Community Economic Development and acute lower respiratory infection in Children

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Introduction

Acute respiratory infection is a major cause of morbidity and mortality in children worldwide. Four million children under five years of age die from respiratory infections each year (Douglas and Kerby-Eaton, 1985; Leowski, 1986; Garenne, Ronsmans, and Campbell, 1992) and most of the deaths are due to acute lower respiratory infection (ALRI), primarily pneumonia (Garenne, Ronsmans, and Campbell, 1992).

The incidence of ALRI has been reported to be as much as fifty times higher in developing countries than in developed countries (Douglas and Kerby-Eaton, 1984; ICCARI, 1991). One possible explanation for this disparity is that it is due to socio-economic status (SES). Indeed, studies in both developed (Gardner, Frank, and Taber, 1984; Margolis et al.,1992) and developing countries (Cruz et al., 1990; Victora et al., 1994) indicate that children from low SES families have higher rates of ALRI. However, most studies of the relationship of SES and ALRI have examined the effects of SES at the individual level.

There is evidence that community characteristics also influence health and well being (Sclar, 1980). For example, differences in the epidemic pattern of coronary heart disease in the United States have been related to the level of community resources (Wing et al., 1992) and differences in the rates of low birth weight, homicide and violent crime have been related to income inequality among states in the US (Kaplan et al., 1996). The explanation may be that economic and social factors within communities result in differences in the availability of material resources or support for families. Thus, it is important to examine variation in ALRI in smaller geographic areas and to assess whether community resources may modify the deleterious effects of low socio-economic states. We used data from a population-based study to examine the effects of the community in which children live on their risk of ALRI. The objectives of the study were to -

Examine the variation of ALRI prevalence among counties (municipios) in four states in north-eastern Brazil
Determine whether rates of ALRI varied among counties at different levels of economic development and urbanization

Examine the extent to which community economic development might modify the effect of low socioeconomic states on rates of ALRI

Methods

Sampling and Data Collection

The data for this analysis were collected in the "1991 Diagnostico de Saude das Criancas do Nordeste", a population-based survey to assess health, nutritional status and utilization of health services among children from northeast Brazil. The region's infant mortality rate is estimated to be 116.1/1000 (IRALA, 1992), the highest in the nation. The north-east of Brazil comprises nine states with a total area of 1,548,672 km2 and a total population of 44,429,181. It is located between the Equator and latitude 15 degrees south. During any year, there is little variation in temperature.

Four states were part of the present study: Maranhao (MA), Paraiba (PR), Pernambuco (PE) and Piaui (PI). Each state is divided into municipios (counties), which are geographically, politically, and administratively defined by the Brazilian Institute of Geography and Statistics Foundation (IBGE). In 1991, the total number of counties in these four states was 593 (MA: 136; PR: 171; PE: 168 and PI: 118) with a total population of children under 5 years of age estimated at 3.25 million (Censo Demografico, 1991).

A detailed description of the methods used in the survey has been published (Victora et al., 1993). In brief, a cross-sectional, stratified, three-stage cluster method was used to select the study sample. In the first stage, approximately 20 counties were selected randomly from each state. A proportionate selection process was used such that the most populated counties had a greater chance of being selected. Since some counties were selected more than once, the total number of counties for each state was less than 20. In the second stage, eight census sectors were selected at random within each county. These census sectors, also defined by the IBGE, contain about 200 households in rural areas and 300 in urban areas. In the third stage, each census sector was mapped, an initial starting point for the survey was chosen at random and 12 adjacent households were visited. All children under 5 years of age living in these households were sampled. Teams of two to four persons, working in pairs, visited two census sectors per day. The process of data collection lasted 10 weeks. Approximately five percent of the measurements were repeated and used to evaluate inter-observer reliability. The sample size of 4,718 children was designed to produce a maximum sampling error of two percent for proportions up to 40% (Victora et al., 1993).

Measurement of ALRI

Acute lower respiratory infection was defined as the mother's report of cough, fever, and fast breathing during the seven days prior to the survey. This measurement is reported to have a sensitivity of 82% and a specificity of 79% to detect ALRI (Kalter et al., 1991).

Measurement of risk factors for ALRI

The family's socio-economic status was assessed by a composite measure constructed using a principal components analysis of nine variables representing the educational level of the household (mother's literacy; mother's years at school; and father's literacy), wealth (possession of a TV set; possession of a radio set; and minimum wage per month) and living conditions (access to piped water; indoor toilet facility; and type of material used to construct the house). Based on the principal components analysis, families were categorized into three levels of SES: low, middle, high.

Economic development was measured as the proportion of low SES children in each county. Measures of community economic development based on individual or family SES are often used when structural indicators of industrial strength and economic development are not available (Susser, 1994). Counties were divided into five equal categories in descending order of development: I (0-9%), II (10-18%), III (19-27%), IV (28-36%), and V (37-45%).

