Brief Report

Seasonal Pattern of Hospitalization from Acute Respiratory Infections in Yaoundé, Cameroon

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Summary

Acute respiratory infections (ARIs) are among the leading causes of childhood morbidity and mortality in Africa. The effects of climatic factors on occurrence of ARIs in the tropics are not clear. During the years 2006–07, we reviewed the clinical registers of the Chantal Biya Foundation (CBF), Yaoundé, Cameroon, paediatric hospital to investigate the association between climatic factors and ARIs in children. Our findings show that rain, high relative humidity and low temperatures are directly associated with an increase in the frequency of hospitalization from ARIs. Given the high frequency of hospitalization from ARIs we suggest that influenza vaccination campaigns should be implemented taking into account the seasonality in Cameroon.

Key words: seasonality, climate, acute respiratory infections, temperature, humidity, sub-Saharan.

Introduction

Acute respiratory infections (ARIs) are among the leading causes of childhood morbidity and mortality throughout the world [1]. In particular, pneumonia kills >2 million children <5 years of age every year, that is more than AIDS, malaria and measles combined [2]. About 70% of the deaths occur in Africa and Southeast Asia [3], where pneumonia and other ARIs are outnumbered only by malaria [3, 4].

In Africa, ARIs represent an important cause for use of health services, and the most frequent cause for hospitalization, accounting for 12–35% of all hospital admissions [5]; of these, 70–80% are due to pneumonia [1]. Most severe cases are caused by bacterial pathogens, and treatment with a full course of effective antibiotics may be life-saving [6].

There is a lack of information about the effect of climatic factors and seasonal patterns of hospitalization for ARIs and/or pneumonia in the tropics. To this regard, a few studies conducted in tropical or subtropical countries in Asia have found some seasonal variation in viral respiratory infections [7–9], whereas a Brazilian study found that seasonal mortality from pneumonia and influenza was less pronounced in tropical areas [10]. To our knowledge, with the exception of a study conducted in South-Africa, there are no relevant data about seasonal patterns of respiratory tract infection (RTI) in Africa.

To fill the current gap in knowledge, we conducted a study in Yaoundé, Cameroon, in 2006 and 2007, in order to evaluate the trend of hospitalization and to describe the characteristics of the patients affected by ARIs.

Methods

The study was based at the paediatric hospital of the 'Chantal Biya Foundation' (CBF) of Yaoundé, Cameroon. The clinical registers of the five units of the CBF hospital were reviewed to collect individual data regarding age, gender, area of residence, diagnosis of other concomitant diseases, antibiotic treatment, date of hospital admission and clinical outcome. All patients admitted to the hospital during the years 2006–07 were considered. ARI was defined by the presence of fever and at least one respiratory symptom, and classified as lower RTI

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(LRTI; bronchitis, bronchiolitis, pneumonia, pleuritis) or upper RTI (URTI; rhinitis, pharingitis, tracheitis) on the basis of clinical signs/symptoms and chest X-ray. Data of minimum and maximum temperatures, relative humidity and number of days with rain for each month (a rainy day being a 24 h period with at least 0.1 mm of rainfall), for the city of Yaoundé were obtained from the National Meteorological Institute of Cameroon.

Negative binomial regressions were fitted with weather variables, seasonal components (three pairs of sine and cosine terms to capture seasonality) and time-trend components (linear term to capture secular trend). Weather variables were standardized about the mean.

The analyses were repeated selecting only LRTIs or URTIs. Because of the acknowledged seasonality and the similar clinical presentation of malaria with pneumonia in tropical and subtropical climates [11], analyses that include and exclude malaria cases were carried out. The effect of malaria cases was also studied separately for LRTI or URTI. All analyses were carried out in STATA 10.0.

