Austin Publishing Group

Research Article

Occurrence of Acute Respiratory Tract Infections among Children Under Five Years Attending Kinango Sub-County Hospital, Kenya

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Abstract

Objective: To examine occurrence of Acute Respiratory tract Infections (ARIs) and determine factors associated with ARIs among children under five years attending Kinango Sub-County Hospital.

Methods: A cross-sectional survey was conducted among mother-child aged between 0-59 month's pairs attending outpatient care. Participants were recruited using systematic sampling method. Data was collected using an interviewer-administered structured questionnaire. Descriptive statistics were used to summarize child, parental and environmental characteristics. Factors associated with ARIs were established using binary logistic regression analysis. Odds Ratio (OR), at 95% Confidence Interval (CI) and $p < 0.05$ significant level was used to describe an association between covariates and the outcome variable. Independent factors associated with occurrence of ARIS were determined by stepwise logistic regression.

Results: 385 children participated in this study. 228 children (59.2%) presented with ARIs, of which 90.8% were due to acute upper respiratory tract infections. 9.2% of the cases were due to pneumonia. Female gender aOR 3.39 [1.21-9.46], stunting aOR 3.62 [1.04-12.61], high parity aOR 11.45 [2.38-55.09], low maternal education aOR 3.54 [1.10-11.32] and recent hospitalization aOR 8.19 [1.75-38.43] increased the odds of occurrence of an ARI while normal birth weight aOR0.06 [0.01-0.62] was protective of ARIs.

Conclusion: A high prevalence of ARIs among children aged below five years was observed in this study, associated with gender, stunting, parity, maternal education, birth weight and recurring hospitalization. Improvements in literacy levels, child nutrition and maternal and child health at large could help to reduce morbidity due to ARIs in this population.

Keywords: Prevalence; Children under five years; Acute respiratory tract infections

Introduction

Acute Respiratory Tract Infections (ARIs) are infections of the respiratory tract of ranging severity that affect both upper and lower respiratory structures, and related organs [1]. They are among the most common causes of morbidity and mortality among children under the age of five years. They account for up to 50% of all diseases that children under five years encounter [2] and a third of under-fives deaths in developing countries [3,4]. According to GBD 2017, mortalities due to acute lower respiratory tract infections only were 118.9 per 100,000 children under five years globally, representing 15% of all under-fives deaths [5]. Over half of all diagnosis among children presenting with ARI symptoms are usually due to acute upper respiratory tract infections [6,7]. A child can experience up to eight episodes of ARIs of varying severity in a year [8-10].

Although ARIs are common among both children and adults, universal treatment is still lacking due to the nature of their causative agents and diagnostic uncertainty. Symptoms of common infections such as the common cold typically clear in one to two weeks but the symptoms can be quite distressing to both the child and caregiver. Moreover, the infection can spread to other parts of the body resulting to more serious clinical disease and even fatality. Respiratory viruses have been shown to have neuroinvasive capacity [11] that results to various types of encephalopathy, alongside other systemic effects due to extension of microbial toxins, inflammation and reduced lung function [12]. ARIs are also a common reason for administration of antibiotics. Approximately 33% of consultations for a child with an upper respiratory tract infection specifically ends up with an antibiotic prescription [13]. Such irrational administration of antibiotics is steadily yielding resistance to convectional antibiotics, reducing therapeutic options for management of bacterial infections [13,14].

Given the nature of childhood ARIs, prevention and control present more viable options for management of ARIs. Several risk factors for ARIs have been postulated [15,16], that modulate occurrence of ARIs, although these differ widely. Proper understanding of the drivers of occurrence of ARIs in particular settings is therefore necessary for
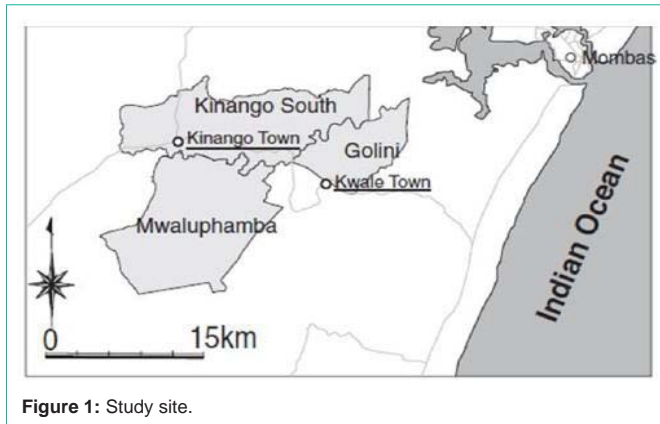
Figure 1: Study site.

development of appropriate prevention and control algorithms. The aim of this study was to examine occurrence of ARIs among children aged below five years attending Kinango Sub-County hospital and determinants of their occurrence.

