concepts form the basis for this research work. Our focus in this study was infant exposure to maternal/caregiver respiratory secretions and or droplets by way of nursing care or proximity.

It was reported that an important epidemiologic feature of virtually all influenza pandemics and seasonal epidemics of any degree of severity is the existence of specific groups of people at elevated risk for severe complications and death, including the very young, the very old and patients with underlying chronic respiratory and cardiovascular conditions and pregnant women and their fetuses they carry [5] [6]. Reports had also shown that about 90% of causative agents of acute respiratory infections are viral agents [7] [8] [9] [10] [11], in which the influenza virus is inclusive and known to be highly contagious. This implied that from disease occurrence point of view, such epidemiologic feature

may be equally observed in all acute respiratory infections.

Further report showed that maternal influenza vaccination had been demonstrated to reduce influenza associated hospitalizations in infants under six (6) months old by 45% - 48% [12].

The study by [13], showed that history of upper respiratory tract infection in the mother or siblings was associated with higher risk of acute lower respiratory tract infection in cases. Most of upper respiratory tract infections were caused by viral pathogens and viral infections are highly contagious and likely to occur in many members of the family. Viral upper respiratory tract infection may predispose a child to acute lower respiratory tract infection [14].

It is therefore auspicious to determine the relationship of pre-existing maternal/caregiver ARI in the pattern and risk of acute respiratory infection among infants in view of this study which may have direct innovative prevention and nursing care measures at household level that will complement efforts directed at case management.

1.1. Aim of the Study

The study aimed to determine the existence and pattern of relationship between risk of ARI among infants and exposure to pre-existing maternal/caregiver acute respiratory tract infection.

1.2. Research Hypothesis

Null Hypothesis H_0—There is no relationship between pattern and risk of ARI and exposure to pre-existing maternal/caregiver acute respiratory tract infection/diseases among infants in Rivers State, Nigeria.

Alternative Hypothesis H_1—There is relationship between pattern and risk of ARI and exposure to pre-existing maternal/caregiver acute respiratory tract infection/diseases among infants in Rivers State, Nigeria.

2. Materials and Methods

2.1. Research Design

The design used for this study was community-based prospective-retrospective (Nested) case-control method, aimed at determination of the pattern and risk of ARI among infants in relation to pre-existing maternal/caregiver ARI in the study areas.

The inclusion criteria for cases were children not up to 12 months of age in the study areas with at least any two of the signs and symptoms of cough, running nose or fever less than three (3) days duration among others within two (2) weeks of enrollment/interview. While the inclusion criteria for controls were children not up to 12 months of age in the study areas without such signs and symptoms within two (2) weeks of enrollment/interview.

The exclusion criteria were removal of any case or control with difficulty in extracting complete information required for the study. See **Figure 1** for the schematic illustration of the design concept.

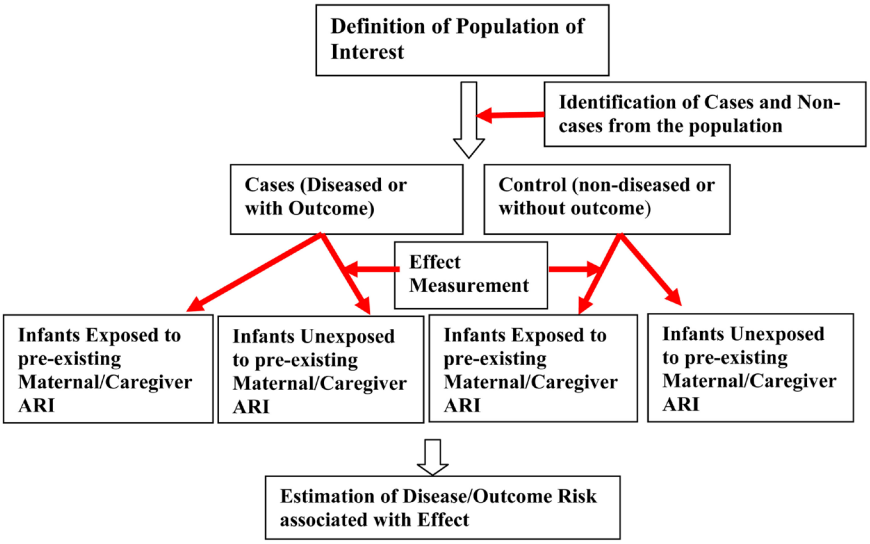

Figure 1. Schematic diagram of case-control study (observational study). Adapted from http://www.drcath.net/toolkit/casecontrol.html.