Results

Overall, 1306 children (1162 LRTIs and 144 URTIs) aged 2 months to 18 years were hospitalized between 2006 (653 cases) and 2007 (654 cases). Of these, 778 were boys and 528 girls (Table 1). Figure 1 describes the seasonal variation of hospitalizations for ARIs in 2006 and 2007 and the seasonal variation in

TABLE 1

Characteristics of children (0–18 years) hospitalized for ARI in Yahoundè between 2006 and 2007 and selected climate variables[a]

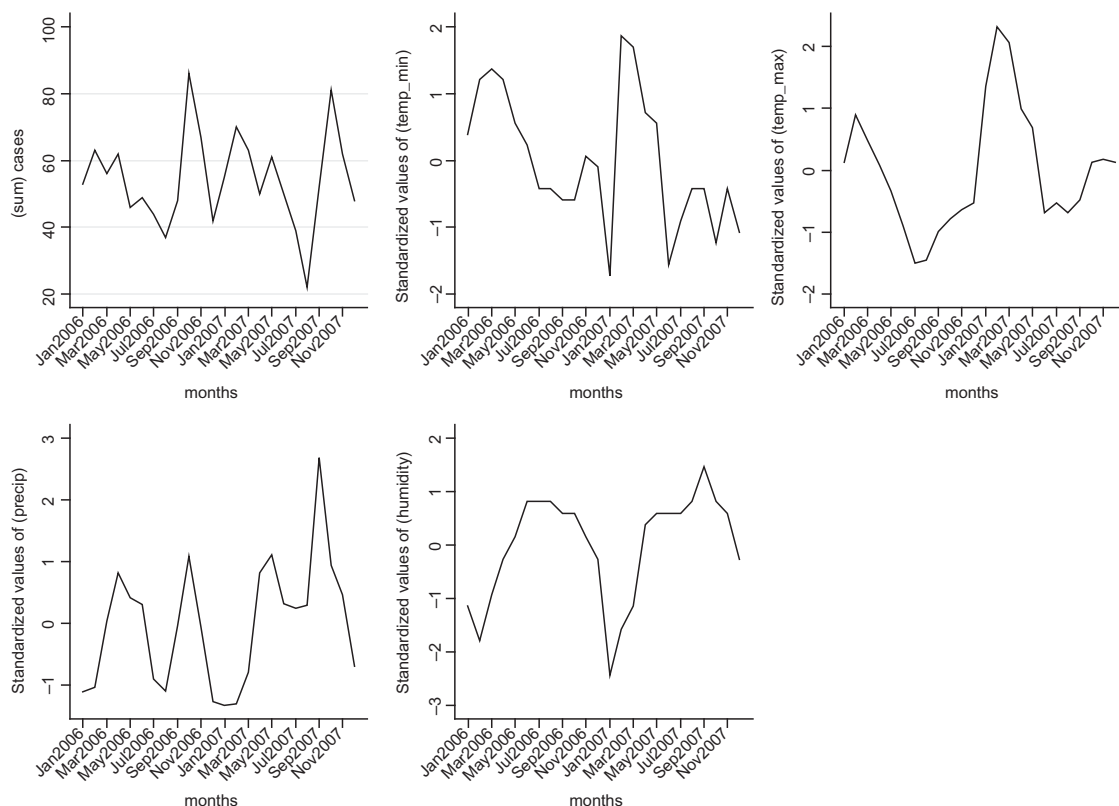| Characteristics	Values
Age, year	10 ± 11
Male, %	60 (778)
Urban area, %	89 (1159)
LRTI, %	89 (1161)
Malaria, %	25 (322)
Maximum temperature, °C	28.0 ± 1.6
Minimum temperature, °C	20.1 ± 1.0
Relative humidity, %	91.2 ± 5.1
Precipitations, mm^3	142.7 ± 107.5

[a]$N = 1306$.

FIG. 1. Frequency of hospitalization for ARIs in children aged 0–18 years and climate variable Z-scores.

TABLE 2

Frequency of hospitalization for ARI in children aged 0–18 years and selected climate variables[a]

	IRR	95% CI
Precipitation, mm^3	1.05	(0.97, 1.14)
Relative humidity, %	1.35	(1.08, 1.69)
Minimum temperature, °C	0.72	(0.59, 0.87)
Maximum temperature, °C	1.94	(1.34, 2.81)

IRR: Incidence rate ratio; 95% CI: 95% confidence interval.
[a]Results from the negative binomial regression adjusted for seasonality and trend.

maximum and minimum temperatures, number of days with rain and relative humidity. The monthly means of minimum and maximum temperatures were 19.6°C (18.5, 20.7) and 29.6°C (range 26.5, 34.0), respectively, between 2006 and 2007. The respective monthly mean relative humidity and mean precipitation were 78.0% (67, 85) and 158.6 mm^3 (0, 431.6). The highest frequency of cases was between October and November and the lowest was in August. The peaks of ARIs generally coincided with high rain.

