

Influence of Humidity on Rotavirus Prevalence Among Nigerian Infants and Young Children with Gastroenteritis

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Received 16 July 1981/Accepted 21 September 1981

Rotaviruses were detected by counterimmunoelectro-osmophoresis in the feces of 16 (13.8%) of 116 infants and young children with gastroenteritis during a 5-month period (September 1979 through January 1980) in Ife, Nigeria. The rate of rotavirus detection varied inversely with relative humidity and was highest in December (38.5% positive) when the humidity was lower. There was not such a distinct relationship with temperature or vapor pressure; and although the rate of rotavirus detection was higher in the drier months (November to January; 19.3% positive) than in the rainy season months (September and October; 8.5% positive), the average humidity was lower in the drier months than in the rainy months. Low relative humidity (49 to 78%) is apparently the most important environmental factor for rotavirus survival and spread in this area.

Since being discovered (2) and subsequently associated with infantile gastroenteritis (10, 15, 22), rotaviruses (19) have exhibited a seasonal prevalence in temperate countries and occur almost exclusively during the cold winter months in Washington (14), Toronto, Canada (21), London, England, the West Midlands of England (3, 28), and Yamagata, Japan (16). This increased prevalence of rotavirus has also been noted during the winter months in Melbourne, Australia (7), and Salisbury, Rhodesia (6). In tropical countries with less dramatic changes in climatic conditions, rotavirus prevalence has not been as well defined (27). However, rotaviruses have been found only during the cool months in southern India and not during the hottest months of the year (17).

From such studies, it seemed that a cool environmental temperature was the most important factor in rotavirus infectivity. The influence of other environmental factors has not been documented.

During preliminary investigations on the prevalence of rotavirus infection in cases of infantile gastroenteritis in Ife, Nigeria (unpublished data), the opportunity arose to qualitatively and quantitatively assess the importance of other environmental factors, namely relative humidity (RH), vapor pressure, and rainfall, on the prevalence of rotavirus infection.

MATERIALS AND METHODS

Study area. Ife is a town in southwestern Nigeria (population about 150,000). It lies within weather region III of Nigeria, an area that experiences a seasonally humid climate with appreciable fluctuations in temperature and humidity compared with the con-

tinuously humid climate along the coast (region IV) with less variation in temperature and humidity. More arid areas are found in regions I and II in the northern parts of Nigeria (23) (Fig. 1). As in the rest of West Africa, two major seasons are recognized: the rainy season lasting from May to October and the dry season lasting from November to April.

Study sample. Fresh feces were obtained from 116 infants and young children between 1 and 48 months old. These children suffered acute gastrointestinal

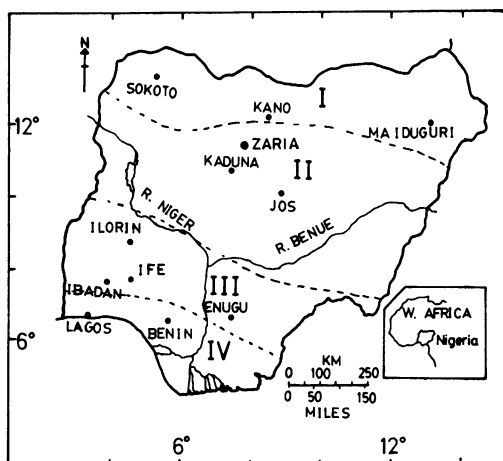


FIG. 1. Map of Nigeria showing weather regions (adapted from Ojo [23]). Region I: Rainless with relatively cool nights (18 to 21°C) and hot days (35 to 40°C), vapor pressure usually below 15 millibars. Region II: Mainly dry, warm nights and hot days. Region III: Seasonally humid with mean afternoon vapor pressure more than 20 millibars. Region IV: Continuously humid, humidity usually more than 77% at midday, no month without appreciable rainfall.

symptoms for which they either attended clinics (86%) at the University Health Center and Mòrè (a district clinic in Ife) or were hospitalized at Ife State Hospital (14%). Fecal samples were obtained within a week of the onset of symptoms and usually before antibiotic treatment was initiated. The collection period lasted from September 1979 to January 1980. A single fecal specimen was collected from each patient.

