

2009-10 Pandemic H1N1 Influenza Surveillance Summary Colorado



Colorado Department
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Communicable Disease Epidemiology Program

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Introduction

On April 21, 2009, the Centers for Disease Control and Prevention (CDC) published a Morbidity and Mortality Weekly Report (MMWR) “Early Release” entitled, “Swine Influenza A (H1N1) Infection in Two Children – Southern California, March-April 2009”. That report described two cases of febrile respiratory illness caused by a unique influenza strain of both swine and human origin. On April 30, 2009, CDC confirmed the first Colorado cases and by May 7th, the Colorado Department of Public Health and Environment (CDPHE) laboratory implemented pandemic H1N1 virus molecular testing. Dr. Margaret Chan, the Director General of the World Health Organization, declared the beginning of the 2009 Influenza Pandemic on June 11, 2009.

Colorado’s influenza surveillance typically runs from the first week in October through the end of May, but due to the newly circulating pandemic influenza virus, surveillance continued throughout the summer months of 2009. While Utah, Colorado’s neighboring state, had a large summer peak of influenza cases, Colorado did not have the same experience. However, once schools reopened in late August, the number of Colorado cases increased fairly rapidly through October. CDC declared the official start of the 2009-2010 (pandemic) influenza season to be August 30, 2009.

Surveillance activities for the 2009-2010 pandemic influenza season in Colorado included:

- 1) reporting of hospitalizations due influenza; 2) reporting of adult and pediatric deaths due to influenza; 3) monitoring influenza-like illness (ILI) at selected healthcare provider sites; 4) reporting of influenza testing volume and aggregate results by sentinel laboratories throughout the state, 5) reporting of influenza virus type and subtype based on molecular testing of submitted specimens at the CDPHE laboratory; 6) reporting of influenza-like illness absenteeism from schools across the state; 7) monitoring of school closures; and 8) monitoring of influenza outbreaks in long-term care facilities (LTCFs). This report summarizes results of these surveillance activities for the 2009-2010 pandemic H1N1 influenza season.

Influenza-Associated Hospitalizations

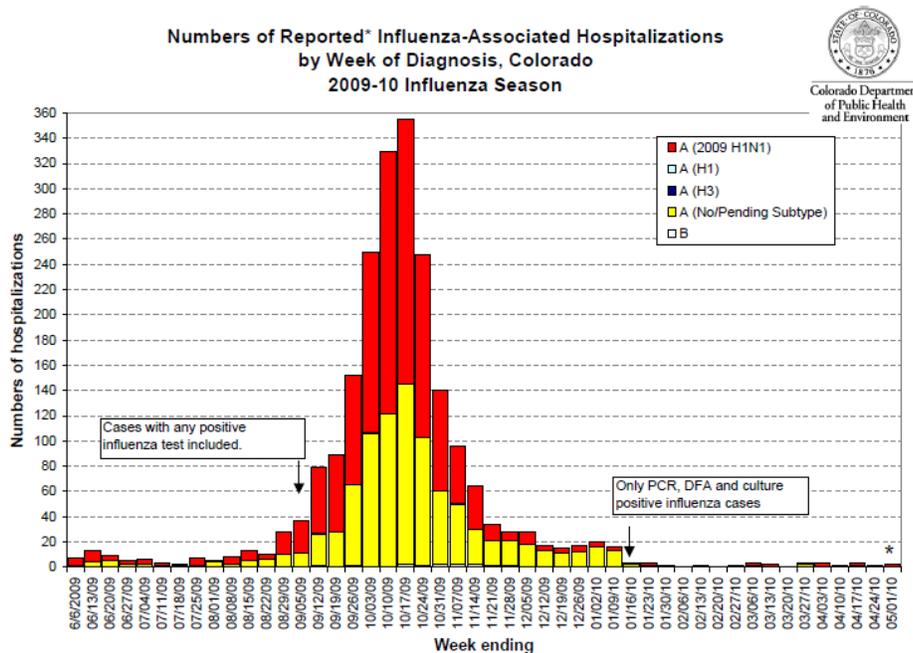
Beginning the week ending September 5, 2009 until the week ending January 16, 2010, a hospitalized patient with any positive test for influenza was counted as an influenza-associated hospitalization, whereas, during the summer 2009 months when there was little evidence of circulating influenza viruses only CDPHE laboratory-confirmed hospitalizations were counted. Similarly, after January 16, when circulating levels of influenza virus had returned to low levels, rapid flu tests were no longer considered adequate criteria for counting hospitalizations.

Confirmatory molecular testing (by polymerase chain reaction - PCR) at the CDPHE laboratory was done to a greater extent for the Denver metro area hospitals than for non-Denver metro area hospitals due to enhanced influenza surveillance and vaccine effectiveness evaluation conducted in the five county (Adams, Arapahoe, Denver, Douglas, Jefferson) Denver metro area as part of CDC-funded Emerging Infections grant activities. The substantially higher sensitivity of influenza PCR testing compared to rapid influenza testing (especially, for pandemic H1N1 virus)

clearly increased influenza-associated hospitalization case ascertainment in the Denver metro area; 63.4% of all reported influenza-associated hospitalizations were from the five Denver metro counties.

A total of 2,041 hospitalizations from 54 counties were reported from the week ending September 5, 2009 through the week ending May 1, 2010. Influenza activity began to increase at the end of August 2009 when schools reopened. Influenza hospitalizations rose sharply from early September to mid-October and peaked the week ending (by date of “diagnosis”) October 17, 2009 with 355 reported hospitalizations. There was a dramatic decline in reported influenza-associated hospitalizations from the October peak through mid-November (Figure 1).

Figure 1.



The overall influenza-associated hospitalization rate during the pandemic surveillance period was 41 per 100,000 population (Table 1). Children under six months of age had the highest hospitalization rate at 310 per 100,000 population (Figure 2, Table 1).

Figure 2.