2.2. Area of Study

The study was carried out in both rural and urban settings, covering 12 communities in 6 Local Government Areas (LGAs), out of 23 LGAs in the 3 senatorial districts in Rivers State, Nigeria. Rivers State, with coordinates, latitudes 4˚51'29.0761" and 4˚51.4846'N, longitude 6˚55'15.2886" and 6˚55.2548'E, [15], is one of the 36 states in Nigeria, with Port Harcourt as the State capital. It occupies an area of about 37,000 square kilometers and bounded in the north by Imo and Abia States; in the south by the Atlantic Ocean; to the east by Akwa Ibom State and to the west by Bayelsa and Delta States.

The 12 communities, randomly selected as the points of sample include; Akinima and Okarki in Ahoada West LGA, Buguma City and Krakrama in Asari-Toru LGA, in Rivers West Senatorial District; Okehi and Chokocho in Etche LGA, Rumuwoji and Town city slum areas in Port Harcourt City LGA, in Rivers East Senatorial District; Oyigbo and Okoloma in Oyigbo LGA, Botem/Genebue-e and Nonwa in Tai LGA, in Rivers South East Senatorial District.

2.3. Study Population

The population used in this study was children less than 1-year-old in 12 selected communities in 6 LGAs in the 3 senatorial districts of Rivers State. The population of Nigeria was estimated to be at about 167 million (2006 census report) and children under 1year of age constitute 4% (6.6 million) of the total population [16].

In developing countries, including Nigeria, 10% - 15% of all ARI may progress to disease of moderate to severe intensity, [2], giving an estimate figure of such intensity to 29,040 to 43,560 cases in Nigeria annually with geographical zones and urban/rural settings variation.

Determination of Sample Size

The sample size for this study was based on [17] formula.

$$\text{Sample size} = r + 1\ (p^*)\ (1 - p^*)\ (Z_\beta + Z_{\alpha/2})^2/(P_1 - P_2)^2 \quad (1)$$

where; r = Ratio of Control to Case, 1 for equal number of Case and Control, p^* = Average proportion exposed = Proportion of Exposed Cases + Proportion of Control Exposed/2, Z_β = Standard normal variant for power = for 80% power it is 0.84 and for 90% power value is 1.26, $Z_{\alpha/2}$ = Standard normal variant for level of significance = 1.96, $P_1 - P_2$ = Effect size or different proportion expected based on previous studies. P_1 is proportion in cases and P_2 is proportion in control.

Therefore, from Equation (1) and assuming power of study of 80% (0.84), expected proportion in case group and control group to be 0.35 and 0.20 respectively and substituting values we have;

$$\text{Sample size} = 1 + 1\ (0.275)\ (1 - 0.275)\ (0.84 + 1.96)^2/(0.35 - 0.20)^2 = 138.9$$

$$\approx 139 \text{ Cases and Control each gives a total of 278 at least.}$$

For a matching power of 1 - 3, the minimum sample size required for this study is;

$$139 \times 3 = 417 + 139 = 556 \text{ Cases and Controls.}$$

However, for a representative sample population for the study, the number was increased proportionally from the selected communities, giving 1100 infants which are greater than 3% of the prevalence value considering the lower ARI prevalence rate of 10%, [2] that may progress to moderate to severe cases.

2.4. Sample and Sampling Techniques

The sample was selected using multi-stage simple random sampling techniques from the LGAs up to the community level through division of each of the communities into convenient zones, followed by selection of a ward in each zone by simple random technique. Also, through simple random technique one area of each ward was selected and study carried out starting from number 1 house in an order, after its determination by simple random techniques till the required number of infants was found. The techniques for sampling, also include Stratified Sampling by way of grouping sample population into age and place of residence. In addition, simple random sampling was used in picking required caregivers/infants of the sample population. In the simple random sampling, balloting was used in choosing the caregivers/infants and the control group who took part in the study, in this manner; every infant/mother/caregiver of the population was given a chance of being selected.