Examination of specimens for rotaviruses. Suspensions of feces in saline or diluted barbital buffer were examined by counterimmunoelectro-osmophoresis for the presence of rotavirus antigen. Techniques were as described by Middleton et al. (20) and Spence et al. (25).

RESULTS

Rotavirus detection. Rotaviruses were detected in 16 (13.8%) of the 116 stool samples examined. (A single stool specimen was collected from each subject.) Rotavirus was detected more often during the months of the dry season (November to January; 19.3%) than during months of the rainy season (September and October; 8.5%) (Fig. 2) but this difference was not significant ($\chi^2 = 2.86$; $P > 0.05$). The peak prevalence of rotavirus gastroenteritis occurred in December (a relatively cool month), and we decided to compare monthly rotavirus detection rates with other environmental parameters which were ascertained independently and routinely by personnel at the weather station.

Influence of environmental factors on rotavirus prevalence. A significant relationship was noted between the mean RH and the rate of virus detection. The rotavirus detection rate varied inversely with the humidity (measured at 10:00 a.m. each day) and was highest in December (38.5%) when mean RH was lowest (77.5%). No virus was detected when mean RH was highest (87.0%; correlation coefficient $r = -0.95$; $P < 0.02$) (Table 1). There was no distinct relationship between the detection rate of rotaviruses and other environmental factors, such as mean minimum temperature ($r = -0.69$; $P > 0.1$), mean maximum temperature ($r = 0.56$; $P > 0.1$),

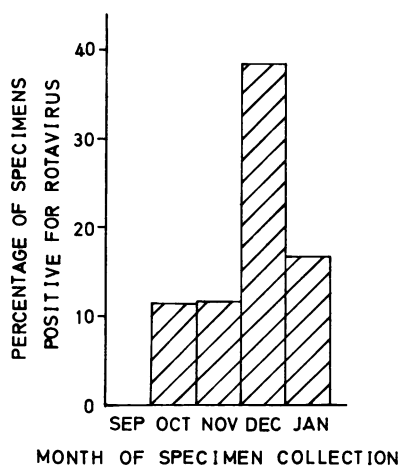


FIG. 2. Histogram showing monthly detection rate of rotavirus in infants and young children with gastroenteritis (September to December 1979; January 1980).

rainfall ($r = 0.66$; $P > 0.1$), or mean vapor pressure ($r = -0.78$; $P > 0.1$) (Table 1).

For readings taken at 4:00 p.m., mean values for RH were much lower than readings recorded earlier in the day and declined from 73.0% in September to 46.3% in January. The rate of rotavirus detection varied inversely with mean RH between September and December ($r = -0.97$; $P < 0.05$) but declined from 38.5% in December (mean RH = 49.3%) to 16.7% in January (mean RH = 46.3%) (Table 2; Fig. 3). No significant correlation was found between mean vapor pressure values taken at this time (4:00 p.m.) and the rate of rotavirus detection ($r = -0.80$; $P > 0.05$).

DISCUSSION

Although the period of study was short, the results of this investigation indicate that low RH rather than cool temperature might be the most important environmental factor in rotavirus sur-

TABLE 1. Relation of climatic factors to monthly detection of rotavirus gastroenteritis

Date	Rotavirus incidence			Climatic factors ^a				
	No. of patients	No. Positive	% Positive	Temp. (°C)		Rainfall (mm)	RH range (%) ^c	Mean VP ^{b,c} (millibars)
				Mean maximum	Mean minimum			
Sept. 1979	15	0	0	29.0	20.0	138	81.5-95.0	27.2
Oct. 1979	44	5	11.4	31.0	21.0	176	70.0-95.0	28.2
Nov. 1979	26	3	11.5	30.0	21.3	40	75.0-91.0	29.0
Dec. 1979	13	5	38.5	31.0	17.2	1	48.5-91.0	23.7
Jan. 1980	18	3	16.7	32.0	21.8	0	67.5-91.5	27.6

^a Source: Weather records, Farm Centre, University of Ife.

^b VP, Vapor pressure.

^c Readings taken at 10:00 a.m.

