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Response to 2009 pandemic influenza A H1N1 among public schools of Georgia, United States—fall 2009

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SUMMARY

Background: Little is known about the extent of implementation or the effectiveness of the Centers for Disease Control and Prevention's (CDC) recommended non-pharmaceutical interventions (NPIs) in schools to control the spread of 2009 pandemic influenza A H1N1 (pH1N1).
Methods: A web-based, cross-sectional survey of all public K–12 schools in Georgia, USA was conducted about preparedness and response to pH1N1, and absenteeism and respiratory illness. Schools that reported ≥10% absenteeism and at least two times the normal level of respiratory illness in the same week were designated as having experienced significant respiratory illness and absenteeism (SRIA) during that week.
Results: Of 2248 schools surveyed, 704 (31.3%) provided sufficient data to include in our analysis. Participating schools were spread throughout Georgia, USA and were similar to non-participating schools. Of 704 schools, 160 (22.7%) reported at least 1 week of SRIA. Most schools reported implementing the CDC recommendations for the control of pH1N1, and only two schools reported canceling or postponing activities. Schools that communicated with parents about influenza in the summer, had shorter school days, and were located in urban areas were less likely to experience SRIA.
Conclusions: Most Georgia schools in the United States adopted the CDC recommendations for pH1N1 mitigation and few disruptions of school activities were reported. Early and timely communication with parents, as well as shorter school days, may have been effective in limiting the effect of pH1N1 on schools.

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1. Introduction

Successful strategies for limiting the transmission of influenza include both pharmaceutical and non-pharmaceutical interventions (NPIs).[1–3] NPIs include a range of infection control strategies, such as cleaning of surfaces that are frequently touched, encouraging hand hygiene and respiratory etiquette, enacting policies on isolation and quarantine, and implementing social distancing measures, such as school closures.[4] The benefits of vaccines and antiviral medications are constrained by supply limitations early in a pandemic, or may not be available in resource-poor settings. NPIs designed to decrease exposure to influenza were shown to reduce the number of deaths and the attack rate during the 1918 pandemic.[5] Because of the severity of the 1918 pandemic, the NPIs employed included lengthy school closures and other aggressive measures, such as public gathering bans and isolation or quarantine. Despite the potential effectiveness of various NPIs, the potential adverse economic and social costs that NPIs, such as school closure, can have on a community should be considered.[6,7]

School-based interventions may be particularly important, as school-aged children have been shown to play an important role in the transmission of influenza in communities.[8–11] Modeling data suggest that transmission of influenza may be greater among children and teenagers within households, school classes, peer groups, and sports teams than in other settings.[12] The same study found that middle and high school children and adolescents had a greater number of random contacts per person per day compared to elementary school children, exceeding all public activities

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including passing periods within school, and school and city bus rides. These activities made these students particularly likely to spread influenza.[12]

During the summer of 2009, the Centers for Disease Control and Prevention (CDC) issued guidance for schools (K–12) on how to reduce student and staff exposure to influenza using NPIs, such as hand hygiene, respiratory etiquette, and keeping ill children at home.[13] It is not known to what degree schools in the USA adopted these recommendations, and if implemented, whether these recommendations were effective in mitigating the effects of 2009 pandemic influenza A H1N1 (pH1N1). Identifying school characteristics or practices associated with reducing transmission within the school may help inform policy makers in preparation for future influenza pandemics. Our study identifies factors that may have contributed to a reduction in transmission of pH1N1 in Georgia public schools in the United States during the fall of 2009.

2. Methods

2.1. Study design and setting

The study was designed as a cross-sectional survey of all public K–12 schools in Georgia, USA. The Georgia Department of Education (GADE) provided contact information for each public school eligible to participate.

2.2. Data collection

The survey was administered using an interactive secure web-based tool, the State Electronic Notifiable Disease Surveillance System (SENDSS), developed by the Georgia Division of Public Health (GADPH) to collect and analyze disease surveillance data. The SENDSS was adapted to conduct the survey of schools. An e-mail was sent to the principals of all Georgia public schools in the United States to request participation in the study. A school administrator or school nurse was asked to complete the survey via an internet link that accessed the secure online survey instrument. Participants also could complete the survey by printing a copy of the survey that could be mailed, faxed, or e-mailed to the study investigators; these surveys were manually entered online. The survey was launched on November 18, 2009, and remained open through December 18, 2009. To increase participation, telephone calls were made to the principals of non-responding schools, e-mail reminders were sent, and superintendents of each Georgia public school district were asked to encourage school principals in their district to participate in the survey.