A total of 1100 infants comprising 275 cases and 825 controls (1:3) were picked proportionally, among the communities based on proportional allocation factor of 6:4 (660:440) for urban and rural communities for both cases and control, reflecting the size of study population of the communities, and a proportional allocation factor of 1:4.5:4.5 (100:500:500) for the age group of <2 months, 2 months - 6 months and 7 months up to 12 months. **Table 1** gives the summary of the study population per sampling points/LGA.

Table 1. Summary of study population per sampling points/LGA.

Sampling Point/LGA	Study Population	
	Cases	Controls
Ahoada West	42	126
Asari-Toru	44	132
Etche	44	132
Oyigbo	44	132
Tai	44	132
Port Harcourt City	57	174
Total	**275**	**825**

2.5. Instrument for Data Collection

The instrument used for data collection was set of structured questionnaires. The items were based on demographic characteristics, knowledge and attitude of the target/study population as it had to do with exposure potentials to pre-existing maternal/caregiver ARI in the pattern and risk of ARI among infants. The questionnaire as developed was reviewed for content validity. Pilot-testing for understanding of items by target/study population was done, using 10 caregivers/infants who did not form part of the sample used for the study.

The questionnaires were personally administered on the mothers/caregivers of the randomly selected infants for relevant information, by the researcher with the help of recruited Community Health Practitioners after one-day training on the pattern of administration of the questionnaires and retrieved on the same day.

To collect data on ARI, mothers/caregivers were asked whether their child under one (1) year of age had been ill with at least any two (2) of the three (3) signs and symptoms; cough, running nose or fever less than three (3) days duration within the two (2) weeks of enrollment/interview. Those infants who suffered from such outcome attributes of ARI at any time during the two (2) weeks of interview were identified or defined as having ARI as cases.

Data from control group of the study was generated from matched study population to the cases of ARI from the same referent population using an uncontrollable variable (age), grouped as less than two (2) months, two (2) months - six (6) months, seven (7) months up to twelve (12) months that ensures as much as possible that the 5% chance of erroneously rejecting the null hypothesis is not increased when making comparism of study variable between cases and control groups of the study.

2.6. Methods and Techniques for Data Analysis

Data from responses were collated and presented in a tabular form with nominal scale, showing values for cases and non-cases (control) for the variable of study (exposure to pre-existing maternal/caregiver ARI). The entries were double

checked for possible error of recording. Statistical analysis was performed using SPSS, version 21.0, to test the hypothesis for result at 5% significant level and also to show distribution of difference in exposed and unexposed infants. Descriptive method was used to represent the characteristics of the subjects and the differences in ARI between exposed and unexposed infants to pre-existing maternal/caregiver ARI were tested in a bivariate logistics regression at 5% level of significance. Odds ratio (OR) was used to interpret the size effect measures of ARI from exposure to pre-existing maternal/caregiver ARI differences.

2.7. Ethical Approval

Ethical approval for the study was gotten from the University of Port Harcourt Teaching Hospital Ethical Committee and the Research Ethics Group of the Centre for Medical Research and Training, College of Health Sciences, University of Port Harcourt. The nature and purpose of the study and level of participation of the respondents (mothers/caregivers) and their infants were clearly explained and their informed consent sought before the interview. Participation in the study was voluntary even after providing consent.

3. Results

Table 2 showed patterns of ARI and exposure status to pre-existing maternal/caregiver ARI of the study population in rural communities (N = 440), with the indication that, for the exposed category N = 49; n = 40 (81.6%) of the cases came under this category, against n = 9 (18.4%) of the controls who were also classified in the same category as at the two weeks of the interview/enrollment for the study.

For the category of unexposed N = 391; n = 321 (82.1%) of the controls were unexposed and came under this category, against, n = 70 (17.9%) of the cases who were also unexposed to pre-existing maternal/caregiver ARI and so equally classified under this category.