Results from the negative binomial regression are reported in Table 2. The risk of hospitalization for ARI increased by 41% per unit increase in relative humidity (RR: 1.41; 95% CI 1.13, 1.77). Taking seasonality and trend into account the association was still statistically robust although the rate ratio (RR) decreased from 1.41 to 1.22 (1.07, 1.40). Precipitation was directly associated with frequency of hospitalization for ARIs after adjustment for seasonality and trend, 1.12 (1.06, 1.18). Significant associations were seen for maximum (1.94: 1.34, 2.81) and minimum temperatures (0.72: 0.59, 0.87).

A total of 391 cases (30%) had at least one concomitant disease at the time of admission to hospital (322 had malaria, 69 were HIV positive). To investigate whether the association with climate variables could depend on the variation in the pattern of hospitalization for concomitant diseases, analyses were repeated after the exclusion of malaria. This yielded results comparable to those obtained for the whole sample [precipitations 1.04 (1.00, 1.09); relative humidity 1.16 (1.05, 1.28); maximum temperature 1.43 (1.12, 1.84); minimum temperature 0.84 (0.74, 0.95) in the fully adjusted model].

Stratified analyses for UTRI and LTRI yielded coefficients of 1.00 (1.00, 1.00) and 1.00 (0.91, 1.10) for precipitations; 1.00 (1.00, 1.01) and 1.70 (1.43, 2.02) for relative humidity; 1.00 (1.00, 1.01) and 0.63 (0.55, 0.72) for minimum temperature and 1.00 (0.99, 1.01) and 2.49 (1.95, 3.18) for maximum temperature in the model adjusted for trend and seasonality. Further analyses restricted to LTRI cases with no

underlying malaria (922/1162 cases) yielded coefficients of 1.12 (1.06, 1.18) for precipitations; 1.23 (1.08, 1.40) for relative humidity; 0.78 (0.69, 0.88) for minimum temperature and 1.77 (1.32, 2.37) for maximum temperature, respectively. A seasonal effect was seen in all models. The annual trend was very small.

Discussion

This study shows a clear seasonal trend for ARIs with peaks occurring from October to November. These peaks were associated with higher precipitations, high relative humidity and lower minimum temperatures independently from seasonality and annual trend. Similar results were obtained after the exclusion of malaria cases and for LRTI.

A few studies conducted in tropical or subtropical countries have found some seasonal variation in respiratory infections [7–9]. This association was less apparent than in temperate areas [10]. Nevertheless, a review carried out in 2003 showed that respiratory syncytial virus (RSV) and influenza outbreaks were correlated with the rainy season in the tropics [12], whereas other viruses were either endemic throughout the year, detected sporadically or associated with epidemics [12]. A study carried out in Singapore between 1990 and 1994 found that the RSV peaks were associated with lower relative humidity [8]. Another study carried out in Dakar found that influenza peaks were related with high rainfall, high relative humidity and high (average) temperatures [13]. High temperatures (maximum or average) were also positively associated with the transmission of influenza in some provinces of southern Thailand and in Pune [14–16].

In general, seasonality is caused by factors that modify components of the basic reproductive number (the average number of secondary infectious cases resulting from the introduction of an infected case into a totally susceptible population) by altering the behaviour (e.g. an increase in contact rates during school terms and a decrease during vacation) and the immunity state of the host (e.g. the immune system is weakened by harsh weather conditions and poor nutrition) [17, 18], the biology and presence of the pathogens [19] and the host–pathogen interaction [20]. A possible explanation for the seasonality pattern observed in our study is that, exposure to high maximum temperatures may increase children's susceptibility to respiratory infections because of the effects of high temperatures and of hot winds in particular on the mucus membranes of the nose. The exposure to heavy rain and high humidity may also lead to: (i) overcrowding of susceptible individuals indoor, and (ii) exposure of children to smoke from cooking and heating fuels that may decrease children's respiratory defence [12, 17]. Another possible

explanation is that diets vary by season affecting children's susceptibility to infection. Clearly, all conditions above may be exacerbated by household poverty.

Before drawing conclusions, some limits and possible biases of the study should be mentioned. First, our study period was limited to 2 years. Second, though the site of our study is the only paediatric hospital in Yaoundé; children affected by ARIs could have attended paediatric departments at other hospitals. Third, other environmental factors not investigated in this study may influence seasonality apart from climate.

