Acute Respiratory Infections in Children: A Community-based Longitudinal Study in Rural Bangladesh

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Summary

A community-based longitudinal study conducted in Matlab, a rural area in Bangladesh, investigated acute respiratory infections (ARI) among children. A cohort of 696 children under 5 years of age was followed for 1 year yielding 183,865 child-days of observation. Trained field workers visited the study children every fourth day. Data on symptoms suggesting ARI, such as fever, cough, and nasal discharge, were collected for the preceding 3 days by recall. To determine the type and severity of ARI, the field workers conducted physical examinations (temperature, rate of respiration, and chest indrawing) of children reporting cough and/or fever. The overall incidence of ARI was 5.5 episodes per child-year observed; the prevalence was 35.4 per hundred days observed. Most of the episodes (96 per cent) were upper respiratory infections (URI). The incidence of acute lower respiratory infections (ALRI) was 0.23 per child per year. The incidence of URI was highest in 18-23-month-old children, followed by infants 6-11 months old. The highest incidence of ALRI was observed in 0-5-month-old infants followed by 12-17-month-old children. Among 559 children who were followed for 6 months or longer, about 9 per cent did not suffer any URI episode and about 16 per cent suffered one or more ALRI episodes. About 46 per cent of URI and 65 per cent of ALRI episodes lasted 15 days or more. The incidence rates of URI were higher during the monsoon and pre-winter periods, and that of ALRI at the end of the monsoon and during the pre-winter periods. Sociodemographic variables were not associated with the incidence of URI or ALRI. The study documents ARI to be a major cause of morbidity among rural Bangladeshi children.

Introduction

Acute respiratory infections (ARI) are important causes of morbidity and mortality in young children in the developing world.1 ARI account for nearly one-third of all deaths among children below 5 years of age in many countries including Bangladesh.2,3 The overall incidence rate of ARI in this age group ranges from 3 to 10 episodes per child per year,46 with the highest incidence among children less than 2 years of age.2 The incidence rates in the developing countries are comparable to those of developed countries, but cause-specific mortality rates from ARI are 10-50 times higher in developing than in developed countries.78 A community-based longitudinal study on ARI conducted in Bangladesh a decade prior to the present study showed that children spent 60 per cent of the time with ARI.9 This study was designed to reassess the problem using more precise current definitions of upper and lower ARI in order to plan future interventions for the control of ARI in children less than 5 years of age in rural Bangladesh.

Methods

The study was conducted in Matlab, a rural area of Bangladesh located 45 km southeast of Dhaka, the capital of Bangladesh. Matlab is a low lying flood-prone area intersected by numerous canals and rivers. There are four distinct seasons, the monsoon period, July-September with an average of 152 cm rainfall (temperature range 23-38°C), the pre-winter period, October-November (temperature range 16-33°C), the dry winter season, December-February (temperature...
range 13–29°C), and the dry hot period (March–June (temperature range 26–38°C). The population density of this area is about 700/Km² and the infant mortality rate is about 90 per 1000 live births. The principal occupations in the Matlab area are farming and fishing. Since 1966, the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) has maintained a Demographic Surveillance System (DSS) in this area comprised of periodic censuses and intervening longitudinal registration of vital events. A central diarrhoeal hospital, staffed by physicians and paraprofessionals provides free therapy for all admitted patients.

The study was carried out in three villages of the Matlab DSS area. A cohort of 696 children aged 0–59 months was followed prospectively from May 1988 to April 1989, yielding 183,865 child-days of observation. A total of 575 children was recruited at the beginning of the study and 10–12 newborns were recruited monthly. Of these, 512 children were followed for a full year and 559 were followed for 6 months or longer duration. Details of recruitment procedures and surveillance methods have been described previously. Briefly, the field workers for the study were recruited from the same village as the study participants. They had at least 10th grade of education, and given 2 months theoretical and practical training in Matlab hospital and in the field. They were trained how to conduct interviews, to record accurately a child’s respiratory rate and temperature, and to recognize cases of chest indrawing. The field workers were provided with paracetamol syrup and packets of oral rehydration salts (ORS). They visited all the study children every fourth day. Data on symptoms suggesting ARI (fever, cough, nasal discharge) were collected for the preceding 3 days by recall. Children with reported cough and/or fever on the day of visit were examined by temperature, the rate of respiration, and the presence of chest indrawing. Upper respiratory infection (URI) was defined as the presence of fever (>37.8°C) with cough and/or nasal discharge. Acute lower respiratory infection (ALRI) was defined as the presence of cough and respiratory rate >50/min with or without chest indrawing. An episode was considered to be an ALRI when the child developed ALRI at the beginning of the episode or started with URI followed by ALRI. For some analyses, cases of URI and ALRI were grouped together as cases of ARI. A new episode was considered possible when the child was free of symptoms of ARI for at least 1 week. The number of days for which information was available for each child were used to calculate the number of child-days observed as the denominator. Incidence and prevalence rates were calculated using person time as the denominator. Data from all 696 children were analysed to calculate the age-specific incidence/prevalence rates, and seasonality of URI and ALRI. Since some children were followed for a short period of time, we restricted other analyses to 559 children who were followed for at least 6 months or longer duration. Children with ALRI needing hospitalized care were referred by the field workers to Matlab hospital.