However, none of the cases and control infants from the rural communities fell under the category of unknown/indeterminate.

In Table 3, that showed the patterns of ARI and exposure status to pre-existing maternal/caregiver ARI among the infants from urban communities (N = 660), in which for the exposed category N = 55; n = 40 (72.7%) of the cases were under

Table 2. Patterns of acute respiratory infection and exposure status to pre-existing maternal/caregiver ARI of Infants in rural communities.

Exposure Status	Total (N)	Cases (n)	%	Controls (n)	%
Exposed	49	40	81.6	9	18.4
Unexposed	391	70	17.9	321	82.1
Unknown/Indeterminate	0	0	0	0	100
Total	**440**	**110**	**25**	**330**	**75**

Table 3. Patterns of acute respiratory infection and exposure status to pre-existing maternal/caregiver ARI of infants in urban communities.

Exposure Status	Total (N)	Cases (n)	%	Control (n)	%
Exposed	55	40	72.7	15	27.3
Unexposed	600	125	20.8	475	79.2
Unknown/Indeterminate	5	0	0	5	100
Total	**660**	**165**	**25**	**495**	**75**

this category, against n = 15 (27.3%) of the controls who were equally classified in the category within the period of the study.

In the category of unexposed N = 600; n = 475 (79.2%) of the controls were unexposed, against n = 125 (20.8%) of the cases who were also not exposed.

While, for the category of unknown/indeterminate N = 5; n = 5 (100%) of the infants' control status of exposure were unable to be determined, against none for the cases.

The evidences shown in Table 2 and Table 3 gave clear indication of existence of patterns relationship between ARI among infants and exposure to pre-existing maternal/caregiver ARI in rural and urban communities with a statistical difference of 11.8% higher in occurrence in rural communities.

Table 4, showing patterns of ARI and exposure status to pre-existing maternal/caregiver ARI of the study population (N = 1100), wherein n = 275 were cases while n = 825 were controls, indicated that, for the exposed category, total (N = 104); n = 80 (76.9%) were cases of ARI, against n = 24 (23.1%) who were controls (non-cases of ARI) as at the two weeks of the interview/enrollment for the study.

For the category of unexposed, total (N = 991); n = 796 (80.3%) were controls, against, 195 (19.7%) who were cases. However, for the category of unknown/indeterminate, total (N = 5); n = 5 (100%) of the infants' control status of exposure were unable to be determined, against none for the cases.

Therefore, considering the evidence provided by the data in Table 4, the cases presented a pattern relationship between exposure to pre-existing maternal/caregiver ARI and acute respiratory infection among infants, in which the exposed infants had higher frequency of 76.9% in occurrence, compared to 19.7% of the cases who were unexposed. We can in this wise, infer that patterns relationship between ARI among infants and exposure to pre-existing maternal/caregiver ARI was observed to exist in this study, with a statistical difference in frequency of 57.2% in occurrence.

Table 5 showed data on relationships between pre-existing maternal/caregiver acute respiratory infection and acute respiratory infection among infants, wherein out of total; N = 104 infants exposed to pre-existing maternal/caregiver acute respiratory infection, n = 80 infants came down with signs and symptoms of acute respiratory infection as cases, while n = 24 infants were without signs and symptoms of acute respiratory infection as controls within the 2 weeks of interview/enrollment for the study.

Table 4. Patterns of acute respiratory infection and exposure status to pre-existing maternal/caregiver ARI of study population.

Exposure Status	Total (N)	Cases (n)	%	Control (n)	%
Exposed	104	80	76.9	24	23.1
Unexposed	991	195	19.7	796	80.3
Unknown/Indeterminate	5	0	0	5	100
Total	**1100**	**275**	**25**	**825**	**75**

Table 5. Relationships between pre-existing maternal/caregiver acute respiratory infection and acute respiratory infection among infants.

Pre-existing maternal/ caregiver ARI	Cases (n)	Control (n)	Total (N)
Exposed	80	24	104
Unexposed	195	796	991
Total (N)	**275**	**825**	**1095**

Ref. = Exposed; OR-Unadjusted = 13.52, ($p < 0.0001$, 95% CI = 0.047 - 0.121); Unexposed.

