**DETERMINANTS OF ACUTE RESPIRATORY INFECTIONS (ARI)**

**Abstract:**

Acute respiratory infections (ARI) is a leading cause of mortality in under five children in developing countries throughout the world (kill an estimated 2.6 million children annually). Therefore, we aim to conduct a study to detect the various modifiable risk factors for acute respiratory infection in children. We have used Bangladesh Demographic & Health Survey data which is a nationally representative data. A multiple logistic regression model was used­­­­­­­ to evaluate major risk factors associated with ARI for this sample group. The prevalence of ARI was higher for males than females (57.06% and 42.94% respectively). Children from households where they use biomass fuel have greater risk (AOR=1.034, 95% CI :0.607-1.812) than household using fossil fuel. Children belonging to age group 0-11 months were significantly more likely to have (AOR = 1.329; 95% CI: 0.92-1.93) ARI as compared to children belonging to other age groups. Mother’s education level is another major factor in this field. Children from mothers with primary education (OR:1.544, 95% CI:1.123-2.119) are more likely to be affected than children from mother’s with secondary education. This study has identified various socio-demographic, nutritional and environmental modifiable risk factors for ARI which can be tackled by effective education of the community and appropriate initiatives taken by the government.

**Introduction:**

Acute respiratory infections (ARI) is a leading cause of mortality in under five children in developing countries throughout the world. Nowadays it is one of the major causes of permanent damage and communicable disease death. Acute respiratory symptoms in the absence of a predominant symptom is typically diagnosed as “upper respiratory tract infection.”[1]. Acute respiratory infection is an intense infection that prevents normal breathing function. Though it is almost inconceivable to validate viruses and bacteria, the main risk factors that increase the likelihood of developing acute respiratory infection, it generally begins in the nose, trachea (windpipe), or lungs. The common viruses that are responsible for ARI are influenza viruses (IFVs), respiratory syncytial virus (RSV), parainfluenza viruses (PIVs) 1–4, enteroviruses (EVs), human rhinoviruses (HRVs), adenoviruses (ADVs), and human coronaviruses (HCoVs) 229E and OC43 [1–4] [6].

The immune systems of children are more prone to be attacked by viruses. It is particularly dangerous for children, older adults, and people with immune system disorders. If adequate steps are not taken, it spreads to the entire respiratory system. Children suffering from such condition needs medical assistance right away. Also, these infections are infectious. The serious rise in illness and mortality caused by respiratory viruses have made ARI a top priority in the global health challenge.

On 12 March 2003, the World Health Organization issued a global alert on a typical pneumonia, called severe acute respiratory syndrome[2]. In 1990 the conditions represented the first cause of disability-adjusted years of life lost among girls and the second in boys under 5 years of age, explaining about 18% of the global burden of disease and producing between 3.5 and 5.0 million deaths[3]. According to the World Health Organization (WHO), acute respiratory infections kill an estimated 2.6 million children annually every year worldwide. 20% to 40% of the children attending outpatient clinics are children with respiratory infections and 12% to 35% of admissions into hospitals[4]. About 500 to 900 million acute respiratory infection cases occur per year in developing countries. Also, around 5 million of children who are under five die of this infection annually, of which 90% occur in developing countries. In the United States, ∼75% of ambulatory antibiotic prescriptions are for the treatment of 5 specific acute respiratory infections (ARIs): otitis media, sinusitis, pharyngitis, bronchitis, and upper respiratory tract infections (URIs)[5].

In the case of children, viruses are the primary cause of respiratory infections while for other age groups it is a substantial cause. The international consultation on control of acute respiratory infections, December 1991 stated that there are high correlations between environmental risk factors ,such as smoke, outdoor air pollution, indoor pollution, passive smoking, overcrowding and risk factors in the child ,such as low birth weight, malnutrition, measles, breast feeding and vitamin ‘A’ deficiency, stunting, wasting, type of cooking fuel, toilet facilities, mothers literacy, medication for intestinal parasite ,place of residence, BMI, wealth index ,media, size of child birth with the infections. Passive smoking also increases the risk. It includes respiratory arrest, respiratory failure, congestive heart failure.

