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Factors associated with acute respiratory infection in children under the age of 5 years: evidence from the 2011 Ethiopia Demographic and Health Survey

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Background: Acute respiratory tract infection (ARI) remains the major cause of child mortality in Sub-Saharan Africa. Various factors are associated with its occurrence and vary by context. However, available large-scale, population-based data are not fully exploited to identify locally relevant risk factors. The objective of this study was to identify factors associated with ARI in children under the age of 5 years in Ethiopia.

Methods: Further analysis of the 2011 Ethiopia Demographic and Health Survey was carried out involving 11,645 children under the age of 5 years and their mothers. Information relevant to the current study was extracted from the main data set and a working data set was prepared. A complex survey logistic regression analysis was applied.

Results: Acute ARI in this study was associated with severe malnutrition. Children who were severely wasted were highly likely to develop ARI (adjusted odds ratio [AOR] 1.7; 95% confidence interval [CI] 1.1–2.5). ARI was less likely to occur in children from families with an educated father and professional mother (AOR 0.4; 95% CI 0.2–0.6 and AOR 0.1; 95% CI 0.01–0.6, respectively).

Conclusion: Malnourished children from a lower socioeconomic category are more likely to suffer from ARI. Targeting disadvantaged children for effective interventions can help reduce the burden of morbidity and death due to ARI.

Keywords: acute respiratory tract infection, pneumonia, severe malnutrition, children, Ethiopia

Introduction

Mortality rates in children under 5 years of age have declined by 49% globally since 2000. Sub-Saharan Africa has also recorded major gains in lowering the mortality rate in children under 5 years by 48% during the same period; however, Sub-Saharan Africa remains one of the regions with the highest rate of mortality among children in this age group.[1] Ethiopia is one of the countries that are on a "fast track" in terms of progress made in reducing child mortality, but still bears a high child mortality burden.[2]

Acute respiratory tract infection (ARI) is a leading cause of morbidity and mortality in children under the age of 5 years throughout the world. Pneumonia is one of the most serious manifestations of ARI. Each year, ARI causes 15% of all deaths in children under the age of 5 years globally. About 50% of these deaths occur in Sub-Saharan Africa.[1] Nearly 265,000 in-hospital deaths of young children took place due to ARI globally in 2010, 99% of which were reported in developing countries.[3]

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Studies show that the majority of cases of ARI occur in rural areas and among children under one year of age.[4] ARI is also a major cause of hospital admission and referrals among young children. Each year, more than 12 million children with severe ARI are admitted to hospitals worldwide. In Ethiopia, ARI is one of the leading causes of morbidity and mortality in children under the age of 5 years. According to the 2011 Ethiopia Demographic and Health Survey (EDHS), the prevalence of ARI was 7%.[5]

Research has shown that many factors are associated with ARI. These factors differ from one country to another. Evidence from developing countries reveals that low birth weight, exposure to indoor air pollution, non-exclusive breast feeding, incomplete immunizations, crowding (more than seven members per household), poor nutrition, formula feeding, weaning, young maternal age, low educational status of mothers and fathers, and premature birth are consistently associated with severe ARI.[6–14] Lack of availability of adequate medical care, low family income, and parental cigarette smoking are also risk factors associated with pneumonia.[15]

A variety of studies done in different regions of Ethiopia show that household use of high-pollution biomass fuel (charcoal, wood, dung, or straw) for cooking, household overcrowding, small height for age, lack of a separate kitchen, and being carried on the mother's back while cooking are primary risk factors for development of ARI in children under the age of 5 years.[16,17]

Despite the public health relevance of this disease in Ethiopia, few studies have assessed the factors affecting the occurrence of ARI in a large representative sample of children in Ethiopia. This further analysis of the 2011 EDHS data addresses knowledge gaps by assessing some of the risk factors associated with ARI in children under the age of 5 years using nationally representative data.

