The trends of influenza infection in Suriname were assessed from February 2010 through February 2011. Testing of 393 patients with symptoms of acute respiratory infection (ARI) revealed 15.3% influenza B and 18.6% could be identified as influenza A positive, consisting of 56% influenza A(H1N1)pdm09 and 44% seasonal A(H3N2). Influenza infection occurred throughout the year, and all three influenza types affected young children as the primary population. The annual incidence of A(H1N1)pdm09 was 6.88 per 100 000 inhabitants (CI 4.87–9.45). The spread of influenza could neither be linked to tourist flow from the Netherlands nor to contact rates related to school schedules.

Keywords: Age groups, incidence, pandemic influenza A(H1N1)pdm09, seasonal influenza A and B, seasonality, Suriname.

Introduction

For centuries, the world has been burdened with disease caused by Influenza viruses. In contrast to temperate countries, information on influenza activity is scarce for tropical countries. The recent pandemic of the novel strain of H1N1 (WHO, June 11, 2009) led to a global effort to increase influenza surveillance and control. On August 10, 2010, the World Health Organization announced the beginning of the post-pandemic period of the A(H1N1)pdm09 infection.

For Suriname, a small country with a tropical climate in South America, CAREC (Trinidad) reported the first laboratory-confirmed case of influenza A(H1N1)pdm09 infection on June 22, 2009, and the first fatal case was reported on August 16. The Ministry of Health launched two vaccination interventions from February to April 2010 with Pandemrix® (GlaxoSmithKline, Wavre, Belgium) and in May 2010 with Panenza® (Sanofi Pasteur, Lyon, France) and started local molecular characterization of influenza on February 5, 2010. Samples collected during the first year of local testing for the national influenza surveillance were analyzed to assess the influenza trends in Suriname.

The aim of the study was to provide the first results for Suriname for a full year of influenza activity and gain insight into the influenza dynamics and characteristics.

Material and methods

Study site

Suriname is located along the North Coast of South America and has a population of 492 829 people with 49.3% living in and around the capital Paramaribo. The climate is tropical, with an average temperature of 27°C and an annual relative humidity of around 80%.

Specimen collection

Nasopharyngeal and throat swabs combined in a single tube were collected from all patients admitted to hospitals as part of the surveillance of severe acute respiratory infection (SARI). The hospital communicable surveillance team performed all collections and the mandatory notifications. Samples were also obtained through the Bureau of Public Health (BOG) from patients within the national ARI surveillance from three of the 25 sentinel sites (Paramaribo North, Paramaribo South, district Wanica).

Swabs were collected from February 5, 2010 to February 28, 2011.

Data collection and analysis

Patient information, including clinical and demographic information obtained from the referring physician, was entered into a patient database. Data of the sentinel syndromic surveillance of ARI were obtained through BOG.
Data of the rainfall amounts in Paramaribo (station Cultuurtuinlaan) were obtained from the national meteorological service.

Data were analyzed using the SPSS Statistics v.17.0 software (SPSS Inc., Chicago, IL, USA). We compared the distribution of cases within age groups between the influenza periods and between influenza types using the chi-squared test. A P-value less than 0.05 was considered statistically significant. Sex-determined differences in susceptibility for each influenza type were calculated using the odds ratio (OR). The incidence rate was weighted to the estimated population size of 2010 based on the latest census from 2004. The 95% confidence intervals (95%CI) were calculated using the normal approximation of the binomial and the weighted proportions.

RNA extraction
Viral RNA was extracted with the Qiagen RNA extraction kit (Qiagen Inc., Benelux B.V., Venlo, the Netherlands) according to the manufacturer’s instructions.

Detection of influenza viruses by Real-Time RT-PCR
Samples were screened with Real-Time RT-PCR for influenza A, influenza B, A(H1N1)pdm09, A(H1N1), A(H3N2), and avian influenza A(H5N1). RNase P served as internal control, and positive and negative controls were processed in each run. RT-PCR was performed with AgPath-ID™ One-Step RT-PCR Reagents (Ambion/Applied Biosystems, Life Technologies Corporation, Carlsbad, CA, USA) in a 96-well format StepOnePlus Real-Time thermocycler system (Applied Biosystems) using 6-carboxyfluorescein (FAM) as reporter and Blackhole Quencher (BHQ) as nonfluorescent quencher. All RT-PCRs were performed according to CDC protocols.3,4

Results
From February 2010 to February 2011, 393 samples were received for influenza testing, of which 7% was invalid because of improper collection or transportation, and 93% was used for further analysis. The investigated samples represented all hospitalized patients (n = 166) from the SARI surveillance and part of the ARI surveillance.

The overall positivity rate for influenza was 33.9%, with 15.3% influenza B positive and 18.6% influenza A positive. No influenza fatalities were reported in this period.

Further subtyping of the influenza A positive samples revealed 56% of pandemic influenza A(H1N1)pdm09 and 44% of influenza A(H3N2). The overall positivity rate of A(H1N1)pdm09 reached 10.4% and the annual incidence of pandemic cases diagnosed in the period February 5, 2010 to February 28, 2011 was 6.88 per 100 000 inhabitants [CI 4.87–9.45. In this period, neither A(H1N1) nor avian influenza A(H5N1) were detected in Suriname.