Severe acute respiratory syndrome (SARS) is an emerging infection that is spreading worldwide .For infections such as ,otitis media and acute sinusitis antibiotics provide some benefits[6]. Due to this over-prescription, many bacteria have become resistant against commonly prescribed antibiotics [7].To overcome this treatment dilemma, several authors proposed changing the treatment strategy of ARI from acute intervention to prophylaxis of recurrence using vaccines and immunomodulating agents [7].

Due to the unavailability of vaccination for most of these viruses, it is essential to study the epidemic patterns and explore how widespread the respiratory virus infections are, so that it can be efficiently detect and prevent in the future.

Many of these risk factors are biddable to corrective measures. Therefore, knowledge of these risk factors related to the accession of ARI will help to prevent. By adopting worthwhile steps to educate the community about health education by the government will lead to a healthy society and a healthy nation. Without knowing which summary measure is being stated, it is hard to use this information to make clinical or infection control decisions[8].The aim of this study is to detect the various modifiable risk factors for acute respiratory infection in children.

The precise magnitude of ARI in Bangladesh is unknown. Our study suggests that ARI, which is already at a very large scale, is increasing at the double. The risk of infectious disease epidemics is usually considered to be low, but this may lead to avoid the common conditions such as ARI which is less noticeable than epidemic-prone diseases in developing countries. There are no acceptable targets for ARI, unlike for cholera or severe malnutrition, making it difficult to monitor the quality of case management on the basis of accepted standards. ARI is key to achieving global child survival targets and Millennium Development Goals. Accordingly, initiatives such as the WHO and UNICEF-led Global Action Plan for Pneumonia prevention and control (GAPP) need to extend their reach to humanitarian relief settings [17]. It appears that a little less than 10% of ARI are pneumonia.[18]. Agencies working in crisis settings should invest greater resources in ARI prevention and control, and explicitly consider ARI as a top priority phase and scenario[17] .

**Method:**

Statistical analysis was performed using the R studio software. Chi square test was used to identify factors associated with ARI in the elderly population of the Sylhet region. ‘P’ value <0.05 was taken as significant and ‘P’ value <0.001 was taken as highly significant. Variables were selected in two stages to assure the final model. In the first stage of variable selection, a chi-square test was carried out to assess the statistical significance of all variables considered as possible predictor variables. Based on the chi-square test, only 13 variables were statistically significant with respect to the ARI variable at a 95% level of significance. Variables with a *p-*value > 0.05 were excluded from the model. Lastly, a multiple logistic regression was carried out with the selected predictor variables. The final adjusted model included the independent variables: child age (in months), stunting, wasting, types of cooking fuel, toilet facilities, mother’s education level, medication for intestinal parasites, sex of a child, place of residence, mother’s age group, body mass index, size of child at birth . The Hosmer and Lemeshow goodness-of-fit test was used to assess the overall fit of the final model.

**Discussion:**

In the developing countries, incidence of ARI ranges between 5.7 and 8.0 episodes per child per year.[9] The various risk factors for ARI were broadly classified under 3 headings-sociodemographic variables, nutritional variables and environmental variables.

**Variables:**

The outcome variable of this study was acute respiratory infections (Yes/no). Potentially associated variables included: child-related (age, sex, vaccination, stunting, wasting, medication for intestinal parasites, size at birth, place of delivery and BMI);maternal factors (formal education, type of delivery, presence of pregnancy complications,); and household (wealth index ,access to safe water, types of cooking fuel, residential area, sanitation).