Methods

Study site

The study was conducted in Kinango Sub-County Hospital, located in Kinango town within Kinango Sub-County in Kwale County, Kenya (Figure 1). The hospital is a level 4 facility with a 94-bed capacity. It has a dedicated maternal and child health clinic, and an outpatient department that serves both adults and children. The hospital's community linkage is well developed, with the community health volunteers actively involved in linking the community to primary care. The hospital's catchment area covers both rural and semi-urban settlements, with varying levels of access by the community.

Kwale County is mostly sparsely populated with a poverty index of 41.8% [17]. It is served by one level four hospital, two level three hospitals and thirty-four level two public health facilities. The average distance to the nearest health facility is about seven kilometers [18].

Study design and sample size calculation

A cross-sectional hospital-based study was conducted. Sample size was calculated using Cochrane formula [19], with a sampling error of 5% at 95% confidence interval assuming a prevalence of 50%, yielding a minimum sample of 385.

Study population

Study subjects were children aged below five years and their mothers. Systematic sampling was used to randomly select study participants. About 800 children aged below five years are usually seen at the outpatient clinic per month. Data was collected from November 2017 to January 2018, during which approximately 2400 children aged below five years were treated. Using a sampling interval of six, every 6th mother-child pair was selected to participate in the study starting from a random point until the sample size was achieved. Children whose mothers consented for their participation were included in the study. Children who were accompanied by caregivers were excluded as well as children whose mothers declined consent.

Study procedure

Recruitment of study participants was conducted during routine outpatient care. Objectives and procedure of the study were explained to the mother-child dyads at the outpatient clinic before consultation. Based on description by WHO [20], an ARI was defined as any acute episode of runny nose, cough, ear discharge, pain or itch, sore throat or hoarseness of voice, difficult or fast breathing with or without fever, or chest in drawing. Upon consultation, cases were classified using the Integrated Management of Childhood Illness (IMCI) criteria [21]. The diagnosis of children who were not suffering from an ARI was also clearly recorded on the health cards. Recruitment of study participants was conducted at the records department after going through the consultation process. Every 6th mother-child pair was requested to participate in the study. In case a selected subject declined consent, the next mother-child pair was requested to participate. The consent form was read and explained to those who agreed to participate in the study after which they were requested to sign the consent document.

Data collection

Following consenting, data collection was conducted using an interviewer-administered structured questionnaire. Presence or absence of an ARI was recorded from the patient's health card. Birth and immunization details of the child were obtained from the maternal and child health booklet where possible or parental recall. The child's weight and height were then taken for computation of Z-scores. The height of infants (0-23 months) was measured in recumbent position using a wooden height board. Heights of children aged above two years were measured in standing position using a vertical height board. The child was placed on board base, to stand in in upright position with head held upright, and back of the head, back and heels against the board. Children aged 0-6 months were weighed using an electronic scale in lying position. Older children who could not stand were weighed in sitting position while those who could stand were weighed in standing position, all lightly dressed.

Statistical analysis

Data was entered into Microsoft access (2016) and exported to STATA Version 14 [22] for analysis. Socioeconomic indicators were summarized using Principal Component Analysis (PCA). Wealth quintiles were then generated and grouped into low, middle and high socioeconomic status. Descriptive and summary statistics were used to summarize child, parental and environmental characteristics in order to describe the study population and calculate the prevalence of ARIs. Factors associated with occurrence of ARIs were established using binary logistic regression. Association was measured using odds ratio at 0.05 significant level and 95% confidence interval. Multivariable regression model was constructed by stepwise estimation, using backward selection. Variables with a P-value greater than or equal to 0.2 were removed sequentially. The model was adjusted for age of the children, gender, birthweight, immunization status, breastfeeding status, underweight, stunting, parental characteristics, exposure to school-going children, contact with an infected person in the past two weeks, previous hospitalization, household density and socio-economic status.