In the temporal profiles of A(H1N1)pdm09, influenza B and A(H3N2) as depicted in Figure 1, the first wave of influenza, caused by A(H1N1)pdm09, lasted from February 2010 to July 2010, while Influenza B cases appeared in April 2010. Near the end of the influenza B wave, an overlap existed with the A(H3N2) infections. Influenza infection occurred throughout the year with peak activity from July to August and January and a very low incidence in November–December. No marked increase in influenza activity could be observed at the start of the school year in

![Figure 1](image.jpg)

Figure 1. Number of influenza cases per subtype in Suriname. Laboratory confirmed influenza positive cases from February 5, 2010 to February 28, 2011. Depicted in bars is the rainfall amount in millimeters set against the influenza activity.
October. Each Influenza type was sustained in two different temporal patterns throughout the study period.

In Figure 1, the positive cases were also plotted against the amount of rainfall to investigate the seasonality of the influenza activity. No apparent relation between influenza activity and rainy seasons could be established.

The morbidity of all three influenza types was significantly higher in children under the age of 10 years ($P = 0.024$), especially for A(H1N1)pdm09, where the majority of the cases (55%) were children in this age group (Figure 2). The median age of the patients with a positive result was 6 years (12 days–70 years), while the patients with a negative result had a median age of 4 years (7 days–87 years). We also observed a trend of decreasing influenza susceptibility with increasing age for all three types. No statistically significant difference could be detected in the age prevalence neither among the three viral types nor between the two peaks for each type nor within each peak.

A difference in the male to female ratio was observed, with influenza B and A(H1N1)pdm09 occurring predominantly in males, while A(H3N2) patients displayed an inverse pattern (Table 1), but no statistical significance could be reached.

We did not observe a difference in clinical symptoms between the different types of influenza. The severity of the infection as measured by hospitalization was highest for A(H1N1)pdm09 (32%), while the percentage of hospitalized patients for influenza B and A(H3N2) was 23% and 18%, respectively. The majority of hospitalized cases were children, 75% for A(H1N1)pdm09, 77% for influenza B, and 100% for A(H3N2). The small numbers however did not allow conclusive statements.

The impact of the flow of tourists from the Netherlands to the former colony was assessed in Figure 3, through a comparison of our results with the influenza activity in the Netherlands. In contrast to Suriname with a year round influenza activity, the Netherlands only exhibits one distinct peak in the winter. Therefore, no relationship exists between the influenza activity in both countries, except for the winter peak which partially coincided with the observed A(H1N1)pdm09 influenza wave in Suriname in the corresponding period.

Data from the national syndromic surveillance of ARI of the Bureau of Public Health were compared with the influx of samples in our study. The samples tested follow the same trend as the ARI surveillance and our results thus reflect the actual situation and can be regarded as national trends.

**Discussion**

This study illustrates for the first time the detailed characteristics of the influenza activity in Suriname throughout one year. Suriname exhibited substantial background influenza activity throughout the year, but the availability of

|                  | Males | Females | Unknown | Ratio  | Odds ratio |
|------------------|-------|---------|---------|--------|------------|
| Negative         | 132   | 106     | 4       | 1:29:1 | –          |
| A(H1N1)pdm09     | 24    | 13      | 1       | 1:85:1 | 1:48 [Cl] 0:72–3:05 |
| A(H3N2)          | 11    | 18      | 1       | 0:61:1 | 0:49 [Cl] 0:22–1:08 |
| Influenza B      | 35    | 18      | 3       | 1:94:1 | 1:56 [Cl] 0:84–2:91 |
data from only one year limited conclusions on seasonality. The absence of A(H1N1) influenza in Suriname suggests that similar to most other countries, the novel A(H1N1)pdm09 strain seems to have displaced the prior circulating seasonal A(H1N1) influenza virus.5

The low morbidity and mortality of the pandemic Influenza A(H1N1)pdm09 cases in Suriname seems to contrast the observed severity in countries as Mexico6 and Guatemala,7 which however was reported for the pandemic period.

In concordance with data from earlier studies the major age group affected with A(H1N1)pdm09 were young children.8 Our comparative analysis could have been confounded by potential differences in vaccination coverage of different age groups. In Suriname, influenza vaccination is not part of the standard vaccination regime and vaccination for pandemic influenza occurred during the investigated period for a selected part of the population.

No correlation could be observed between the influenza activity in the Netherlands and Suriname, therefore dismissing the notion that the spread of influenza in Suriname might be driven by the influx of tourists from the Netherlands to the former colony.

The influenza activity was also not driven by contact rates related to school schedules, because no marked increase in influenza activity could be observed in October when children return to school after the holidays, which contrasts other reports.9,10

In addition, we could not substantiate the notion that young children may drive the spread of influenza epidemics,11 because no age-specific difference could be observed in the timing of peak activity as the mean age in the first period of each influenza peak was not significantly lower than in the remainder of the peak.

This first national study on influenza characteristics in Suriname, although partially conducted in the A(H1N1)pdm09 post-pandemic period, contributes valuable insight in the influenza pattern in Suriname and the tropics.

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Author contributions

MRA conceived of the study, participated in its design and coordination, and drafted the manuscript. MG and MLB participated in the design, laboratory testing, and helped to write the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors have no competing interests.

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