**SOCIODEMOGRAPHIC VARIABLES:**

**Mothers education and area of residence:**

The importance of educated mother on child’s health has been well documented several times. In rural Bangladesh, ARI is attributed to negligence of mothers. There is a superstition that children in the first few weeks of their life are vulnerable to spirit attacks, which leads mothers to seek the wrong kind of care. A study by the Department of International Health, Johns Hopkins University (1996) found that most mothers believed that a ‘wind-carrying disease can kill their child,[10] whereas ARI is considered to be more manageable. Qualitative data from other ARI studies found that decision of seeking care from clinics is usually taken depending on the advice of family members or in-laws, particularly grandmothers and neighbors. Following to the tradition rural people prefer kabiraj or quack instead of clinic. This underscores the importance of educating mother as well as women about the possible dangers of ARI. Data on ARI suggest that mothers often wait for 3 or more days before seeking care (Department of International Health, Johns Hopkins University 1996; Zaman et al. 1997; Pieche 1998; Parker year?).[10]Government effort to educate girls beyond secondary level is therefore called for. The government’s free primary and secondary educational program is very relevant in this case and hence should be strengthened and be propelled to higher levels.[12] This is probably because mothers utilizing immunization services are better aware of health care facilities and probably seek early consultation for illness of their children, which probably avoids severe illness. [11] This study showed infants children whose mothers are not literate at all have 1.193% greater chance to be affected by ARI than mothers with higher secondary education and children with mothers who have primary education have 1.544% more chance than mothers with higher education.

**Mother’s Age Group:**

Our result indicates that women from higher age cohorts, compared to those in the 15-24 age cohort, and those with a higher birth order, compared to the first, reduce the probability of occurrence of ARI. This can be attributed to the knowledge and experience concerning childcare accumulated by older women over time which unambiguously gives them an edge over younger women[12] .

**Wealth index:**

Household wealth was defined according to the respondents reported household assets and was assigned a standardized score and was categorized into three categories namely, lower, middle and higher. According to the study, lower class people are 11.2% and middle-class people are 11.41% more likely to be affected. Being in a higher wealth status, compared to the lower and middle was revealed to reduce the probability of occurrence of ARI. Therefore, the government should pay effort to raise the incomes of the poor and earmark funds that can facilitate individual access to healthcare irrespective of the ability to pay to overcome this situation.

**Media:**

Mass media is one of the important sources of information in most of the countries. Information gained from media can affect a wide range of outcomes involving raising awareness about ARI and other infectious disease. Parents who use mass media gain knowledge about the disease and response to the children symptoms on time.

**NUTRITIONAL VARIABLES:**

**Vaccinations (medication for intestinal parasites):**

A child was deemed to have received full vaccination at appropriate age included: BCG in the first week of life; DPT and OPV first dose at 2 months of age; DPT and OPV second dose at 4 months of age; DPT and OPV third dose at 6 months of age; Measles at 9 months of age; Measles, Mumps and Rubella at 15 months of age; and DPT and OPV first booster 1 year after last dose[13] .Compared to the people who received vaccine are at 74.9 times less affected than those who didn’t receive.

**BMI:**

Overweight (BMI 25 kg/m2) is a growing problem which has been associated risk for acute respiratory infections[14] .The incidence and severity of infectious illnesses are higher in obese persons than in lean persons.

**Size at birth, stunting, wasting:**

Acute respiratory infection is found to be the most significantly associated factor with malnutrition during childhood. In our study, the incidence of ARI was higher in stunted infants, wasted infants and infants that have low birth weight .Stunting is related to the long time exposure to poor environmental conditions and low socioeconomic status in childhood[9].The frequent and longer episodes of ARI may cause the retardation of growth. Moreover, other nutritional disorders are also associated with ARI. Presence of malnutrition was significantly associated with ARI in the present study, similar to other studies [15]. A study in the Philippines included age stratified risks in children less than 23 month of age and reported highest risk of death from ARI due to malnutrition among those aged 12-22 month [14]. A study in New Delhi revealed severe malnutrition as the predictor of mortality in ARI in 2 week to 5 years old children[15] Overall malnutrition is associated with a two to three fold increase in mortality from ARI [16].