Data on socio-economic conditions (sex of the child, family size, average monthly income, maternal age, maternal education) were collected from study households at the beginning of the study. About three quarters of the study children had a Z score below –2 weight-for-age and height-for-age, and about one-quarter had a Z score below –2 for weight-for-height. The immunization status of the children at the beginning of the study was very low. Only 2–3% of children had received diphtheria-pertussis-tetanus and BCG vaccine. After 3 months of follow-up all children aged 9–23 months were immunized against measles.

Data quality was ensured through proper training of workers, fortnightly meetings, standardization of

### Table 1
Incidence and prevalence rates of upper and lower respiratory infections by age of study children (n = 696), Matlab, Bangladesh, May 1988 to April 1989

<table>
<thead>
<tr>
<th>Age group (months)</th>
<th>Child days observed</th>
<th>No. of episodes</th>
<th>URI Incidence*</th>
<th>URI Prevalence†</th>
<th>ALRI No. of episodes</th>
<th>ALRI Incidence</th>
<th>ALRI Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5</td>
<td>10,651</td>
<td>162</td>
<td>5.55</td>
<td>41.55</td>
<td>15</td>
<td>0.51</td>
<td>8.87</td>
</tr>
<tr>
<td>6–11</td>
<td>20,456</td>
<td>352</td>
<td>6.28</td>
<td>38.44</td>
<td>11</td>
<td>0.20</td>
<td>0.76</td>
</tr>
<tr>
<td>12–17</td>
<td>20,292</td>
<td>262</td>
<td>4.71</td>
<td>30.81</td>
<td>19</td>
<td>0.34</td>
<td>5.20</td>
</tr>
<tr>
<td>18–23</td>
<td>23,649</td>
<td>422</td>
<td>6.51</td>
<td>34.82</td>
<td>16</td>
<td>0.25</td>
<td>2.53</td>
</tr>
<tr>
<td>24–29</td>
<td>27,236</td>
<td>379</td>
<td>5.08</td>
<td>34.29</td>
<td>18</td>
<td>0.24</td>
<td>1.84</td>
</tr>
<tr>
<td>30–35</td>
<td>24,018</td>
<td>311</td>
<td>4.73</td>
<td>27.69</td>
<td>10</td>
<td>0.15</td>
<td>1.97</td>
</tr>
<tr>
<td>36–41</td>
<td>21,335</td>
<td>284</td>
<td>4.86</td>
<td>30.02</td>
<td>15</td>
<td>0.26</td>
<td>4.38</td>
</tr>
<tr>
<td>42–47</td>
<td>17,839</td>
<td>261</td>
<td>5.34</td>
<td>26.24</td>
<td>9</td>
<td>0.18</td>
<td>2.49</td>
</tr>
<tr>
<td>48–59</td>
<td>18,389</td>
<td>239</td>
<td>4.74</td>
<td>32.67</td>
<td>4</td>
<td>0.08</td>
<td>0.86</td>
</tr>
<tr>
<td>Total</td>
<td>183,865</td>
<td>2672</td>
<td>5.30</td>
<td>32.59</td>
<td>117</td>
<td>0.23</td>
<td>2.86</td>
</tr>
</tbody>
</table>

* Per child-year observed, incidence rate = no. of new episodes (URI or ALRI)/total days observed * 365.
† Per 100 days observed, prevalence rate = no. of days with URI or ALRI/total days observed * 100.
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Results

A total of 2823 ARI episodes was identified of which 2789 were new (incident) cases and the remaining 34 cases were present at the time of enrolment. The overall incidence of ARI in the study children was 5.5 episodes per child-year observed. Most of the episodes (96 per cent) were URI (incidence 5.3 per child per year). Only 4 per cent of the total episodes were ALRI; the incidence of ALRI was 0.23 episodes per child per year (Table 1). The incidence rate of URI was highest in children 18–23 months old followed by infants 6–11 months. The highest incidence of ALRI was observed in infants below 6 months of age.