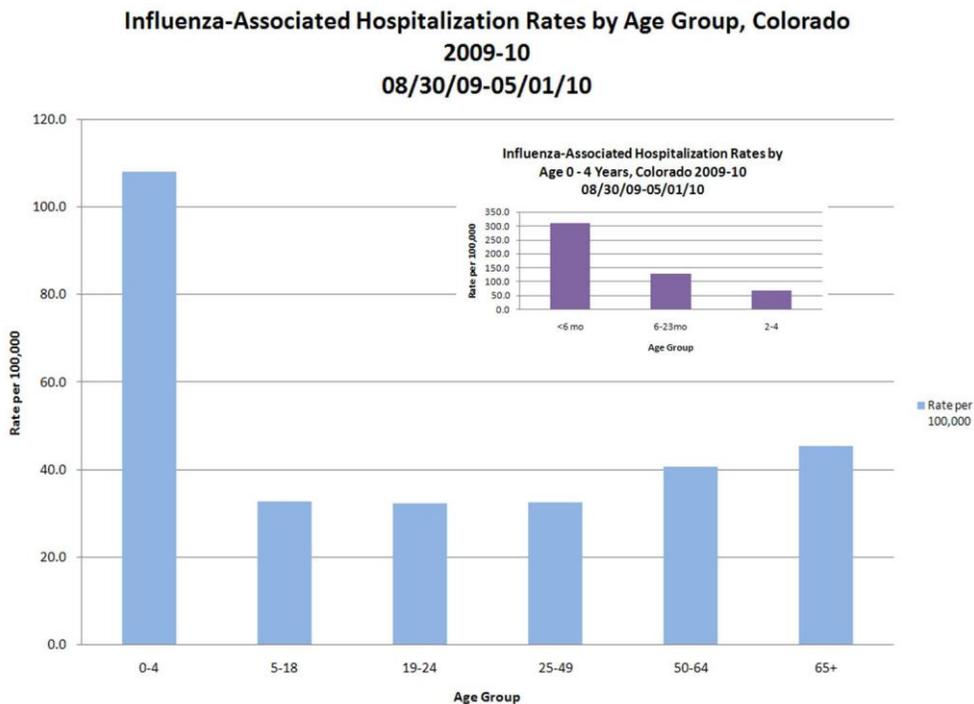


Table 1.

**Influenza-Associated Hospitalizations
by Age Group, Colorado 2009-10
08/30/09 - 05/01/10**

Age	No.*	%	CO pop dist	Rate per 100,000
<6 mo	110	5.4	35533	309.6
6-23mo	135	6.6	106394	126.9
2-4	142	7.0	216092	65.7
5-18	316	15.5	960783	32.9
19-24	151	7.4	466280	32.4
25-49	589	28.9	1804500	32.6
50-64	378	18.5	928421	40.7
65+	220	10.8	488725	45.0
Total	2041	100	5006729	40.8

2008-based final population estimates from Demography Section, Colorado Dept. Local Affairs

In a typical type A subtype H3 predominant influenza season, the age-specific hospitalization rate curve appears “U-shaped” with high rates in young children and older adults (≥ 65 years) (Figures 3 and 4). The 2009-2010 pandemic influenza season age-specific hospitalization rate curve appears more like a “J” (on its side) as the rates in older adults were blunted (note: also observed in the 2006-07 and 2008-09 flu seasons which were “seasonal” H1N1virus predominant).

Figure 3.

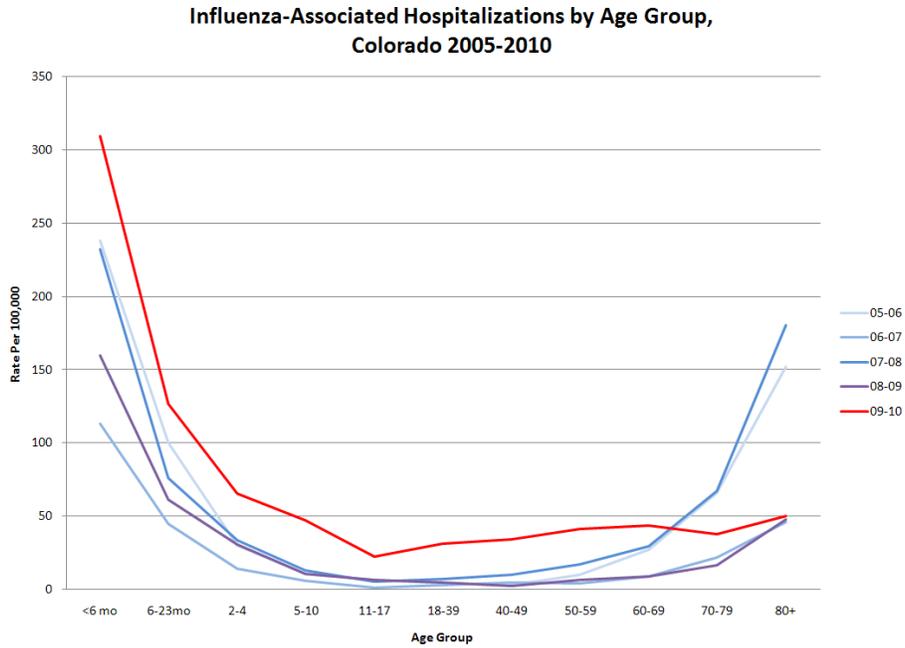
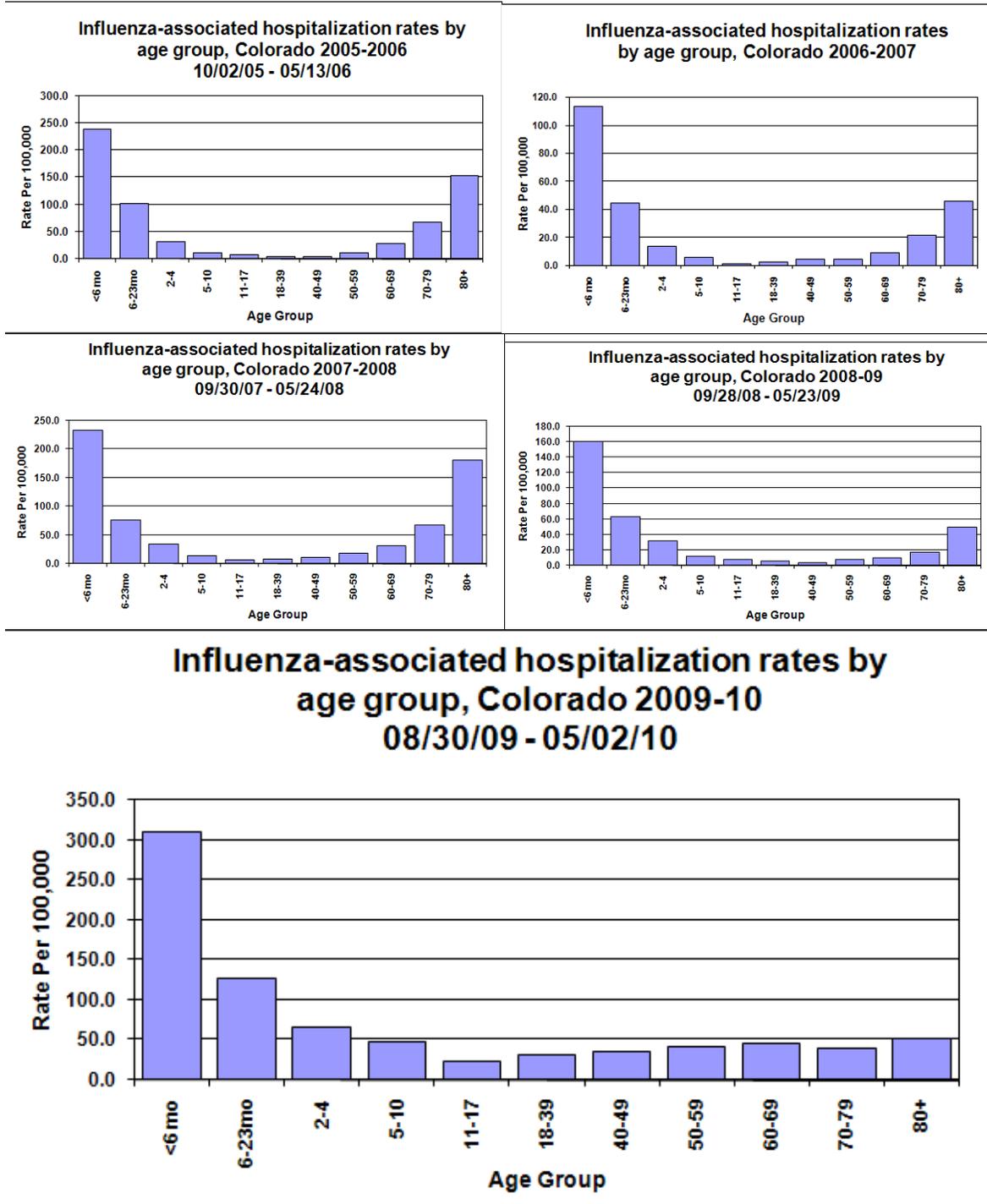