Although we acknowledge the above mentioned limits, the study has at least two important strengths. First, this is one of the few studies that evaluates the association between ARIs and several climatic factors in the tropics. Second, we were able to distinguish between ARIs and cases of malaria.

It is important to investigate longer time-series to better understand dynamics and risk factors for ARIs in tropical areas. Studies should take household wealth into account as this can confound the association between climate variation and ARIs. Given the high frequency of hospitalization for ARIs we suggest that influenza vaccination campaigns should be implemented in Cameroon. If our findings are confirmed in other studies these campaigns should also take seasonality into account. Preventing influenza spread will contribute to reduction in the economic impact of hospitalization.

References

1. Pio A, Lowski J, Ten Dam HG. The magnitude of the problem of acute respiratory infection. In: Douglas RM, Kerby-Eaton E (eds). Acute Respiratory Infections in Children. Adelaide: University of Adelaide, 1984; pp. 3–17.
2. Wardlaw T, Salama P, Johansson EW, et al. Pneumonia: the leading killer of children. Lancet 2006;368:1048–50.
3. Williams BG, Gouws E, Boschi-Pinto C, et al. Estimates of world-wide distribution of child deaths from acute respiratory infections. Lancet Infect Dis 2002;2:25–32.
4. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet 2003; 361:2226–34.
5. Wafula EM, Onyango FE. Acute respiratory infections: epidemiology and control. In: International Epidemiological Association (ed). Proceedings of the Third African Conference of the International Epidemiological Association – Epidemiology in Health Care Planning. Nairoby: International Epidemiological Association, 1986, pp. 135–43.
6. World Health Organization. Technical Basis for the WHO Recommendations on the Management of Pneumonia in Children at First-Level Facilities. http://www.who.int/child-adolescent-health/New_Publications/CHILD_HEALTH/WHO.ARI.91.20.pdf (30 August 2009, date last accessed).
7. Doraisingham S, Goh KT, Ling AE, et al. Influenza surveillance in Singapore: 1972–86. Bull World Health Organ 1988;66:57–63.
8. Chew FT, Doraisingham S, Ling AE, et al. Seasonal trends of viral respiratory tract infections in the tropics. Epidemiol Infect 1998;121:121–28.
9. Chiu SS, Lau YL, Chan KH, et al. Influenza-related hospitalizations among children in Hong Kong. N Engl J Med 2002;347:2097–103.
10. Alonso WJ, Viboud C, Simonsen L, et al. Seasonality of influenza in Brazil: a travelling wave from the Amazon to the subtropics. Am J Epidemiol 2007;165:1434–42.
11. Mulholland K. Childhood pneumonia mortality—a permanent global emergency. Lancet 2007;370:285–89.
12. Shek LP, Lee BW. Epidemiology and seasonality of respiratory tract virus infections in the tropics. Paediatr Respir Rev 2003;4:105–111.
13. Dosseh A, Ndiaye K, Spiegel A, et al. Epidemiological and virological influenza survey in Dakar, Senegal: 1996–1998. Am J Trop Med Hyg 2000;62:639–43.
14. Youthao S, Jaroensutasinee M, Jaroensutasinee K. Climatic factors affecting influenza cases in southern Thailand. Proc World Acad Sci Eng Tech 2007; 21:387–388.
15. Rao BL, Yeolekar LR, Kadam SS, et al. Influenza surveillance in Pune, India, 2003. Southeast Asian J Trop Med Pub Health 2005;36:906–909.
16. Rao BL, Banerjee K. Influenza surveillance in Pune, India, 1978–90. Bull World Health Organ 1993; 71:177–81.
17. Altizer S, Dobson A, Hosseini P, et al. Seasonality and the dynamics of infectious diseases. Ecol Lett 2006; 9:467–84.
18. Dowell SF, Ho MS. Seasonality of infectious diseases and severe acute respiratory syndrome— what we don't know can hurt us. Lancet Infec Dis 2004;4:704–708.
19. Hemmers JH, Winkler KC, Kools SM. Virus survival as a seasonal factor in influenza and poliomyelitis. Nature 1960;188:430–31.
20. Tobias A, Diaz J, Saez M, et al. Use of poisson regression and box-jenkins models to evaluate the short-term effects of environmental noise levels on daily emergency admissions in Madrid, Spain. Eur J Epidemiol 2001;17:765–71.