Results

Out of the 385 children who participated in the study, 228

Table 1: Diagnosis observed among study children.

Diagnosis	Number of Children	%
Acute respiratory infection	216	56.1
Acute respiratory tract infection with co-infection	12	3.1
Acute febrile illness	53	13.8
Dermatological conditions	40	10.4
Gastrointestinal infection	19	4.9
Malaria	4	1

(59.2%) presented with ARIs. 5% were co-infected mostly with gastrointestinal and dermatological conditions. Acute febrile illness and dermatological conditions were frequently reported as shown

on Table 1. According to IMCI guidelines, 207 (90.8%) children had ARIs and 21 (9.2%) had pneumonia. No cases of severe pneumonia were observed.

Demographic characteristics of study children

Of the study sample, 192 (49.9%) were male. Mean age was 22.14 ± 14.7 months. Majority of the participants; 237 (61.6%) were aged below two years of whom 58 (15.1%) were aged below six months. Only 95 (24.7%) children were born at home. Average breastfeeding duration was 20.1±5.1 months. Children who were fully immunized as per schedule were 277 (72%) as shown in Table 1. Prevalence of underweight, stunting and wasting was 15.8%, 26.3% and 11.4% respectively.

Table 2: Demographic characteristics of study children and association between ARIs and children's demographic characteristics.

Characteristic	No. of Participants (%)	No. of Cases (%)	OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age (Months)						
0-6	58 (15.1)	33 (56.9)	1.06 (0.57-1.96)	0.846		
7-12	67 (17.4)	42 (62.9)	1.35 (0.74-2.44)	0.318		
13-24	112 (29.1)	71 (63.4)	1.39 (0.84-2.30)	0.196		
25-59	148 (38.4)	82 (55.4)	Reference			
Gender						
Male	192 (49.9)	103 (53.6)	Reference		Reference	
Female	193 (50.1)	125 (64.8)	1.59 (1.05-2.39)	0.027	3.39 (1.21-9.46)	0.02
Birth Weight						
Low	25 (8.9)	15 (60.0)	Reference		Reference	
Normal	256 (91.1)	151 (59.0)	0.96 (0.41-2.22)	0.921	0.06 (0.01-0.61)	0.018
Place of Birth						
Home	95 (24.7)	54 (56.8)	Reference			
Hospital	290 (75.3)	174 (60.0)	1.14 (0.71-1.82)	0.59		
Breast Feeding Status						
Supplemented	61 (18.3)	37 (60.7)	Reference			
Exclusive	272 (81.7)	161 (59.2)	0.94 (0.53-1.66)	0.833		
Breast Feeding Duration						
0-12 months	18 (9.6)	11 (61.1)	2.36 (0.31-17.85)	0.407		
13-24 months	165 (87.8)	93 (56.4)	1.94 (0.31-11.90)	0.475		
25-36 months	5 (2.7)	2 (40.0)	Reference			
Immunization Status						
Complete	277 (72.0)	169 (61.0)	Reference			
In progress	87 (22.6)	48 (55.2)	0.79 (0.48-1.27)	0.333		
Incomplete	21 (5.4)	11 (52.4)	0.70 (0.29-1.71)	0.438	0.06 (0.00-1.28)	0.071
Weight for Age						
Normal	324 (84.2)	194 (59.9)	Reference			
Underweight	61 (15.8)	34 (55.7)	0.84 (0.48-1.46)	0.547		
Height for Age						
Normal	284 (73.8)	166 (58.4)	Reference			
Stunted	101 (26.3)	62 (61.4)	1.13 (0.71-1.80)	0.606	3.63 (1.04-12.61)	0.043
Height for Weight						
Normal	341 (88.6)	209 (61.3)	Reference			
Wasted	44 (11.4)	19 (43.2)	0.48 (0.25-0.91)	0.024		

Table 3: Environmental characteristics of study participants and association between ARIs and children's environmental characteristics.