The overall prevalence of ARI was 35.4 per hundred days observed; the prevalence of both URI and ALRI were highest in infants under 6 months of age (Table 1). About 46 per cent of URI and 65 per cent of ALRI episodes lasted 15 days or more. The median duration of URI episodes was 13 days and that of ALRI episodes was 28 days. The distribution of children by incidence rates of URI is shown in Fig. 1; 9 per cent of the children did not experience a URI episode during the period of study, 7 per cent experienced one, 7 per cent experienced two, 9 per cent experienced three and another 10 per cent experienced four episodes. About 11 per cent suffered 10 or more URI episodes.

The distribution of the study children by incidence rates of ALRI was highly skewed; 84 per cent of the children did not experience any ALRI episode, 11 per cent experienced one episode per child year and about 5 per cent experienced two or more episodes per child year (data not shown).

The distribution of children by ARI prevalence rates showed that 8 per cent children suffered from ARI for 1–4 per cent of the days, 5 per cent for 5–9 per cent of the days. About 31 per cent children

Discussion

This study clearly demonstrates that ARI is an important cause of morbidity among rural Bangladeshi children.
The overall incidence of ARI was in the same range as obtained from studies in both developing and developed countries.4-6 However, the prevalence was much lower than reported by Black et al.9 from the same community. This might be due to differences in surveillance methods and/or the definitions used for ARI episodes. The study by Black et al. was based on alternate day surveillance and used a less restrictive definitions.9 Furthermore, the incidence rate of ALRI was much lower than the rates reported from Costa Rica15 and Gambia.16

Some methodologic differences need to be considered when comparing rates of ARI from different studies. First, we used a more restrictive definition of URI, taking the presence of fever as a necessary sign although fever had not been shown to be a necessary indicator for ALRI.17 Secondly, we used a cut off point of 50 respirations/minute irrespective of the age of the child to define a case of ALRI. This may have resulted in underestimation of ALRI cases in children 12-59 months age since a new criterion of 40 respirations/ min has been suggested by WHO in that age group, but a partially offsetting over-estimation of ALRI in children under 2 months old, a group in which WHO now suggests a cut off of 60 respirations/min.17 Finally, we have calculated the ARI incidence rates for each child using total days observed as the denominator. The rate may be less than in other studies11 where child-days at risk (days without ARI) were used as the denominator. The frequent morbidity surveillance by a group of trained field workers resident in the respective village should have resulted in identification of most of the episodes.

The highest incidence of ALRI in our study was in the first 6 months of life, similar to previous reports.18 The median duration of an ALRI episode in our study was similar with Philippine study13 but much longer than in American community study.19 This longer duration of ALRI episode might be due to inclusion of days with URI in an ALRI episode and the high prevalence of malnutrition among study children.15 We observed a higher incidence of URI during the monsoon and pre-winter season, whereas ALRI peaked at the end of the monsoon and in the pre-winter seasons. In some countries the highest incidence was observed during winter and in others in the warm season, however, the seasonal peaks of ALRI were often different from those of ARI.11,20

No community-based aetiological study on ARI has been conducted in Bangladesh. A hospital-based study in Bangladesh revealed that respiratory syncytial virus (RSV) was the most common ALRI pathogen in children under 5 years of age.21 In a community-based study in Colombia RSV was the most common viral agent for children below 18 months of age.18

The mortality was substantially low among our study children. We observed only three deaths during the follow-up periods. Using the age specific mortality rate of the community during the same period of time22 the expected number of deaths would be 10. Factors associated with this low mortality may be the early recognition of symptoms by frequent home visits of the field workers, timely referral of severely sick children to Matlab hospital, provision of ORS, measles immunization to all eligible children, and treatment facilities for minor illnesses at the household level.

We did not find any association between low socio-economic status or family size with the occurrence of URI or ALRI. Such a result agrees with findings in Burkina-Faso,23 but differs from those in India.24 In the Indian study higher incidence of ARI was observed among children from low socio-economic group than children from the high socio-economic group.

We have demonstrated that children in this setting have high rates of both URI and ALRI. Our ability to control URI is limited since these are mostly viral infections25 for which no vaccine exist, however, control strategies can be directed at ALRI which have a high case fatality rate. Other studies have shown that ALRI, predominantly pneumonia, is due to bacterial infections26 for the majority of the cases and that case management with effective antibiotics can reduce ALRI mortality by half.27 This study indicates that approximately 15 per cent of all under five children need to be treated each year using current WHO ALRI case management guidelines. Although this is a sizable commitment of health resources, it has been shown to be highly cost effective health intervention in developing countries.28 Additional technologies e.g. vaccines against RSV and bacterial pneumonic pathogens, are needed to sustain reductions in ALRI mortality in developing country children.

References