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Abstract. An influenza survey was conducted in seven sentinel sites in Dakar, Senegal from June 1996 to December 1998. Throat or nasal swab cultures were randomly collected from 804 patients suffering from influenza-like symptoms. Influenza viruses were isolated at a similar proportion in adults and in children (P = 0.29). Strains of influenza B viruses were isolated from sporadic cases in 1997, whereas type A virus was associated with an isolated peak. Proportions of influenza virus isolation varied from 17.5% to 40.0% between 1996 and 1998 during the peak period (July/September) of acute respiratory infection in Dakar. Rainfall, humidity, and temperatures rose during the same period. Influenza in Dakar seems to be an-all-age groups respiratory infection characterized by high transmission during the hot and rainy season. The antigenic similarity of the A(H3N2) and B viruses to those circulating elsewhere in the world at the same time was confirmed. However, the A(H1N1) strains were found to be more closely related to an Asiatic strain which had not been isolated outside Asia previously. Consequently, the strain close to the A(H1N1)/Wuhan/371/95 strain isolated in Dakar was included in the composition of the 1998/1999 influenza vaccine. This reinforces the importance of setting up a national influenza control strategy in tropical regions.

INTRODUCTION

Influenza is an acute, highly contagious respiratory infection that has the potential to cause very serious illness. Typical clinical symptoms are characterized by a short incubation period, high attack rates, and the progression of the disease through the population. Due to the major antigenic changes occurring with the influenza A virus, epidemics occur every year on a seasonal basis. Influenza B is responsible for less frequent outbreaks. Influenza epidemiology varies according to geographical location. In the temperate regions, influenza is epidemic and occurs during winter, whereas in tropical regions influenza is endemic and more than one period of activity may occur in any given year. Because of significant mortality, morbidity, and the loss of productive human-hours associated with influenza, strategies for prevention and control have been set up in temperate regions. Influenza surveillance activity is also maintained by the global network of laboratories (108 National Influenza Centers in 73 countries) sponsored by the World Health Organization (WHO). These laboratories participate by circulating current influenza viral isolates and identifications to the biannual recommendations for the composition of vaccines. Senegal is the only West African country involved in this network. At the National Influenza Laboratory (Institut Pasteur) the isolation of the influenza type B virus in December 1995, after a 4-year absence of detection, prompted us to conduct a more vigorous epidemiological influenza survey in Senegal partially in order to contribute to a better understanding of the epidemiology of influenza in tropical regions.

MATERIALS AND METHODS

Description of the study site. Three health units located in the town center and 4 in the suburbs of the Dakar region of Senegal were selected as sentinel sites for the study (Figure 1). A large part of the population in the city is served by these health units. Of the patients taking medical advice in the 3 sites located in the town center, most were children under 15 years old, whereas the 4 suburban sites served patients from all age groups. All the sentinel sites had the advantage of drawing patients from different neighborhoods in the area. The average weekly number of patients for each unit was 174.

Study subjects. Subjects included all patients who presented influenza-like symptoms from June 1996 to December 1998. These symptoms included a combination of fever, sore throat, and nasal discharge within the past 4 days. A standardized questionnaire was used to obtain demographic data, medical history, and clinical features for each patient. Throat or nasal swab cultures were collected at the same time.

Data collection. To assess the magnitude of influenza-like illness, data on the number of acute respiratory infections (ARI) were recorded weekly by physicians in 6 of the 7 sentinel sites. ARI definitions included all acute infections involving the respiratory tract, except chronic and allergic infections, tuberculosis, and asthma. The proportion of ARI was calculated by dividing the number of ARI cases by the total number of patients. Proportions for Week 4 were calculated as a mean of 4 weeks. Data concerning rainfall, temperature, and relative humidity in Dakar were recorded monthly from the national climatology office in order to study the influence of climatological factors on the spread of influenza in Dakar.

Identification and characterization of viral isolates. Specimens collected in a tryptose phosphate broth were inoculated on Madin Darby Canine Kidney (MDCK) cell lines in a medium which contained trypsin. Supernatant cultures at 34°C were subjected to hemagglutination tests with goose red blood cells (0.5%) as soon as a cytopathic effect (CPE) was evident or after a 7-day incubation period in the absence of CPE. Supernatants with a negative hemagglutination reaction were reinoculated into fresh cultures and tested as before. Supernatants with a positive hemagglutination reaction were further characterized by hemagglutination inhibition assay using antisera to type B and A subtypes (H1N1, H3N2). Antigenic characterization and sequencing of the isolated viruses were performed at WHO Collaborating Centers for Reference and Research on Influenza at the London Medical Research Council and also at the Institut Pasteur in Paris.)
RESULTS

Enrollment. From July 1996 to December 1998 a total of 804 subjects (178, 192, and 434 per year respectively), with influenza-like symptoms were enrolled in the sentinel sites. Their ages ranged from 0 to 91 years (mean age = 13 years). The majority of patients were under 15 years of age (64.1%), with some patients (3.7%) more than 54 years of age (Table 1). The sex ratio was 1.1 (women/men). Fifty-nine percent of the patients had fever and their body temperatures ranged from 38.0°C to 40.4°C. In 88% of the cases, swabs were collected within the first 4 days of the beginning of the onset of symptoms, allowing for virus isolation. Only 2 patients had been vaccinated against influenza.