Characteristic	No participants (%)	Prevalence	Univariable analysis OR (95% CI)	P-value	Multivariable analysis aOR (95% CI)	P-value
Household density						
2-4	171 (44.4)	98 (57.3)	Reference			
5-7	156 (40.5)	95 (60.9)	1.16 (0.75-1.80)	0.51		
≥8	58 (15.1)	35 (60.3)	1.14 (0.62-2.08)	0.686		
Number of rooms						
1	23 (6.0)	13 (56.5)	Reference			
2	193 (50.1)	113 (58.5)	1.09 (0.45-2.60)	0.852		
≥3	169 (43.9)	102 (60.4)	1.17 (0.48-2.82)	0.725	2.34 (0.76-7.20)	0.139
History of contact with an infected person						
Had contact	166 (43.1)	99 (59.6)	Reference			
No contact	219 (56.9)	129 (58.9)	0.97 (0.64-1.46)	0.885		
School-going sibling						
Yes	260 (67.5)	164 (63.1)	Reference			
No	125 (32.5)	64 (51.2)	0.61 (0.40-0.95)	0.027		
Hospitalization within the past 3 months						
No	306 (79.5)	180 (58.8)	Reference			
Yes	79 (20.5)	48 (60.8)	1.08 (0.65-1.79)	0.755	8.19 (1.74-38.43)	0.008
Cause of hospitalization						
Respiratory infection related	41 (51.9)	26 (63.4)	1.26 (0.51-3.11)	0.616		
Not respiratory infection related	38 (48.1)	22 (57.9)	Reference			
Exposure to cigarette smoke						
No	238 (61.8)	138 (58.0)	0.87 (0.57-1.33)	0.53		
Yes	147 (38.2)	90 (61.2)	Reference			
Socioeconomic status						
Low	132 (35.9)	79 (59.8)	Reference			
Middle	116 (31.5)	69 (59.5)	0.98 (0.59-1.63)	0.953	4.23 (0.90-19.96)	0.068
High	120 (32.6)	69 (57.5)	0.91 (0.54-1.50)	0.705	3.01 (0.68-13.23)	0.145

Demographic characteristics of parents of study children

Average maternal age was 26±6.1 years. Age ranged from 17 to 47 years. Mothers who had primary level of education were 182 (47.3%). Only 47 (12.2%) of the mothers had attended secondary education and above. Most mothers; 252 (65.5%) were unemployed while 310 (86.4%) fathers were in various forms of employment as shown on Table 2.

Environmental characteristics of study participants

Majority of the children, 288 (74.8%) lived in mud walled houses. Most of the houses; 254 (66.0%) had iron sheet roofing and 298 (77.4%) houses had earthen floor material. Firewood (80%) and charcoal (13%) were the most common sources of cooking energy while kerosene (57.7%) and solar (32.0%) were the most common sources of lighting energy.

Univariable analysis of factors associated with ARIs

As shown in Table 1, female children were significantly more likely (OR 1.59; 95% CI: 1.05-2.39) to be infected with an ARI compared to male children. Odds of infection increased with increase in age, with children aged between 13 to 24 months presenting the highest odds of

infection (OR 1.39; 95% CI: 0.84-2.30). Breastfeeding was protective of ARIs by 6% (OR 0.94; 95% CI: 0.53-1.66), as well as normal birth weight (OR 0.95; 95% CI: 0.41-2.22) although not significantly. Odds of infection decreased with increasing breastfeeding duration. Immunization was generally protective of ARIs, with children who were up-to-date on the immunization schedule presenting up to 30% reduced odds of infection (OR 0.70; 95% CI: 0.29-1.71).

The risk of getting an ARI decreased by 43% among children whose fathers were educated up to primary school (OR 0.57; 95% CI: 0.34-0.96). Age, marital status, level of education and employment status of mothers were not statistically significant determinants of occurrence of ARIs. However, odds of infection decreased with increase in mothers' age and with increasing level of education as shown on Table 2.

Not having school going siblings was a significant protective factor too (OR 0.61; 95% CI: 0.40-0.95). Odds of infection increased with increase in household density and number of rooms although not significantly. Absence of contact with an infected person marginally reduced the odds of infection by 3% (OR 0.97; 95% CI:

Table 4: Parental socio-demographic characteristics and association between ARIs and Parental socio-demographic characteristics.