Methods and materials

A community-based cross-sectional study design was used, and a nationally representative secondary data analysis was done on the 2011 EDHS. The samples were selected using a two-stage stratified cluster sampling technique. Initially all nine regions were stratified into urban and rural clusters. From 624 enumeration areas, 187 urban and 437 rural clusters were considered. Of 18,720 households, 5,610 urban and 13,110 rural households were selected. All women aged 15–49 years who were usual residents or who slept in the selected households the night before the survey were eligible for participation. All women with children aged 0–59 months were included in the current analysis.

The children's record data and household members' record data were merged to obtain a working dataset. The dataset provided potential household and individual level predictor variables. The data include 11,645 observations. Since the survey used a two-stage cluster sampling design, a complex survey binary logistic regression was employed. SVY syntax was used to weight the analysis. A logit model of complex logistic regression analysis was used. The adequacy of the models was checked using an *F*-test.

Variables

Socioeconomic, demographic, and behavioral factors were extracted from the dataset for further analysis. A wealth index was provided in the dataset. It was constructed by combining information on household assets, such as ownership of consumer items, type of dwelling, source of drinking water, and availability of electricity, into a single index. The wealth index was categorized as poorest (1), poorer (2), middle (3), richer (4), and richest (5). The age of the child was categorized as <6 months, 6–11, 12–23, 24–35, 36–47, and 48–59 months.

Anthropometric measurements were extracted for the current analysis. The *Z*-score is a measure of how far a child is from the median weight of the reference distribution for children of the same height, taking into consideration the standard deviation of the reference distribution, which increases as children get older.[18] Based on the World Health Organization definition, −2 to +2 standard deviation (SD) is normal, −2 to −3 SD is moderate, and below −3 SD is severe stunting (height for age). These classifications are the same for wasting (weight for age) and underweight (weight for height). A child is classified as obese if the *Z*-score is above +2 SD.

Birth order of the child is also categorized as 1 (first), 2–3, 4–6, or ≥7. Source of drinking water is also categorized as piped water (1), other protected source, eg, protected dug well (2), unprotected dug well (3), and other unimproved source (4).

The occupation of the children's mothers and fathers was broken down into various categories. Maternal occupation was classified as unemployed, professional/technical/managerial, agricultural sales and service, skilled manual labor, or unskilled manual labor. Paternal occupation was categorized as unemployed, armed forces, student, professional/technical/managerial, agricultural, clerical, sales and service, skilled manual labor, or unskilled manual labor.

The dependent variable was constructed as the occurrence of cough accompanied by short, rapid breathing in the 2 weeks preceding the survey. The result was considered as a binary variable, with a code of 1 if a child had ARI and 0 otherwise.

The analysis was done using Stata version 12 software (Statacorp, College Station, TX, USA). First, strata were generated using region and residence as stratification variables. A normalized weight was then generated. Data were declared to be complex survey data. A complex sample binary logistic regression model was employed to assess the association between the explanatory variables and the outcome of interest. A P-value <0.025 was taken to select variables for the multivariable analysis. In addition to the statistical criteria used to select variables for the final model, previous theoretical knowledge was used. As a result, use of a shared latrine and birth order of the child were included in the multivariable analysis. The odds ratio (OR) with a 95% confidence interval (CI) was reported, and all variables that were found significant at a P-value <0.05 were considered risk factors for childhood ARI.

Ethical approval

Ethical clearance for this survey was obtained from the Ethiopia Health and Nutrition Research Institute Review Board, the National Research Ethics Review Committee at the Ministry of Science and Technology, and the Institutional Review Board of ICF International and the Centers for Disease Control and Prevention. Informed verbal consent was obtained from all mothers/caretakers of the selected children, including mothers under the age of 18 years on behalf of their children, and recorded by the research team on the ethical consent form.