**ENVIROMENTAL VARIABLE:**

**Types of cooking fuel:**

Surprisingly, the source of cooking fuel also has effect on ARI. It is attributed to the fact that some households using biomass fuel are affected more compared to households using fossil fuel. The most associated variable among investigated environmental characteristics is biomass fuels, increasing a risk 3.4% compared to fossil fuel.

**3 Results**

**3.1 Assessing the statistical significance of all variables**

The results of chi-square analysis for identifying factors associate with ARI were shown in Table 1. The results of the chi-square analysis indicated that types of the cooking fuel, age of the children, stunted infants, wasted infants, toilet facility, mothers education level, medication for intestinal parasites, gender of the child, mother’s age, residence, mother’s BMI, wealth index, size of the child at birth, media are significant factors (p<.0001).

From the Table 1 it can be said that burning of biomass fuel (85.25%), wasted infants (80.71%), without modern toilet facility (89.20%), lack of medication for intestinal parasites (71.31%), residence in the rural area (73.96%), lower wealth index (49.03), lack of information gained from media (63.71%) are mostly responsible for frequent ARI in children

Table 1. Chi-square test for identifying factors associate with ARI

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Factors | ARI | | |  |
| Yes, N (%) | No, N (%) | Total, N (%) | P-value |
| Type of cooking fuel | | | | |
| Fossil fuel | 34 (14.75) | 957 (9.42) | 991 (14.47) | 0.01 |
| Biomass fuel | 327 (85.25) | 5532 (90.58) | 5859 (85.53) |  |
| Child age(months) | | | | |
| 0-11 | 96 (17.86) | 1161 (26.59) | 1257 (18.32) | 0.00 |
| 12-23 | 84 (20.41) | 1327 (23.27) | 1411 (20.56) |  |
| 24-59 | 181 (61.73) | 4014 (50.14) | 4195 (61.13) |  |
| Stunting | | | | |
| Yes | 152 (45.10) | 2200 (63.58) | 2352 (36.88) | 0.001 |
| No | 185 (54.90) | 3840 (36.42) | 4025 (63.12) |  |
| Wasting | | | | |
| Yes | 65(19.29) | 857(14.19) | 922(14.46) | 0.012 |
| No | 272(80.71) | 5183(85.81) | 5455(85.55) |  |
| Toilet facility |  |  |  |  |
| Modern Toilet | 39(10.80) | 1200(18.46) | 1239(18.06) | 0.000 |
| Other | 322(89.20) | 5301(81.54) | 5623(81.94) |  |
| Mothers education level |  |  |  |  |
| Secondary or Higher | 173(47.92) | 3649(56.12) | 3822(55.69) | 0.001 |
| Primary | 131(36.29) | 1794(27.59) | 1925(28.05) |  |
| No Education | 57(15.79) | 1059(16.29) | 1116(16.26) |  |
| Medication for intestinal parasites |  |  |  |  |
| Yes | 103(28.69) | 2461(37.91) | 2564(37.42) | 0.000 |
| No | 256(71.31) | 4031(62.09) | 4287(62.58) |  |
| Sex of Child |  |  |  |  |
| Male | 206(57.06) | 3334(51.28) | 3540(51.58) | 0.037 |
| Female | 155(42.94) | 3168(48.72) | 3323(48.42) |  |
| Mothers age group (in years) |  |  |  |  |
| 15-24 | 191(52.91) | 3057(47.02) | 3248(47.32) | 0.027 |
| 25-34 | 132(36.57) | 2894(44.51) | 3026(44.09) |  |
| 35-44 | 36(9.97) | 517(7.95) | 553(7.95) |  |
| 45+ | 2(0.55) | 34(0.52) | 36(0.52) |  |
| Division |  |  |  |  |
| Barisal | 33(9.14) | 760(11.69) | 793(11.55) | 0.675 |