Characteristic	No of participants (%)	ARI Prevalence %	OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Maternal age						
<20	52 (13.5)	27 (51.9)	Reference			
21-30	249 (64.7)	152 (61.0)	1.45 (0.79-2.64)	0.225		
>31	84 (21.8)	49 (58.3)	1.30 (0.65-2.60)	0.465		
Marital status of mother						
Married	359 (93.3)	209 (58.2)	0.51 (0.21-1.25)	0.143		
Single	26 (6.7)	19 (73.1)	Reference			
Education level of mother						
No formal education	156 (40.5)	90 (57.7)	Reference			
Primary education	182 (47.3)	110 (60.4)	1.12 (0.73-1.73)	0.609	3.54 (1.10-11.32)	0.033
Secondary education and above	47 (12.2)	28 (59.6)	1.08 (0.56-2.10)	0.819		
Education level of father						
No formal education	90 (25.1)	58 (64.4)	Reference			
Primary education	177 (49.3)	90 (50.8)	0.57 (0.34-0.96)	0.035	0.37 (0.13-1.09)	0.07
Secondary education and above	92 (25.6)	61 (66.3)	1.09 (0.59-2.00)	0.792		
Employment status of mother						
Housewife	52 (13.5)	27 (51.9)	Reference			
Unemployed	252 (65.5)	155 (61.5)	1.48 (0.81-2.70)	0.201	5.14 (0.90-29.36)	0.065
Employed	81 (21.0)	46 (56.8)	1.21 (0.60-2.45)	0.582	7.21 (0.84-61.58)	0.071
Employment status of father						
Unemployed	49 (13.7)	33 (67.3)	Reference			
Employed	310 (86.4)	176 (56.8)	0.64 (0.33-1.21)	0.166		
Parity						
1-2	182 (47.3)	106 (58.2)	Reference			
3-4	106 (27.5)	62 (58.5)	1.01 (0.62-1.64)	0.967	4.69 (1.20-18.28)	0.026
≥5	97 (25.2)	60 (61.9)	1.16 (0.70-1.92)	0.558	11.46 (2.38-55.09)	0.002

0.64-1.46), as well as not having been previously hospitalized in the last three months (OR 0.86; 95% CI: 0.50-1.46). Absence of a smoker in a household lowered the odds of infection by 13% (95% CI: 0.57-1.33) as shown on Table 3.

Housing characteristics, source of cooking and lighting energy and overall exposure of a child to wood smoke were not significantly associated with occurrence of an ARI. These factors were used to calculate socioeconomic status of participants using PCA. Computed scores were categorized onto low, middle and high socioeconomic status, which too were not significantly associated with occurrence of ARIs.

Multivariable analysis

Female children were three times more likely (aOR 3.39; 95% CI: 1.21-9.46) to be infected with an ARI compared to male children. Normal birth weight was significantly protective of ARIs, with up to 94% (aOR 0.06; 95% CI: 0.01-0.62) reduced odds of infection while stunting posed a three-folds increase in odds (aOR 3.62; 95% CI: 1.04-12.61) of getting and ARI as shown on Table 1. Among the parental characteristics, primary level of education among mothers increased a child's odds of getting an ARI by three times (aOR 3.54; 95% CI: 1.10-11.32). High parity also significantly increased odds of infection,

with having five and above children increasing odds of infection by 11 times (aOR 11.45; 95% CI: 2.38-55.09) as shown on Table 4. Recent hospitalization significantly increased odds of getting an ARI by 8 times (aOR 8.19; 95% CI: 1.75-38.43).

Discussion

ARIs remain an important public health problem, causing significant morbidity and mortality, and children continue to bear the highest burden of these infections. This study reported a prevalence of 59.2%. In agreement with this finding, Muthoni & Ngesa [9], reported an estimated ARI prevalence of 55-60 % for Kwale County from models based on national health and demographic survey data. Additionally, a high individual risk of infection by various respiratory viruses, up to 93.4% was reported in a large household survey in rural North Coast with similar settings [23], suggesting a high likelihood of occurrence of ARIs along the larger coastal region. The high prevalence observed could also be as a result of timing of the study, since the study was conducted during a peak season for transmission of respiratory diseases. Equally high prevalence rates were observed in related studies [16,24,25], highlighting a substantial burden of ARIs among children under five years in various settings.

ARI infections peaked at two years. This age group has been shown

to be highly vulnerable to ARIs mostly due to underdevelopment of their immune system [26], coupled with incomplete development of their lungs and relatively short bronchial tree that causes an infection to spread faster [27]. Additionally, increasing contact between the child and other household members as the child grows older and decreasing protective effects of passive maternal immunity, coupled with increased contact with fomites makes them more exposed to ARIs.