In addition, ethical clearance was obtained from the Institutional Review Board of Hawassa University College of Medicine and Health Science. Official permission was also granted by Measure DHS (Monitoring and Evaluation to Assess and Use Results Demographic and Health Surveys) to use the data set for the current study. The data source is a secondary human dataset from 2011 EDHS. The primary 2011 EDHS has passed through all relevant ethical clearance procedures and has received clearance from the responsible bodies. There is no personal identifier attached to the dataset. New primary data were not collected.

Results

Prevalence of ARI

The prevalence of ARI was higher among children whose mothers had no education (6.7%), as compared with mothers with higher educational status (2.36%). Similarly, children whose father had no education (6.8%) showed a higher prevalence of ARI than children whose father had a secondary (3.29%) or higher educational level (2.39%).

The prevalence of ARI was also higher in children with malnutrition, being 7% among children with normal weight for age, 7.56% for moderately wasted children, 11% for severely wasted children, 7.13% for with normal weight for height children,11.27% for moderately underweight children, and 10.78% for severely underweight children. The prevalence of ARI in children who were severely stunted was 7.43% (see Table 1).

Factors associated with ARI

In the bivariate analysis, parents reading a newspaper at least once a week, father's educational status, age of the child, source of drinking water, floor materials, wealth index,

Table 1 Prevalence of ARI among children under 5 years of age cross-tabulated by selected background characteristics in Ethiopia, 2011

Characteristics	Unweighted number of children	Children with ARI
WFA *Z*-score		
Normal	6,130	6.98
Moderately wasted	2,460	7.56
Severely wasted	938	10.9
Obese	91	1.66
WFH *Z*-score		
Normal	8,530	7.13
Moderately underweight	850	11.27
Severely underweight	127	10.78
Obese	112	1.35
HFA *Z*-score		
Normal	6,059	7.56
Moderately stunted	1,978	7.02
Severely stunted	1,582	7.43
Maternal occupation		
Jobless	6,438	6.54
Professional/technical/managerial	103	0.31
Agricultural	2,377	6.12
Sales and service	1,882	7.2
Skilled manual	798	6.86
Unskilled manual	56	6.52
Maternal education status		
No education	8,142	6.7
Primary education	2,930	6.22
Secondary	386	6.79
Higher	196	2.36
Paternal educational status		
No education	5,982	6.8
Primary education	4,181	6.79
Secondary	800	3.29
Higher	478	2.34
Total	10,808	7

Abbreviations: ARI, acute respiratory infection; HFA, height for age; WFA, weight for age; WFH, weight for height.

maternal occupation, duration of breast feeding, whether or not the child had ever had a vaccination, had received vitamin A in the previous 6 months, place of residence, weight for age, and weight for height were statistically significant. However, only the age of the child, weight for age, father's educational status, and maternal occupation remained statistically significant in the multivariable analysis.

Based on a multivariable complex logistic regression analysis, the odds of ARI decreased as the age of the child increased. A 50% reduction in the odds of ARI was observed in children aged 48–59 months as compared with infants under 6 months of age (adjusted OR 0.5; 95% CI 0.3–0.8). The odds of ARI among severely wasted children were 1.7 times higher than in normal children (adjusted OR 1.7; 95% CI 1.1–2.5). Maternal occupation also has a statistically significant association with ARI; accordingly, compared with children of unemployed mothers, children whose mothers were professionals had a 90% reduced odds of having ARI (adjusted OR 0.1; 95% CI 0.01–0.6). Paternal educational status is another factor found to be significant in this study. A 60% reduction in the odds of ARI was observed in children whose fathers had tertiary education (adjusted OR 0.4; 95% CI 0.2–0.6) and a 50% reduction was observed in children whose fathers had secondary education compared with children whose fathers had no education (adjusted OR 0.5; 95% CI 0.3–1.0; see Table 2).