Figure 4.



A seroepidemiologic study by Hancock et al. (N Engl J Med 2009;361:1945-52) showed that cross-reactive antibodies to the 2009 pandemic H1N1 virus were found in a significantly greater portion of stored sera from those individuals born before 1950 than those individuals born after 1980. This likely explains the lower than expected rates of influenza-associated hospitalizations among older adults. Figure 5 below, from the Hancock et al. study shows cross-reactive antibody titers to the 2009 H1N1 virus by birth cohort.

Figure 5.

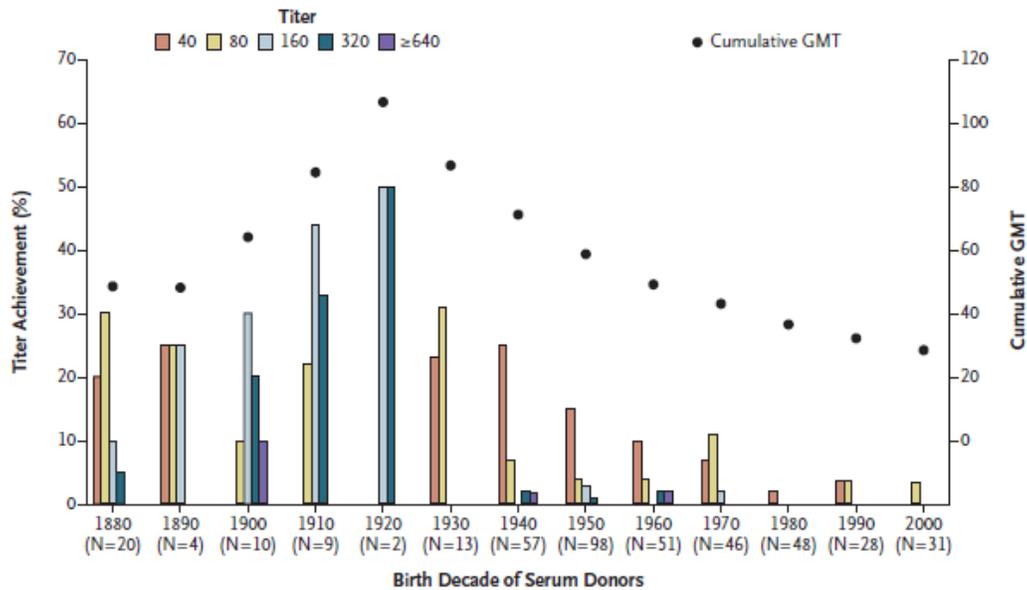


Figure 1. Neutralizing Antibody Titers against the 2009 Pandemic H1N1 Virus among Serum Donors, According to Birth Decade (1880–2000).
 Serum samples that were collected in 1971 and between 2002 and 2009 were tested by microneutralization assay. The proportion of subjects with neutralizing antibody titers of 40, 80, 160, 320, and ≥640 are plotted on the left ordinate, according to the birth decade of the serum donor. The cumulative geometric mean titer (GMT) for all subjects in a birth decade and in all preceding birth decades is plotted on the right ordinate and is shown with black circles.

from: Hancock K, et al. N Engl J Med 2009;361;p.1950

Denver, Arapahoe and Adams counties had the greatest numbers of reported influenza-associated hospitalizations and also the highest rates per 100,000 population as shown in Tables 2 and 3. As mentioned previously, influenza PCR testing, which is more sensitive than rapid flu testing used by most hospitals, was performed to a greater extent in the 5-county Denver metro area than other parts of the state.