This study identified female gender as a significant determinant for occurrence of ARIs. Although previous studies [1,28,29] have consistently reported a higher risk among males. Involvement of gender in development of ARIs remains relatively non-conclusive. For instance, no consistent sex differences in the burden of ARIs was observed over a period of twenty-four years, even after controlling for possible confounding factors while examining sex-specific trend of childhood ARIs in Nigeria [30]. Since perception of gender as a potential modulator of response to infection persists, it is necessary to elucidate its mechanisms and establish whether it is applicable to childhood ARIs in order to understand ARIs development in each gender.

Normal birth weight was significantly protective against ARIs in this study. Birthweight is an important modulator of child survival, growth and development [31]. Children born with low birth weight are more susceptible to respiratory infections [6] especially of the lower respiratory tract [32]. Protective effect of normal birth weight observed in this study was tentatively due to immune system sufficiency and optimal lung function conferred by normal birthweight, despite potential confounding by factors such as malnutrition and continued exposure to environmental triggers.

Childhood stunting increased the odds of getting an ARI in this study. The high prevalence of malnutrition that has been extensively reported in this population [33-35] tentatively explains this observation. Although the relationship between infections and malnutrition is mostly bidirectional [36,37], a child with underlying malnutrition lacks nutrients needed for immune activation, increasing their susceptibility to acute infections [38]. Further, the process of linear growth catch-up that could reverse stunting and its effects on immunity may be slow or impossible in this setting due to food insecurity and high burden of infectious diseases resulting in sustained stunting with sustained susceptibility to ARIs [39]. In concurrence, an association between stunting and occurrence of ARIs among children was similarly observed in a study conducted in Bangladesh [40].

Maternal education status was significantly associated with occurrence of ARIs too. Children whose mothers were educated up to primary level had significantly increased odds of getting an ARI. Moreover, odds of infection decreased with increasing level of maternal education in the unadjusted model although not significantly. Generally, a higher level of education among mothers promotes adoption of good childcare practices that reduce exposure of children to ARIs and other infections. It is also likely to improve social and environmental conditions of a household resulting in improvements in child health by modifying factors such as employment and household income. In agreement with the findings of this study, a meta-analysis of observational studies from low and middle-income countries identified low maternal education as a risk factor for mortality due to acute infections of the lower respiratory tract [41], confirming the impact of maternal education.

Hospitalization in the preceding three months significantly increased the odds of getting an ARI. Recurrent hospitalization in early childhood increases the risk of morbidity with acute respiratory infections and even asthma in a dose response manner [42]. Recurrent ARIs particularly increase the risk of subsequent respiratory infections [43]. Of the children who had been previously hospitalized in this study, 51.9% had been hospitalized for respiratory related infections especially pneumonia and asthma, suggesting that recurrent ARIs potentially increase the risk of getting an ARI in future.

Parity was shown to affect occurrence of ARIS, with odds of getting an ARI increasing with increasing parity. High parity could have increased household density and person-to-person contact, facilitating transmission of respiratory pathogens. Moreover, this study observed an association between school-going siblings and occurrence of ARIs, who have been shown to be important introducers of respiratory pathogens in households [44], suggesting a potential risk posed by multiple siblings. High parity compromises quality of care accorded to each child too, due to increased financial and social requirements. This affects not only living conditions but also nutritional care of children especially since this population has been shown to be relatively food insecure [33], generally increasing susceptibility to infectious diseases.

An important limitation of this study is that prevalence of ARIs was captured at the hospital level hence it may not be a true reflection of the activity of ARIs in the community. A longitudinal study will illustrate the epidemiology of ARIs among under-fives better. Additionally, diagnosis was made based on clinical symptoms using IMCI guidelines. Over diagnosis or under diagnosis is possible given the limitations surrounding its application.

Conclusion

This study highlights a high burden of ARIs among children under five years. Female gender, stunting, low maternal education and high parity were significantly associated with occurrence of ARIs. Normal birth weight and absence of hospitalization in the previous three months were protective factors. This study suggests that improvements in maternal education, with increased awareness on maternal and child health could minimize morbidity due to ARIs in this population. Prevention and management of other infectious diseases is also likely to reduce the burden of ARIs and improve overall health of children. Since no intervention can singly reduce morbidity and mortality due to ARISs, modulation of core risk factors could substantially help to reduce preventable deaths.

Acknowledgement

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