Table 2 Multivariable analysis of factors associated with acute respiratory infection in children under the age of 5 years in Ethiopia

Characteristics	Crude OR (95% CI)	Adjusted OR (95% CI)
Child's age, months		
<6	1	1
6–11	1.3 (0.8–2.1)	1.1 (0.7–1.8)
12–23	1.3 (0.9–1.9)	1.0 (0.7–1.5)
24–35	1.0 (0.6–1.5)	0.7 (0.4–1.1)
36–47	1.0 (0.7–1.5)	0.8 (0.5–1.2)
48–59	0.6 (0.4–1.0)**	0.5 (0.3–0.8)**
Maternal occupation		
Unemployed	1	1
Professional/technical/managerial	0.0 (0.0–0.2)**	0.1 (0.0–0.6)**
Agricultural	0.9 (0.7–1.2)	0.9 (0.7–1.2)
Sales and service	1.1 (0.8–1.5)	1.1 (0.8–1.5)
Skilled manual	1.1 (0.7–1.7)	1.1 (0.7–1.8)
Unskilled manual	1.0 (0.2–4.2)	1.4 (0.3–5.7)
WFA *Z*-score		
Normal	1	1
Moderately wasted	1.1 (0.9–1.4)	1.1 (0.9–1.4)
Severely wasted	1.6 (1.1–2.4)**	1.7 (1.1–2.5)**
Obese	0.2 (0.0–1.2)	0.2 (0.0–1.1)
Paternal educational status		
No education	1	1
Primary		1.0 (0.7–1.2)
Secondary		0.5 (0.3–1.0)**
Higher		0.4 (0.2–1.0)**
Household with separate kitchen		
No	1	1
Yes	1.0 (0.6–1.4)	0.9 (0.6–1.4)

Note: **Significant variable $P<0.005$.
Abbreviations: CI, confidence interval; OR, odds ratio; WFA, weight for age.

Discussion

In the current analysis, age of the child, weight for age, paternal education, and maternal occupation were found to be significantly associated with ARI. The multivariable analysis showed that the age group of 48–59 months has lower odds of ARI. This result is in line with studies done in Ahmadabad City and in other low-income and middle-income countries.[9,13] Studies done in the People's Republic of China and South India have also shown that the prevalence of ARI is very high in children aged 6–36 months.[19,20] This could be due to the fact that as children get older, their immunity grows stronger and becomes better able to resist infection.

The prevalence of ARI was found to be higher in children with malnutrition. This result is also consistent with studies done in India, Solapur and Gujarat, Ethiopia, and in other developing countries.[4,7,9,10,12,16,20,21] This result also demonstrates the fact that children with malnutrition tend to have low immunity and are vulnerable to a number of infections, including ARI. On the other hand, having a paternal educational status of secondary school or higher is a factor protecting against ARI in children under the age of 5 years. This finding is in line with studies done in Southeast Nigeria,[22] but contradicts studies done in Solapur and Ethiopia, which reported no statistically significant association between ARI and paternal education.[12,16] Our study also found mothers working in a professional/technical occupation is a protective factor against ARI. This may be because these mothers spend less or no time cooking food for their family while carrying their children on their back, thus reducing their children's exposure to indoor air pollution. Further, mothers working in professional or technical occupations are likely to have a literacy level equivalent to secondary education or higher, so their educational background may also indirectly contribute to their ability to protect their children from infectious diseases such as ARI. Therefore, higher education and better income are protective factors for reducing the occurrence of ARI in children under the age of five. This result is consistent with studies done in India, Ahmadabad City, Baghdad/Iraq, and Ethiopia.[12–14,17]

Conclusion

Malnutrition is one of the key modifiable risk factors for ARI in children under the age of 5 years. The risk of ARI decreases as the age of the child increases. Higher paternal education contributes to the reduction of ARI. Therefore, governments should continue to strengthen their provision of educational opportunities for all citizens. Alleviation of poverty is one of the important strategies for reducing the risk of ARI in children under the age of 5 years.

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Disclosure

The authors report no competing interests in this work.

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