Table 2. Numbers of Reported Influenza-Associated Hospitalizations by County, Colorado, 2009-2010

County	Population	# Influenza-Associated Hospitalizations	Rank
Denver	622,105	394	1
Arapahoe	570,235	322	2
Adams	439,836	286	3
Jefferson	547,728	200	4
El Paso	605,979	188	5
Weld	256,980	109	6
Douglas	289,444	92	7
Pueblo	159,693	72	8
Boulder	301,804	66	9
Larimer	297,270	62	10

2008-Based final population estimates from Demography Section, Colorado Dept. Local Affairs

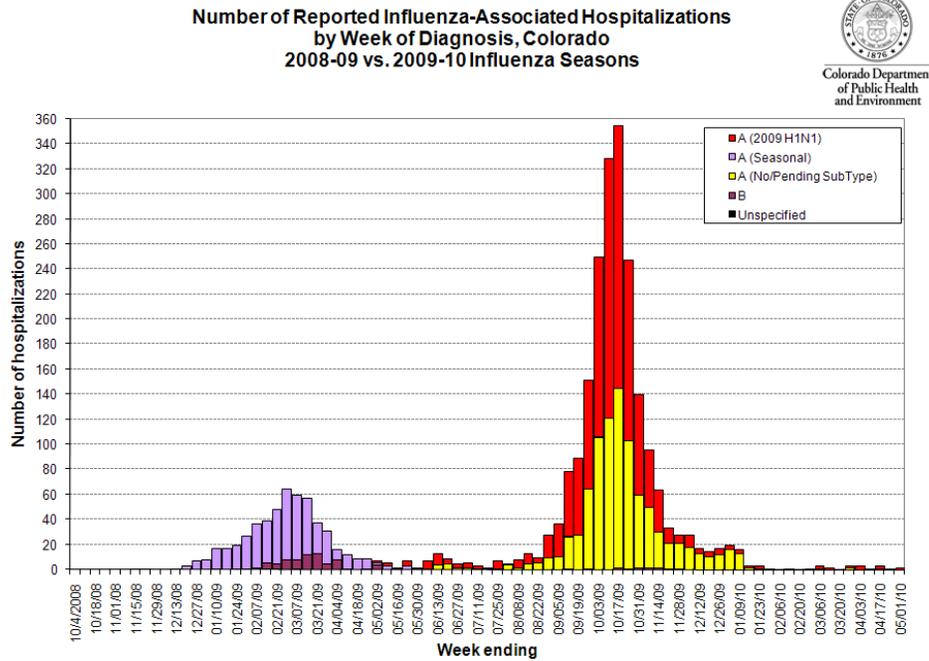
Table 3. Influenza-Associated Hospitalization Rates by County, Colorado, 2009-2010

County	Population	Rate per 100,000 Population	Rank
Adams	439,836	65	1
Denver	622,105	63	2
Arapahoe	570,235	56	3
Pueblo	159,693	45	4
Weld	256,980	42	5
Jefferson	547,728	37	6
Douglas	289,444	32	7
El Paso	605,979	31	8
Boulder	301,804	22	9
Larimer	297,270	21	10

2008-Based final population estimates from Demography Section, Colorado Dept. Local Affairs

When the 2009-2010 pandemic H1N1 influenza season is compared to the 2008-2009 influenza season (considered to have been a “mild” influenza season), the numbers of influenza-associated hospitalizations were higher from the week ending September 12, 2009 through the week ending November 14, 2009 than any week during the 2008-2009 influenza season (Figure 6).

Figure 6.



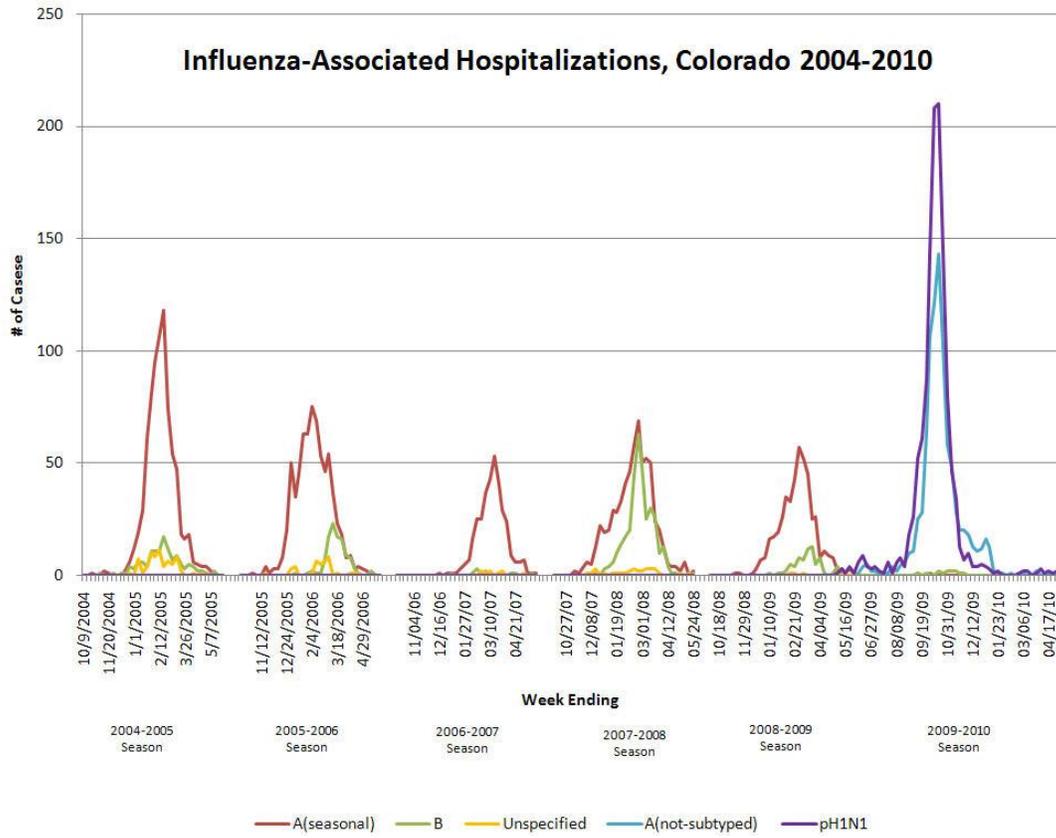
Overall, the number of reported influenza-associated hospitalizations during the 2009-2010 pandemic H1N1 influenza season was at least twice that of the most active of the previous five influenza seasons (Table 4 and Figure 7). It is important to note that these counts are not completely comparable due to the increased surveillance and PCR testing during the pandemic season relative to previous flu seasons.