Most counties in the north-east of Brazil cannot be classified as completely "rural" or "urban" because they are large and have both rural and urban areas. A county's degree of urbanization was therefore classified according to the proportion of children in the sample who lived in rural areas. Counties were divided into four equal categories of degree of urbanization: very high (0-25%), high (25-50%), low (50-75%), very low (75-100%).

Variables related to the home environment included the type of cooking fuel (wood or coal), and household crowding (number of persons in the household per room) (Selwyn, 1990; Victora et al., 1994). Since the current ALRI episode could lead to some degree of malnutrition, height-for-age was used as a measure of nutritional status (WHO, 1986). Children were weighed and measured following standard criteria (Epidemiologia da Saude Infantil, 1991). The National Center for Health Statistics reference population was used to calculate z-scores (WHO, 1986). Four categories were created to estimate deviation from the standard: <-1 z score; -1 to -1.9; 2 to 2.9; and >3 z scores. We also recorded age and gender because ALRI is more common in infants and males (Graham, 1990; Selwyn, 1990; Shah et al., 1994).

Statistical Analysis

The first step was to determine whether the prevalence of ALRI varied among counties. Next, we evaluated the relationship to ALRI of both community economic development and urbanization. Finally, we explored the influence of these community-level variables on the relationship between SES and ALRI. Prevalence odds ratios (POR), calculated using logistic regression, were used to summarize the strength of the relationship between ALRI and risk factor variables.

Because economic development and level of urbanization did not have a linear relationship with the logit of the ALRI variable, these variables were coded using indicator variables. Both SES and nutritional status were included in the models as interval-level variables after plots showed that each had a linear relationship with the logit of ALRI (Hosmer and Lemeshow, 1989). A test for trend was performed using a Wald test (Kleinbaum, 1994).

The prevalence of ALRI was estimated at different levels of SES in stratified analysis. Confounding was assessed by examining the relationship with ALRI and SES of both community and individual-level risk factors. Logistic regression was used to assess the joint effects of confounding variables while simultaneously considering the interaction between SES and economic development. Effect modification was assessed by including all two-way interaction terms between family SES and county economic development in the models (Kleinbaum, Kupper, and Morgenstern, 1982). Only interaction terms which led to a clear change in the effects and a p-value<0.10 (likelihood ratio test) were returned. Standard errors and confidence intervals were calculated by the method of Huber (Huber, 1967) because of the cluster design.

Results

Characteristics of Study Communities and Participants

The study sample consisted of 4,718 children under 5 years of age in 70 counties in four states. Fewer than two percent of families refused to participate (Victora et al., 1993). Similar numbers of counties and children were studied in each state. The proportion of low SES children in each county ranged from 0 to 45% (mean: 12.6; standard deviation: 10.8), and the proportion of low SES children in rural areas of counties ranged from 0 to 100% (mean: 65.8; standard deviation: 29.5). The prevalence of risk factors for ALRI such as malnutrition, household crowding, and the use of wood or coal as fuel for cooking was high among study children (Table 1).

Relationship of ALRI to Community and Individual Characteristics

Overall, 10.2% (95% CI: 8.9-11.4) of the 4,718 children were classified as having ALRI at the time of the interview. ALRI prevalence varied significantly among the four states: Pernambuco 7.5% (95% CI: 5.8-9.3); Paraiba 8.4% (95% CI: 6.4-10.3); Maranhao 10.2% (95% CI: 8.4-12.1); and Piaui 14.6% (95% CI: 10.6-18.6). The prevalence of ALRI was highest in the least economically developed counties (POR: 1.65; 95% CI: 1.05-2.58), and in the most rural communities (POR: 1.46; 95% CI: 1.02-2.08) (Table 2).

The prevalence of ALRI was 13.6% among low SES children, 10.4% in the middle SES group, and 6.8% among the high SES group (POR highest vs. lowest: 2.11; 95% CI 1.36-3.26; POR middle vs. lowest: 1.45; 95% CI: 1.16-1.80; p=0.001 for linear trend).

Effect of Risk Factors on the relationship of SES to ALRI

All risk factors, except for younger age and being boys, were more prevalent among low SES children. Low economic development, malnutrition, the use of wood or charcoal cooking fuel were also all associated with higher rates of ALRI (Data not shown).

The association between ALRI and SES was assessed after adjusting for risk factors in a stratified analysis (Table 3). Malnutrition and cooking fuel had the greatest effects on the relationship of ALRI and SES. Crowding, age, and gender had negligible effects. Although crowding was not strongly related to ALRI, we included it in later analyses because it was associated with SES and has been associated with ALRI in other studies. Age and gender were excluded from further analysis.