Acute respiratory infection. Fluctuations by Week 4 of the ARI proportion among patients are shown in Figure 2. Annual peaks of ARI occurred between Weeks 33 and 49.

<table>
<thead>
<tr>
<th>Month</th>
<th>1996</th>
<th>1997</th>
<th>1998</th>
<th>Total</th>
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<tbody>
<tr>
<td>January</td>
<td>ND</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
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<td>ND</td>
<td>0%</td>
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<td>2%</td>
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<td>March</td>
<td>ND</td>
<td>11.4%</td>
<td>0%</td>
<td>5.4%</td>
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<tr>
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<td>ND</td>
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</tr>
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</tr>
<tr>
<td>Total</td>
<td>5.6%</td>
<td>12.5%</td>
<td>3.2%</td>
<td>5.4%</td>
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</tbody>
</table>

ND = not determined.
**Figure 2.** Proportion by week 4 of acute respiratory infection in Dakar (1996–1998). Week 1 = weeks 1 to 4. Week 9 = weeks 9 to 12. Week 25 = weeks 25 to 28. Week 33 = weeks 33 to 36. Week 41 = weeks 41 to 44. Week 49 = weeks 49 to 51.

(approximately between July and September) corresponding to the hot and rainy season (Figures 3A and 3B).

**Virus isolation and identification.** Forty-eight influenza virus strains were isolated during the period 1996–1998: 10 in 1996, 24 in 1997, and 14 in 1998. The proportion of influenza virus isolation ranged from 0% in subjects ≥ 55 yr of age to 7.4% in the 15–34 yr age group (Table 1). Influenza A and B were isolated in all age groups except in that ≥ 55 yr. Proportions of virus isolations were higher in 1997 than in 1996 or 1998. Annual peaks of virus isolations (Figure 3C) were observed to coincide with the period of high rainfall, humidity, and temperature with a proportion ranging from 17.5% in 1996 to 40% in 1997 (Table 2). All 3 influenza virus types were isolated in 1997 and in addition A(H3N2) strains were isolated in 1996 and 1998.

**Antigenic characterization.** The isolated strains were similar to those circulating during the same period in other countries with the exception of the A(H1N1) strain. The latter was antigenically close to the A/Wuhan/371/95 strain, one which previously had never been isolated outside China, Hong Kong, and Singapore.

**DISCUSSION**

Our sentinel surveillance network has allowed us to demonstrate the seasonal circulation of influenza viruses in Dakar since 1996. During this period, influenza-like illnesses affected all age groups, with children under 15 years accounting for 516 of 804 cases (64.2%) as observed in the temperate regions. The proportion of specimens associated with influenza virus isolation was similar in age groups 0–14 years and 15–54 years (P = 0.29) and between age groups 15–54 years and ≥ 55 years (P = 0.23), suggesting that influenza is an all-age-group acute respiratory infection. In temperate regions, the elderly and the children are particularly at risk. Acute respiratory infection in Dakar shows minor annual fluctuations during the first 6 months and the last 3 months of the year, and a peak between July and September, the period when most of the influenza viruses were isolated which is also characterized by high rainfall, temperature, and relative humidity.

The pattern of influenza infection was similar for 1996 and 1998, characterized by a preferential circulation of A(H3N2) viruses and a peak of isolation between June and July. The 1997 pattern differs slightly in that during this period, all 3 influenza virus types were isolated with 2 peaks in March and August and from all age groups. With the isolation of 5 strains of H1N1 subtype (closely related to the A(H1N1)/Wuhan/371/95 strain) in the same sentinel site over a period of 2 months, there seems to have been an epidemic. The significance of these viral isolations is unclear because of the unavailability of travel histories of the subjects from whom the viruses were isolated. Sporadic cases of influenza B were observed annually, particularly in 1997, but peaks were mostly associated with A(H3N2) viruses which are known to cause more severe illness than the H1N1 subtype and are involved in most of the outbreaks.

These results are in contrast to temperate regions where influenza occurs during the winter season. If cold weather is responsible for the high sensitivity of the nasal mucosa and respiratory tract in favoring influenza virus multiplication, perhaps the increase of relative humidity during the hot and rainy season is responsible for better survival of the virus. Vigorous and continuous influenza surveillance is needed in Dakar as the hot and rainy season draws near because of the new strain isolated here. Indeed, the introduction of a new strain into a population with a low level of immunity facilitates rapid and extensive virus spread and can provoke a significant outbreak. For this reason, WHO decided to include in the 1998/1999 influenza vaccine a
strain close to the A(H1N1) strain isolated in Dakar. The high percentage of positive samples during the hot and rainy season in comparison to the rest of the year suggests that the influenza epidemic period in Dakar is between July and August. Our findings are in agreement with a previous study that indicated that influenza in Dakar affects all age groups and is characterized by sporadic cases during the first 6 months and the last 3 months of the year, with an epidemic period during the hot and rainy season in contrast to temperate regions where winter is the influenza season. A sentinel network for national influenza surveillance is essential to determine the impact of this infection in terms of morbidity and mortality on the Senegalese population.

Implementation of a sentinel network reinforces the importance of a national strategy for the control and prevention of influenza.

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