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# Incidence of influenza-associated hospitalization in rural communities in western and northern India, 2010–2012: A multi-site population-based study

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## KEYWORDS

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**Summary** *Background:* The global burden of influenza is increasingly recognized, but data from India remain sparse. We conducted a multi-site population-based surveillance study to estimate and compare rates of influenza-associated hospitalization at two rural Indian health and demographic surveillance system (HDSS) sites at Ballabgarh and Vadu during 2010–2012. *Methods:* Prospective facility-based surveillance for all hospitalizations (excluding those for trauma, elective surgery and obstetric, ophthalmic or psychiatric reasons) was conducted at 72 health facilities. After collection of clinical details, patients had nasopharyngeal swabs taken and tested by reverse transcription polymerase chain reaction for influenza viruses. Annual healthcare utilization surveys (HUS) were conducted in HDSS households to identify

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proportion of hospitalizations occurring at non-study facilities to adjust for hospitalizations missed through facility-based surveillance.

**Results:** HUS showed that 69% and 67% of hospitalizations occurred at study facilities at Ballabgarh and Vadu, respectively. Overall, 6004 patients hospitalized with acute medical illness at participating facilities were enrolled (1717 from Ballabgarh; 4287 from Vadu). The proportion of patients with influenza was higher at Vadu than Ballabgarh annually (2010: 21% vs. 5%,  $p < 0.05$ ; 2011: 18% vs. 5%,  $p < 0.05$ ; 2012: 23% vs. 5%,  $p < 0.05$ ). Annual adjusted influenza-associated hospitalization rates were 5–11 fold higher in Vadu (20.3–51.6 per 10,000) vs Ballabgarh (4.4–6.3 per 10,000). At both sites, influenza A/H1N1pdm09 and B predominated during 2010, A/H3N2 and B during 2011, and A/H1N1pdm09 and B during 2012.

**Conclusion:** The markedly different influenza hospitalization rates by season and across communities in India highlight the need for sustained multi-site surveillance system for estimating national influenza disease burden. That would be the first step for initiating discussions around Influenza prevention and control strategies in the country.

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## Introduction

Estimates of disease burden are critical to decision making about prevention and control strategies for any disease. Although, the burden of influenza-associated morbidity and mortality is now recognized in many developed countries, data on influenza in most developing countries remain sparse. In a recent review of studies on influenza in the Western Pacific region, only 15% of studies on influenza burden and 13% of studies of influenza-associated hospitalization were from low- and middle-income countries.<sup>1</sup> Based on available data on influenza disease burden and mathematical models, an estimated 90 million cases of influenza and 20 million cases of influenza-associated acute lower respiratory tract infection (ALRI) occur annually among children aged <5 years.<sup>2</sup> In the same age group, an estimated 160,000–450,000 in-hospital deaths due to all-cause ALRI occur globally each year with roughly 80% of ALRI deaths thought to occur outside hospitals.<sup>3</sup> Such global estimates are often questioned by policy makers in developing countries because these estimates rely heavily on extrapolation of data from developed countries. In part, data on influenza burden in developing countries has remained limited because measuring influenza incidence is challenging in these settings due to lack of regular influenza testing, delays in reaching health facilities where influenza testing is available resulting in lower detection rates, and absence of known population denominators. Data on influenza disease burden are critical to inform policy decisions about influenza prevention and treatment, including use of influenza vaccines, diagnostic tests, and antiviral medications.

India is a large and geographically, climatically, and demographically diverse country where influenza incidence is likely to vary by region. Surveillance studies from the A/H1N1pdm09 pandemic and annual influenza epidemics in India suggest that influenza positivity varies across the country as well as from year to year.<sup>4,5</sup> Most studies of influenza in India have been hospital-based<sup>6,7</sup> and have not estimated incidence due to lack of population denominators and data on healthcare seeking behaviour. In addition globally, most burden studies have used influenza-like-illness (ILI) or severe acute respiratory infection (SARI) case definitions which may miss influenza cases with primarily non-

respiratory clinical presentation. To estimate severe influenza incidence for India and determine how incidence varies, population-based, multi-site, multi-year studies with broader case definition are needed. Therefore, we conducted a multi-year (2009–2012) population-based study using broad enrolment criteria at two rural Health and Demographic Surveillance System (HDSS) Sites in northern (Ballabgarh) and western (Vadu) India to estimate and compare incidence of influenza-associated hospitalization.

## Methods

### Study sites

The HDSS sites at Ballabgarh and Vadu are close to Delhi and Pune, respectively. Both sites are representative of Indian rural communities situated close to major urban centers. Ballabgarh has a temperate climate with seasonal rains in July–August, whereas Vadu has a tropical climate with mild winters and seasonal rains in May–September. Both HDSS sites monitor deaths, marriages and migrations through an annual household census.<sup>8</sup> During this study, both population and population density were higher in Vadu compared with Ballabgarh (population 120,586 vs. 89,187; population densities 520 vs. 276 persons per square km) (Table 1). However, the age and sex compositions of the populations at the two sites were similar.

### Study health facilities

At the Ballabgarh site, the main healthcare facilities providing inpatient care included three government-funded secondary level facilities and a large number of private facilities (5–35 beds each). Of these, thirty-three healthcare facilities agreed to participate in this study, including the three secondary level facilities. Of participating hospitals, two were located within the HDSS area and the remaining 31 were located outside the HDSS area but within the district (Table 1).

At the Vadu site, inpatient care was provided by a secondary level public facility with 35 beds, a primary health center with 5 beds, and 28 private nursing homes (2–30 beds each). Unlike in Ballabgarh, 36 of 38 facilities

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