TABLE 2. Relation of mean RH and mean vapor pressure to monthly detection of rotavirus gastroenteritis^a

Date	Rotavirus detection (%)	Mean RH (%)	Mean VP ^b (millibars)
Sept. 1979	0	73.0	28.2
Oct. 1979	11.4	68.0	27.0
Nov. 1979	11.5	62.0	28.0
Dec. 1979	38.5	49.3	22.4
Jan. 1980	16.7	46.3	22.5

^a Readings taken at 4:00 p.m. each day.

^b VP, Vapor pressure.

vival and spread in Nigeria. Optimal virus activity in this study apparently occurred between RH values of 49 and 78% (Fig. 3).

These findings are in agreement with other observations. Dossetor et al. (8) surmised that rotavirus could be incriminated in 61% of 21 children with gastroenteritis in Zaria, northern Nigeria, a relatively dry area (Fig. 1, region II); and although specimens were collected in September and October (the last 2 months of the rainy season), mean readings for RH estimated from data supplied by Ojo (23) were about 70% in either month. On the other hand, researchers found rotaviruses in only 2% of 150 children with diarrhea in Lagos (O. Ogunbi, O. O. Honu-ponu-Wusu, A. O. Coker, D. E. Agbonlahor, K. C. Uzoma, O. Oguntade, and E. O. Solanke, *Abstr. 6th Int. Conf. Global Impacts Appl. Microbiol.* 1980, p. 20). This locality experiences constantly high RH, which is usually more than 77% at midday (23). High RH could also explain the absence of rotaviruses in specimens collected during the rainy season in Gambia (24), another West African country. At the time of the study, RH values were about 90 to 95% at sunrise in that area (12).

Low humidity might account for the high seasonal prevalence of rotavirus observed in another tropical locality. In Taipei, Taiwan, where Echeverria et al. (9) conjectured that the peak prevalence of rotavirus infectivity occurred during summer, and not during winter, mean RH values vary between 78 and 81% in summer and between 81 and 84% during winter (29). Also, Cameron et al. (4) reported that over a 15-month period, the monthly incidence of rotavirus remained relatively constant among babies with diarrhea who were in the special-care nursery of the Royal Women's Hospital in Melbourne. In this nursery, the humidity is maintained at 55%, and air temperature is maintained at 22 to 23°C.

No consistent pattern of association between RH and rotavirus prevalence could be discerned in subtropical and temperate localities where

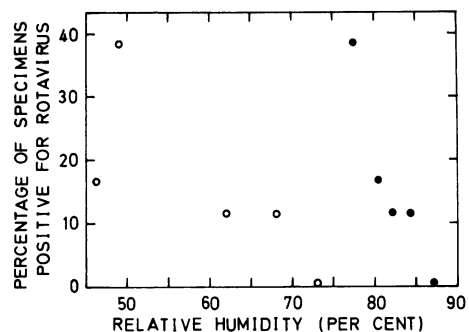


FIG. 3. Relation of RH to the prevalence of rotavirus gastroenteritis. Symbols: ●, mean monthly RH for readings taken at 10:00 a.m. each day; ○, mean monthly RH for readings taken at 4:00 p.m. each day.

rotavirus prevalence is high during winter months (6, 7, 15, 16, 21, 28). In these areas, RH values in winter generally exceed those in summer and vary in the former period from roughly 65 to 75% in Toronto, Washington, Salisbury, and Melbourne (5, 11, 13, 26) to 85 to 90% in London and Yamagata (1, 18); whereas in the summer, readings vary from approximately 50 in Salisbury to 75% in Yamagata (1, 26).

The transmission of any infectious disease is necessarily complex and multifactorial, involving both host and environmental factors. Some of these environmental factors have not been considered in this study, which, although based upon limited observations, suggests that RH might be the most important environmental determinant of rotavirus infectivity in a number of tropical situations. Further long-term research is needed to elucidate other climatic agents that can influence rotavirus activity.

ACKNOWLEDGMENTS

Sincere thanks to L. Spence and P. J. Middleton for the supply of materials and reagents, to O. O. Ogunkoya and P. Tenbe for assistance in interpreting climatological data, and to P. C. Egbe and K. Adetugbo for their critical review of the manuscript.

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