| Chittagong | 67(18.56) | 1253(19.27) | 1320(19.24) |  |
| Dhaka | 59(16.34) | 1139(17.52) | 1198(17.46) |  |
| Khulna | 43(11.91) | 704(10.83) | 747(10.89) |  |
| Rajshahi | 47(13.02) | 772(11.87) | 819(11.93) |  |
| Rangpur | 44(12.19) | 792(12.18) | 836(12.18) |  |
| Sylhet | 68(18.84) | 1082(16.64) | 1150(16.76) |  |
| Place of residence |  |  |  |  |
| Urban | 94(26.04) | 2102(32.33) | 2196(32) | 0.015 |
| Rural | 267(73.96) | 4400(67.67) | 4667(68) |  |
| Vaccination |  |  |  |  |
| Yes | 79(83.16) | 1796(85.24) | 1875(85.15) | 0.169 |
| No | 16(16.84) | 311(14.76) | 327(14.85) |  |
| Source of drinking water |  |  |  |  |
| Piped Water | 20(5.54) | 539(8.29) | 559(8.14) | 0.071 |
| Tube Well | 324(89.75) | 5749(88.42) | 6073(88.49) |  |
| Other | 17(4,71) | 214(3.29) | 231(3.37) |  |
| Body mass index (mother) |  |  |  |  |
| Obese | 14(3.91) | 240(3.72) | 254(3.74) | 0.000 |
| Overweight | 42(11.73) | 1046(16.22) | 1088(15.99) |  |
| Normal Weight | 190(53.07) | 3743(58.06) | 3933(57.79) |  |
| Under Weight | 112(31.28) | 1418(21.99) | 1530(22.49) |  |
| Season |  |  |  |  |
| Summer | 98(27.15) | 1721(26.47) | 1819(26.51) | 0.618 |
| Autumn | 81(22.44) | 1487(22.87) | 1568(22.85) |  |
| Winter | 95(26.32) | 1556(23.93) | 1651(24.05) |  |
| Spring | 87(24.10) | 1738(26.73) | 1825(26.59) |  |
| Type of delivery |  |  |  |  |
| Caesarean | 49(19.14) | 872(22.86) | 921(22.63) | 0.193 |
| Non-caesarean | 207(80.86) | 2942(77.14) | 3149(77.38)) |  |
| Told about pregnancy complications |  |  |  |  |
| Yes | 100(50.25) | 1337(46.93) | 1437(47.14) | 0.404 |
| No | 99(49.75) | 1512(53.07) | 1611(52.86) |  |
| Wealth index |  |  |  |  |
| Higher | 107(29.64) | 2631(40.46) | 2738(39.90) | 0.000 |
| Middle | 77(21.33) | 1226(18.86) | 1303(18.98) |  |
| Lower | 177(49.03) | 2645(40.68) | 2822(41.12) |  |
| Size of Child at birth |  |  |  |  |
| Below average | 64(25) | 716(18.77) | 780(19.16) | 0.048 |
| Average | 163(63.67) | 2608(68.38) | 2771(68.08) |  |
| Above average | 29(11.33) | 490(12.85) | 519(12.75) |  |
| Number of living child |  |  |  |  |
| Less or equal 2 | 239(66.2) | 4401(67.69) | 4640(67.61) | 0.834 |
| 3-4 | 97(26.87) | 1681(25.85) | 1778(25.9) |  |
| Greater or equal 5 | 25(6.93) | 420(6.46) | 445(6.48) |  |
| Place of delivery |  |  |  |  |
| Home | 163(63.67) | 2345(61.48) | 2508(61.62) | 0.528 |
| Hospital | 93(36.33) | 1469(38.52) | 1562(38.38) |  |
| Media |  |  |  |  |
| Yes | 131(36.29) | 2883(44.34) | 3014(43.92) | 0.003 |
| No | 230(63.71) | 3619(55.66) | 3849(56.08) |  |
| Total |  |  |  |  |

**3.2 Determinants of ARI**

The odds ratio,95% confidence interval and p-value of the adjusted multiple logistic regression model were shown in Table 2 which shows that children age between 0-11 months was 1.33 times (AOR = 1.329; 95% CI: 0.92-1.93) more likely to have ARI as compared with children age between 24-59 months. Children from mothers having a primary education was 1.54 times (AOR = 1.54; 95% CI: 1.123-2.119) more likely to have ARI as compared with the children from mothers with secondary education.