Similarly, out of total; N = 991 infants unexposed to pre-existing maternal/caregiver acute respiratory infection, n = 195 infants came down with signs and symptoms of acute respiratory infection as cases, against n = 796 infants without signs and symptoms of acute respiratory infection as non-cases (controls) within the 2 weeks of interview/enrollment for the study.

On subjection of the data as presented in Table 5 to bivariate logistic regression analysis for odds ratio (unadjusted) to indicate if any association exist between pre-existing maternal/caregiver acute respiratory infection and acute respiratory infection among infants, revealed significant relationship OR-Unadjusted = 13.52, ($p < 0.0001$, 95% CI = 0.047 - 0.121), meaning infants exposed to pre-existing maternal/caregiver acute respiratory infections were more than 13 times at risk (OR = 13.5) of contracting ARI than infants without exposure to pre-existing maternal/caregiver acute respiratory infection.

4. Discussion

A relationship between pattern and risk of acute respiratory infection among infants and exposure to pre-existing maternal/caregiver acute respiratory infection, was observed in this study, noting that infants exposed to pre-existing maternal/caregiver acute respiratory infections are more than 13 times (OR = 13.5) at risk of contracting acute respiratory infection than their unexposed infants by bivariate logistic regression analysis. Also, statistical difference in patterns of ARI among infants and exposure status to pre-existing maternal/caregiver ARI between rura land urban communities was found to be 11.8% higher in occurrence in rural communities.

This finding corroborates with existing body of knowledge as reported in the studies by [12] [13]. This may provide explanation that, the influence of proxim-

ity and or close contact to source of infection, more so viral agents that are transmissible by airborne route to portal of entry into the body system is strategic in disease occurrence.

Nevertheless, the period of infancy in humans is influenced by several factors that regulate the susceptibility potential to respiratory tract infections among which are the immune factor; associated with immunosuppressed/hypo-responsiveness, lack of previous exposure/immune memory, reduced innate immune response and reduced adaptive immune response; viral factors; influencing inhibition of type 1interferon (IFN) and increased exposure to virus; physical factors; involving small body size, limited energy reserves and small airways. The interplay of these factors on the immune and anatomical structure of the respiratory system affects the physiology of the respiratory system leading to reduction in gaseous exchange thereby compromising respiration and eventually the disease [8].

This is particularly important in our consideration, noting the antigenic and phenotypic characteristics of viral agents on immune system of human body, in which acute respiratory infections may not be an exception and involving infants whose immune system are immature (still developing). Therefore, we may adduce the high frequency (pattern) and risk of contracting ARI among infants through exposure to pre-existing maternal/caregiver ARI as revealed by this study to principally, ignorance influenced increased exposure potential to the source of infection which is mainly viral in nature and discovered to be higher in the rural communities than their urban counterpart.

Our finding will therefore widen the horizon as an innovation in the etiological consideration regarding acute respiratory infection among infants vis-à-vis exposure potential to pre-existing maternal/caregiver acute respiratory infection occasioned by nursing care that will guide specific intervention strategies up to household level in resolution of the problem.

5. Conclusion

The existence of relationships between such predisposing or host factor in the patterns and risk of acute respiratory infection among infants is quite auspicious in the principles of nursing care and disease prevention and control of ARI. This calls for innovative prevention plan of action for effective management of infants' conditions to promote effective growth, development and health.

Recommendation

1) Community based sensitization programme on barrier nursing care techniques and personal hygiene practices for mothers/caregivers concerning acute respiratory infection should be given priority attention to reduce influence of exposure to pre-existing maternal/caregiver acute respiratory infection on infants' ARI burden.

2) Further studies should be carried out on this host factor in the patterns and risk of ARI among infants in a similar research design and setting for consisten-

cy and or complementarities.

3) Variability in exposure potential to maternal and caregiver pre-existing or concurrent ARI in terms of duration and differences in barrier nursing care should be looked into in the patterns and risk of ARI among infants in further studies.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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