Table 4. Numbers of Reported Influenza-Associated Hospitalizations, Colorado, 2004-2010

Flu Season	Hospitalizations
2004-2005	980
2005-2006	848
2006-2007	364
2007-2008	1004
2008-2009	530*
2009-2010	2041**

*Regular flu season surveillance is conducted October-May. *The 2008-09 flu season ended May 2, 2009, four weeks earlier than normal due to the emergence of 2009 H1N1 influenza virus. **The 2009-2010 surveillance period was from August 30, 2010 - May 1, 2010.*

Figure 7.



Influenza-Associated Deaths

Pediatric influenza-associated deaths have been a reportable condition in Colorado since the 2004-05 flu season. During the (unusual) 2003-2004 (“Fujian flu”) season, however, 12 pediatric flu deaths were reported (without any numbers from prior seasons for comparison). The numbers of pediatric flu deaths reported during subsequent flu seasons were as follows: 2 (2004-05); 2 (2005-06); 1 (2006-07); 2 (2007-08); and 6 (2008-09). Due to resource and infrastructure limitations, as well as substantial methodologic challenges, adult influenza deaths have not been routinely tracked as part of influenza surveillance.

As part of the response to the 2009-10 H1N1 influenza pandemic, the Colorado Department of Public Health and Environment (CDPHE) conducted surveillance for adult influenza-associated deaths as well as pediatric influenza-associated deaths. To accomplish this, influenza-associated deaths were ascertained by two methods: 1) the “usual” method, which included deaths reported by hospitals among cases of influenza-associated hospitalizations, along with deaths reported by coroners; and 2) the “death certificate” method which included influenza-associated deaths reported on death certificates either in text or by ICD-10 codes.

The usual method of influenza-associated death ascertainment identified a total of 69 influenza-associated deaths with laboratory confirmation from August 30, 2009 through May 1, 2010 (57 adult and 12 pediatric deaths), whereas, death certificates identified 84 potential influenza-associated deaths. After matching these two sets of reports and performing final resolution, a total of 82 laboratory confirmed influenza-associated deaths were identified in Colorado during the 2009-2010 pandemic influenza season.

Influenza associated death rates by age group for the 2009-2010 pandemic are shown below (Table 5). Of note, death rates in general increased with age, with the 65 years and above age group having the highest death rate (although, this age group did not have one of the higher hospitalization rates - Table 1 and Figure 2), consistent with increasing age being a strong predictor of death for many diseases.

Table 5. – Influenza-Associated Deaths by Age Group, Colorado 2009-2010

Age	Deaths	%	CO pop dist	Rate per 100,000
0-17	12	14.6	1318802	0.91
18-24	4	4.9	466280	0.86
25-49	26	31.7	1804500	1.44
50-64	24	29.3	928421	2.59
65+	16	19.5	488725	3.27
Total	82	100.0	5006729	1.64

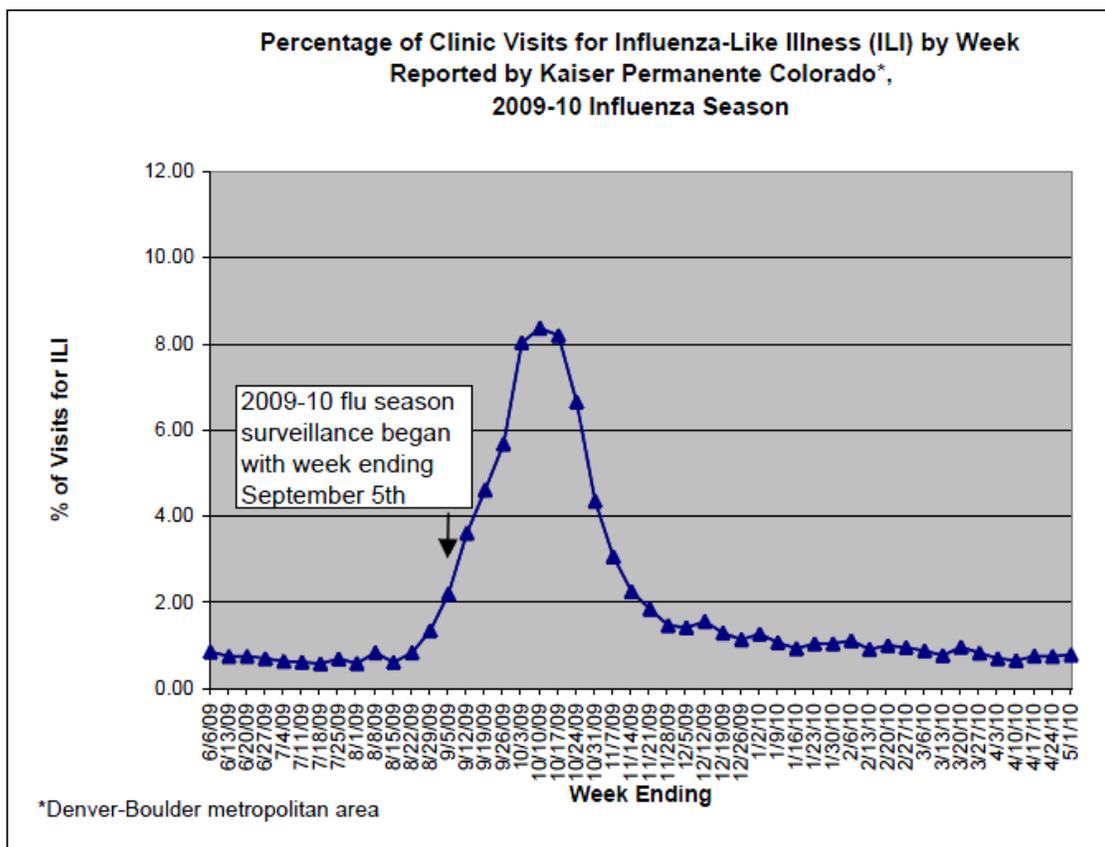
2008-Based final population estimates from Demography Section, Colorado Dept. Local Affairs

Influenza-Like Illness (ILI) Surveillance

The Colorado Department of Public Health and Environment (CDPHE) received weekly influenza-like illness (ILI) surveillance data primarily from Kaiser Permanente Colorado (KPC) for primary care clinic visits in the Denver-Boulder metropolitan area. This included between 15,000 and 20,000 weekly patient visits during the 2009-2010 influenza pandemic season. The percent ILI is based on the number of primary care clinic visits assigned a diagnosis consistent with influenza-like illness (based on selected diagnostic codes) divided by the total number of clinic visits for the week. The ILI diagnosis is a clinical or “syndromic” diagnosis not associated with laboratory testing for influenza.