Effects of Community Characteristics on Relationship Between Poverty and ALRI

The prevalence of ALRI among low SES children living in the least economically developed counties was 22.8%. In contrast, the prevalence of ALRI was 12.0% among low SES children in the most economically developed counties (Table 4). For counties in Category I (highest level of economic development), the unadjusted odds ratio of ALRI among high SES children compared to low SES children was 2.19 (95% CI: 1.05-4.56). However, among counties in Category V (lowest economic development), the odds of ALRI among high compared to low SES children was 10.60 (95% CI: 5.0-22.69) (Table 5).

We used logistic regression to evaluate the association between ALRI and SES after adjusting for community and individual-level risk factors. The model included malnutrition, cooking fuel, and crowding as confounders and an interaction term between SES and economic development (likelihood ratio test for interaction p=0.01) (Figure 1). After adjusting for risk factors, the influence of SES was lower among counties in the highest category of economic development (Category I) as compared to counties with lower economic development. In the counties with higher economic development, the odds of ALRI among very poor children compared to less poor children decreased from 2.19 to 1.34 (95% CI: 0.62-2.87). In contrast, for counties in Categories IV and V, the change in the relationship of SES to ALRI was negligible (Table 5).

Discussion

We found substantial variation in rates of ALRI among the counties in north-eastern Brazil. ALRI was more prevalent in less economically developed counties and also in more rural counties. In addition, children with low SES experienced a higher prevalence of ALRI than children with high SES. After adjusting for other risk factors, the effect of SES was significant only among children living in less economically developed counties; this effect was not explained by differences in individual-level risk factors such as nutritional status and environmental factors, such as crowding.

Few studies have examined the geographical variation of childhood disease in developing countries. However, data from one group of investigations conducted in seven developing countries (the Bostid community studies) found that the incidence of ALRI varied greatly among countries (Selwyn, 1990). Several other recent studies also indicate that ALRI is more common in rural areas (Muhe et al., 1995; Sow et al., 1995). Extending the research done thus far on ALRI, our study explored variation in rates of disease across smaller geographical areas and examined individual and community-level variables that might explain the observed differences.

To date, studies of the relationship of SES to ALRI in developed and developing countries have yielded conflicting results. Although ALRI is more frequent in less educated families in developed countries (Gardner, Frank, and Taber,1984; Margolis et al., 1992) studies in developing countries have found a less consistent relationship (Hortal et al., 1990; Vathanophas et al., 1990; Smith et al., 1991; Kartasasmita et al., 1992). The specific measure of SES used may have influenced the results observed (Cruz et al., 1990). For example, single indicators of SES such as education may not be sensitive enough to detect differences in family resources in developing countries. That is, mothers may have a reasonable education for a region (e.g., elementary education) because of the presence of schools but have a very low income because jobs are scarce.

The influence of community characteristics on child health has received little attention. In the U.S., income disparities in different states have been associated with discrepancies in a variety of health outcomes (Kaplan et al., 1996). Our findings extend this observation. The results from our analysis indicate that community characteristics such as economic development and urbanization may moderate the effects of family SES on health.

Our study had several limitations. We used a questionnaire measure of ALRI. The measure we used has a sensitivity of 82% and a specificity of 79% (Kalter et al., 1991) and some misclassification of the outcome may have occurred. In general, this would tend to diminish the association between ALRI prevalence and SES. Most of the ALRI cases detected in this study were of mild to moderate severity. Although more serious cases of ALRI are of clinical importance, the study of less severe forms is valuable because the frequency of bacterial pneumonia in developing countries is high (WHO, 1993).

ALRI variability among countries could perhaps be explained by the occurrence of epidemics in different counties. However, in the north-eastern region of Brazil, seasonal variation in respiratory illness is uncommon. The brief period of data collection would also have limited the influence of such a problem. We did not measure indoor air pollution directly in this study; and in particular, did not measure tobacco smoke exposure. This risk factor, however, may be less important in developing countries because of the greater exposure to other sources of indoor air pollution.

Our findings extend the understanding of how social stratification influences health. Low SES families living in more developed communities may have greater access to social, human, and material resources, and thus better health. For example, greater social organization and networks may facilitate cooperation among families for mutual benefit (Coleman, 1988; Putman, 1995). The types of jobs and the material resources available, such as food and housing, may also be of considerable importance. In addition, differences in economic development may influence herd immunity (Fine, 1993). In less economically developed counties, the higher concentration of low SES children may promote transmission of disease. Future research can help to clarify how community-level factors influence child health.

Conclusion

Children in economically less developed communities and in low SES families in north-eastern Brazil experienced a higher prevalence of ALRI. Among children living in less developed communities, there was a strong effect of low socioeconomic status on ALRI that could not be explained by factors in the home environment, such as nutrition and crowding. However, in more developed communities, the effect of SES was less, and could be explained by factors in the home environment. These results suggest that the importance of individual risk factors, including socioeconomic status, depends on community economic development. Efforts to decrease poverty and to promote community development may thus have important health benefits for children.

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