Table 2. Odds ratio of the adjusted multiple logistic regression model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables |  | Adjusted OR | 95% CI | P-value |
| Child age (in months) | 0-11 | 1.329 | [0.922, 1.9254] | 0.000 |
|  | 12-23 | 0.939 | [0.664, 1.330] | 0.724 |
|  | 24-59 | 1.00a |  |  |
| Stunting | Yes | 1.354 | [1.007, 1.816] | 0.034 |
|  | No | 1.00a |  |  |
| Wasting | Yes | 1.184 | [0.826, 1.664] | 0.344 |
|  | No | 1.00a |  |  |
| Type of cooking fuel | Biomass fuel | 1.034 | [0.607, 1.812] | 0.903 |
|  | Fossil fuel | 1.00a |  |  |
| Toilet facility | Modern Toilet | 1.00a |  |  |
|  | Other | 1.259 | [0.771, 2.109] | 0.368 |
| Mothers education level | No education | 1.193 | [0.765, 1.829] | 0.425 |
|  | Primary | 1.544 | [1.123, 2.119] | 0.007 |
|  | Secondary or Higher | 1.00a |  |  |
| Medication for intestinal parasites | Yes | 0.749 | [0.517, 1.068] | 0.117 |
|  | No | 1.00a |  |  |
| Sex of Child | Female | 0.747 | [0.567, 0.981] | 0.037 |
|  | Male | 1.00a |  |  |
| Place of residence | Rural | 1.073 | [0.762, 1.532] | 0.691 |
|  | Urban | 1.00a |  |  |
| Mothers age group (in years) | 15-24 | 1.00a |  |  |
|  | 25-34 | 0.891 | [0.662, 1.195] | 0.446 |
|  | 35-44 | 1.018 | [0.556, 1.760] | 0.950 |
|  | 45+ | NA | 1.44\* 10^8 | 0.976 |
| Body mass index (mother) | Under weight | 0.670 | [0.326, 1.527] | 0.305 |
|  | Normal weight | 0.546 | [0.275, 1.212] | 0.106 |
|  | Overweight | 0.485 | [0.221, 1.151] | 0.082 |
|  | Obese | 1.00a |  |  |
| Wealth index | Lower | 1.120 | [0.706, 1.798] | 0.634 |
|  | Middle | 1.141 | [0.730, 1.784] | 0.560 |
|  | Higher | 1.00a |  |  |
| Media | Yes | 0.979 | [0.674, 1.421] | 0.912 |
|  | No | 1.00a |  |  |
| Size of Child at birth | Below average | 1.00a |  |  |
|  | Average | 0.772 | [0.561, 1.076] | 0.119 |
|  | Above average | 0.704 | [0.425, 1.139] | 0.161 |

a Indicates the reference group

* 1. **Hosmer and Lemeshow goodness of fit test**

Hosmer and Lemeshow goodness of fit test has been given in Table 3.

**Table 3.** Test for goodness of fit of the final model.

|  |  |  |
| --- | --- | --- |
| Goodness-of-Fit Tests | | |
| Method | Chi-Square | P-value |
| Hosmer-Lameshow | 7.748 | 0.458 |

So, the Hosmer-Lemeshow test does not gives us significant evidence of good fit on 46% of occasions.

**Conclusion:** In this study, we found that there is a wide range of factors, which are significantly associated with ARI among under five children. The finding demonstrates that the primary risk factors for acute respiratory infection are type of fuel, media, mother’s education, area of residence. Moreover, a significant proportion of the parents are not aware of the consequence of this disease, only a small proportion of them are concern. Using fossil fuel is vital to reduce risk of respiratory infections. Media have a crucial role in influencing lifestyle decisions. Health care delivery in south Asia is through formally and informally trained and traditional health professionals, who should become part of prevention strategies for ARI to obtain the maximum effect. ARI can be included cost effectively in existing training programs for these health professionals.

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