The Kaiser ILI “curve” (Figure 8) shows a sharp increase in the percent ILI from the week ending August 29 through the week ending October 3, 2009, peaking at just over 8%. For comparison, the KPC peak ILI during the mild 2008-09 influenza season was only 2.2%.

Figure 8.



When the KPC ILI data are stratified by age group, it can be seen that school aged children/young adults (ages 5-24 years) had the highest percent, peaking above 18% during the week ending October 3, 2009 (Figure 9). Nearly one in every five patients aged 5-24 years seen in a KPC primary care clinic during that week was seen for an influenza-like illness. The next highest ILI level was in the 0-4 year age group.

Mesa County Health Department also conducted ILI surveillance in collaboration with the largest medical practice in the county. Both the pediatric and adult ILI levels peaked during the week ending October 23, 2009 at approximately 18% and 12%, respectively (Figure 10). Of note, this peak was three weeks later than the Kaiser ILI peak for the Denver-Boulder metro area.

Figure 9.

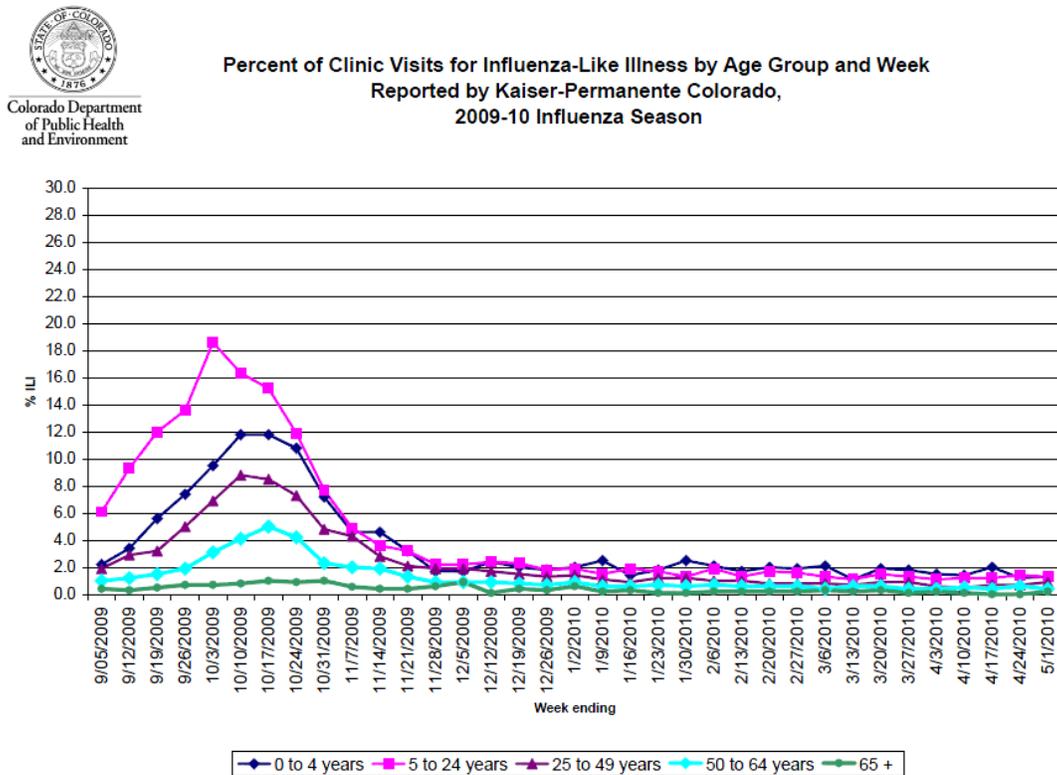
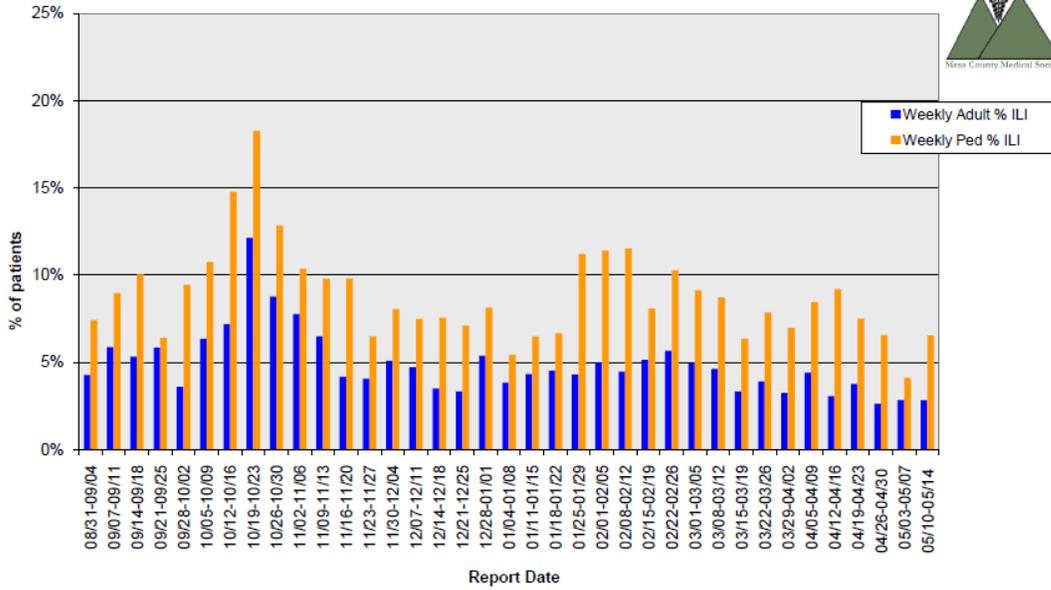


Figure 10.



Primary Care Partners, total patients diagnosed with influenza-like illness (ILI)* percentages shown by week (2009-2010).

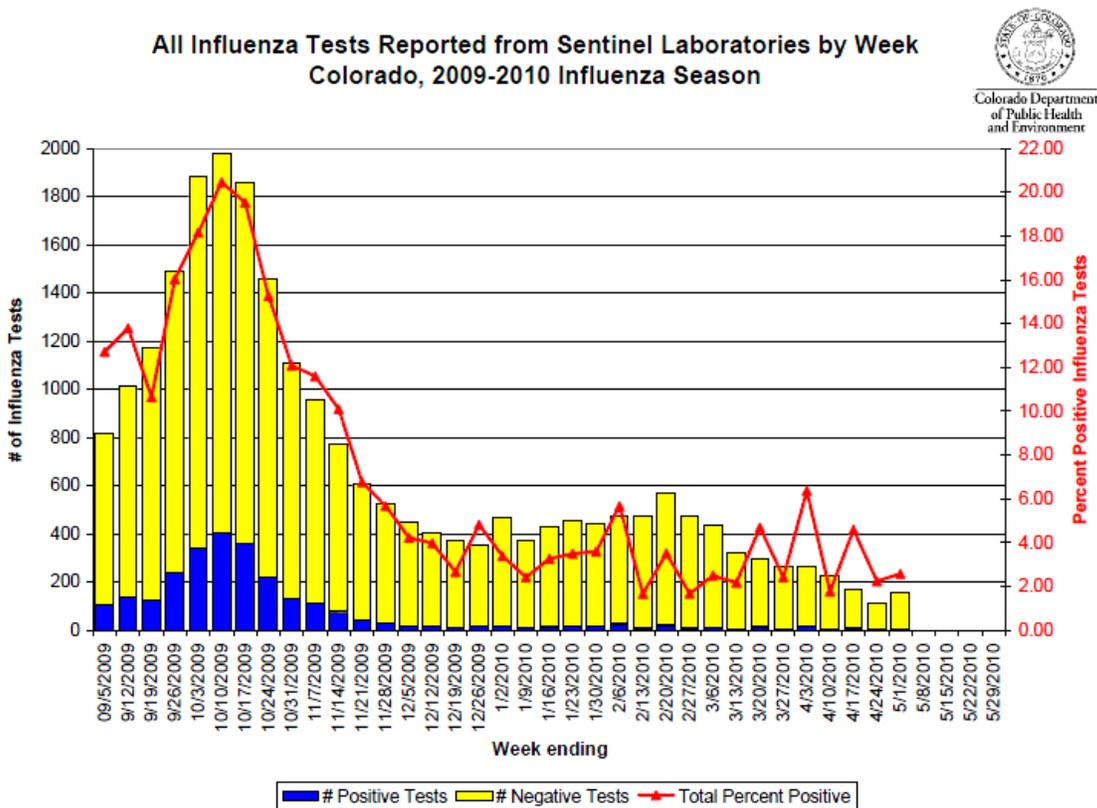


* Influenza-like illness (ILI) is defined as a patient diagnosed with one of the following: Flu Syndrome (487.1); Fever (780.8); Viral Infection (079.99); Upper Respiratory Illness (465.9).

Laboratory Testing and Subtyping

Selected clinical laboratories from around the state (n=18) reported on a weekly basis the numbers of influenza tests performed and the numbers that were positive for influenza A vs. B (Figure 11). A steep increase in the total numbers of positive influenza tests and percent positive tests occurred from the week ending September 19 through October 10, when sentinel labs performed nearly 2000 influenza tests (that week) with the percent positive just over 20%. The time course of sentinel laboratory positivity mirrored that for influenza-associated hospitalizations and for ILI.

Figure 11.



Influenza virus typing and sub-typing performed by the Colorado Department of Public Health and Environment (CDPHE) laboratory indicated that nearly 100% of circulating influenza viruses in the state during the 2009-10 influenza pandemic season were the 2009 H1N1 pandemic virus (Table 6).

Table 6. – Percent of Influenza Virus Subtype in Colorado 2009-2010

	Current Week (Week Ending 05/01/10)	Cumulative (8/30/09 – 05/01/10)
Total Positive for A	2	1736
Subtypeable	2	1635
A (2009 H1N1)	2 (100%)	1633 (99.9%)
H3	0	2 (0.1%)
H1	0	0
Non-subtypeable	0	101
Pending	0	0
Total Positive for B	0	0
Total Positive by PCR	2	1736

School-Based Influenza-Like Illness (ILI) Absenteeism Surveillance

The purpose of this surveillance activity was to monitor influenza-like illness (ILI) absenteeism in Colorado schools during the 2009-10 influenza pandemic. School absenteeism surveillance had previously been used, in addition to medical provider office visit-based ILI surveillance to monitor the community impact of influenza. For this surveillance activity, local public health agencies (LPHAs) worked with school districts, administrators, office staff and school nurses to collect data on the number and percent of students absent due to influenza-like illness. The data collected and methods of collection varied by schools. LPHAs reported weekly to CDPHE the numbers and percents of schools, by school type, that had ILI rates between 0-5%, 5-10%, 10-15%, 15-20% and >20%.

Twenty-nine LPHAs, covering nearly two thirds of the counties in Colorado, participated in this surveillance activity. School absenteeism data were captured from an average of 600 schools weekly (range: 24 – 853 schools) out of the state’s 1,770 (approx.) schools.

Figure 12.

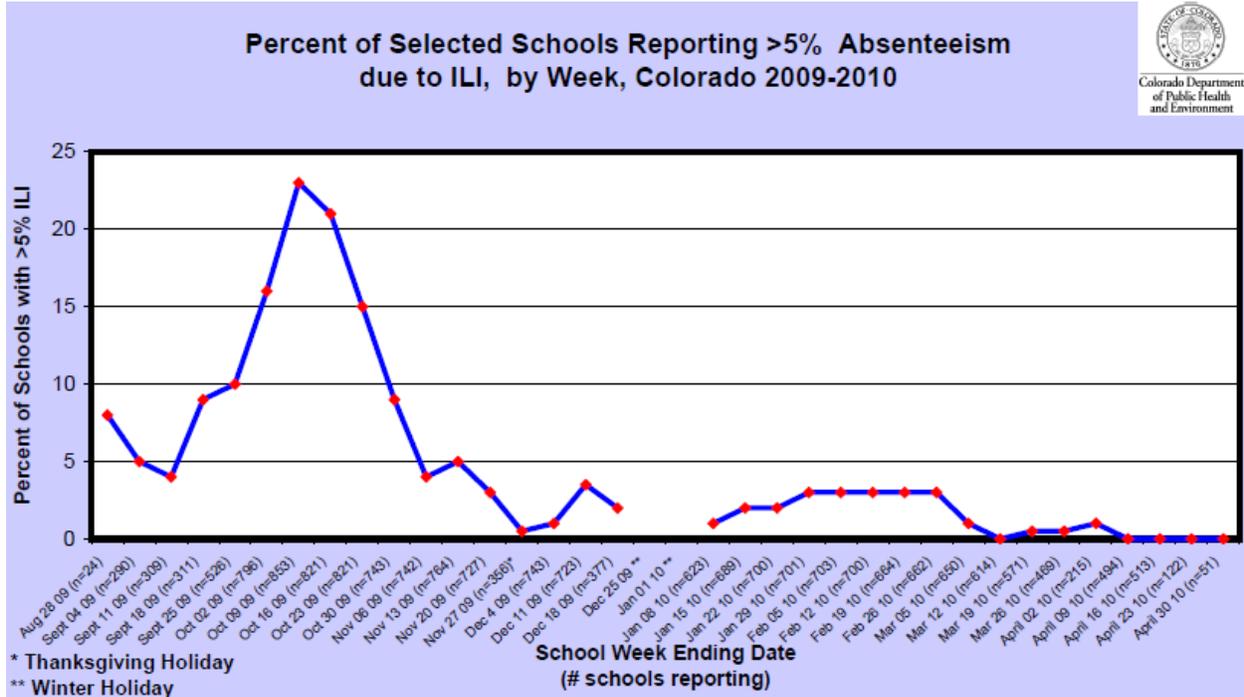
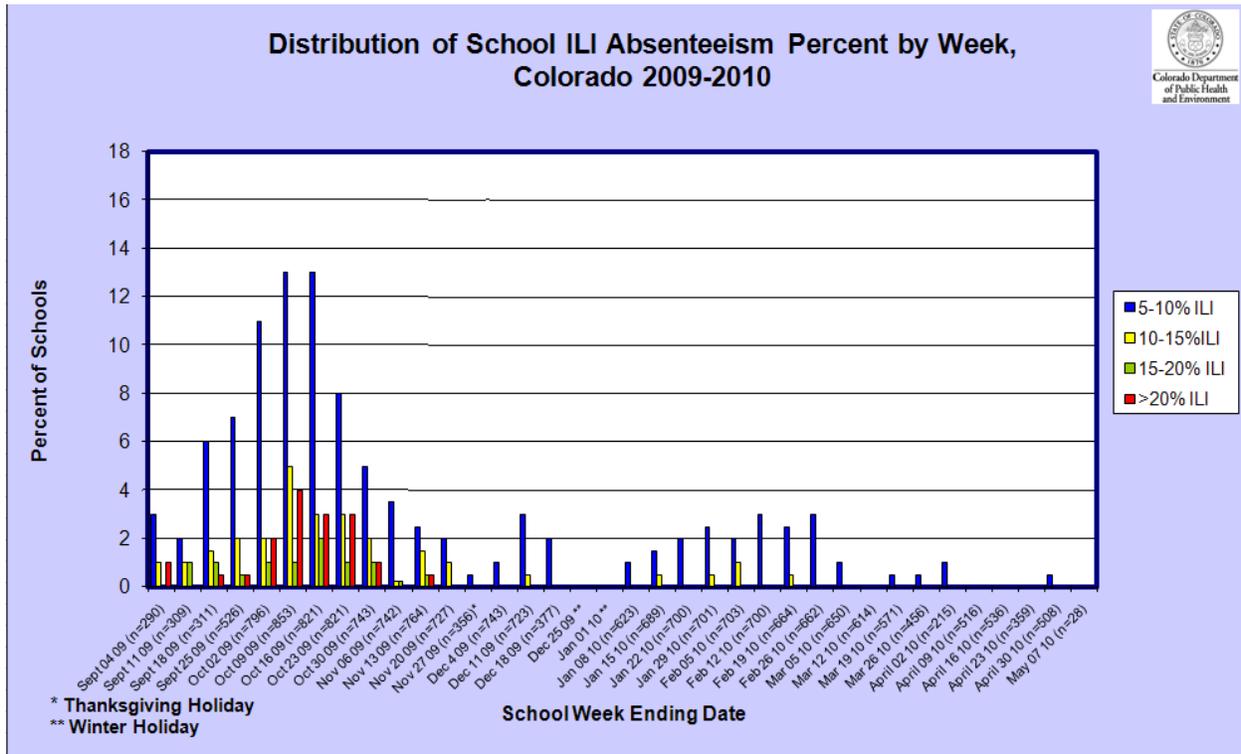


Figure 12 shows the percent of all schools reporting each week that had ILI absenteeism levels greater than 5%. Overall school ILI absenteeism peaked during the week ending October 9, 2009. Figure 13 displays the percent of schools stratified by levels of reported ILI absenteeism: 5-10% ILI absenteeism in blue, 10-15% in yellow, 15-20% in green, and >20% in red. Similar to overall ILI absenteeism, the weeks ending October 9 and October 16 had the largest percents of schools reporting higher levels (i.e., yellow, green, and red bars) of ILI absenteeism.

Figure 13.



The Centers for Disease Control and Prevention (CDC), in coordination with state departments of education and state health departments monitored school closures due to 2009 H1N1 pandemic influenza. In Colorado, 29 schools closed during the pandemic based on school administrative decisions; eighteen of these were during the week ending October 16, 2009. Anecdotally, high student absenteeism, staff illness, and community/political pressure were all contributing factors leading to decisions to temporarily close schools.

Summary

The 2009-2010 pandemic influenza season was a significant influenza season, and by all indicators, more severe than preceding non-pandemic flu seasons. The number of influenza-associated hospitalizations and the peak ILI were substantially higher than previous seasons. The number of reported pediatric influenza-associated deaths was higher than past seasons, except for the unusual “Fujian” flu season of 2003-2004 which was equaled. The Colorado Department of Public Health and Environment along with local public health agencies responded by increasing the scope and extent of influenza surveillance activities to successfully track this unique pandemic event.