2.3. Survey

2.3.1. Independent variables

Survey respondents were asked to provide information about the physical characteristics of the school, as well as demographic information on students and staff. In addition, questions were asked about the school's implementation of policies and practices for pH1N1 control; these questions were adapted from the CDC document "CDC guidance for state and local public health officials and school administrators for school (K–12) responses to influenza during the 2009–2010 school year",[13] and were designed to assess preparation for and response to pH1N1.

The following information was assessed: length of school day, number of classrooms used regularly, proportion of students taking the bus to school, size of the student body relative to capacity, availability of onsite healthcare professionals, whether a school experienced a larger than expected number of students with influenza in spring 2009, whether a school undertook any interventions (i.e., school closure, active monitoring for ill students/staff, isolation of ill students/staff) in spring 2009, frequency of cleaning surfaces, availability of a sick room for ill students, and provision of masks to ill students/staff. In addition, respondents were asked whether schools had engaged in communication with parents about influenza or about the prevention of influenza in spring 2009, summer 2009, and/or during the first 2 weeks of the fall 2009 semester. Related to the same time-periods, respondents were also asked whether their school increased provision of tissues, hand sanitizers, soap, or disinfection of surfaces. Finally, the following demographic information was obtained by linking schools to the GADE and National Center for Education Statistics (NCES) databases: type of school (urban, suburban, rural), school instructional level (primary, middle, high), proportion of females, proportion of African–American students, total school enrollment, student–teacher ratio, and proportion of students who are eligible for free or reduced-price lunch.

2.3.2. Dependent variable

The outcome variable for the study was assessed by using two questions that were asked in relation to each week of school during the study period, which began with the opening of school to the middle of November 2009. The first question was "Did your school have 10% or more absenteeism?" The second question was "Did your school have at least two times more than normal respiratory illness?" For both these questions, respondents were asked to fill in their responses against each individual week during August 3–November 13. Respondents were asked to compare the time-period of these responses with similar periods from the previous year, i.e., August–November, 2008. Schools in the USA routinely maintain yearly absenteeism data, and these were used for comparison purposes by the participating schools. Further, GADPH had previously implemented a voluntary reporting system among schools in response to pH1N1, asking schools to report when they had 10% or greater absenteeism. Many participating schools of Georgia in the United States were also collecting information on respiratory illness because of pH1N1 in the region. The outcome variable, hereafter labeled as a week of 'significant respiratory illness and absenteeism' (SRIA), was calculated by combining responses to these two questions. That is, any school that reported having $\geq$10% absenteeism and at least two times the normal level of respiratory illness in the same week during any week of the study period was designated as being SRIA-positive during the study period, whereas schools that did not meet both criteria in the same week during the study period were designated as SRIA-negative.

2.4. Data management

All completed surveys were downloaded from SENDSS to Microsoft Excel. Duplicate submissions from schools (n = 43) were removed; the latest or most complete survey was retained and supplemented with any missing information from the previous survey. To conduct demographic comparisons of responding and non-responding schools, survey data were merged with school demographic information that was obtained from the GADE[14] and NCES[15] websites. Schools were matched to these databases by using the school names, zip codes, and counties, provided by the survey respondents.

Additionally, for validation of the data in this study, we compared weekly levels of SRIA within schools to the number of weekly influenza-like illness (ILI) visits in the emergency department of Georgia hospitals in the United States during the same period. ILI syndromic surveillance data are routinely collected in hospitals and urgent care centers throughout the state, and are collected by the Georgia Division of Public Health (GDPH). During the fall of 2009, approximately 51% of all emergency department visits statewide were collected and analyzed by the Syndromic

Surveillance System. Patient chief complaint data were classified into syndromes through a text parsing algorithm. The ILI syndromic surveillance requires that the patient's chief complaint includes mention of a fever and a cough or sore throat.

2.5. Data analysis

Analyses were performed using JMP version 8.0 statistical software.[16] Statistical comparisons were performed by comparing schools that participated in the survey to non-participating schools on the demographic variables obtained through the GADE and NCES databases. Descriptive statistics were calculated related to the participating schools' policies and practices on the prevention of HIN1 in the spring, summer, and fall. We compared schools that were SRIA-positive for any week during the study period to schools that were SRIA-negative during the entire study period on demographic variables, as well as policies and procedures implemented to prevent pH1N1. The differences between groups were compared using Chi-square tests (categorical variables) and Student *t*-tests (continuous variables). All factors that were significant ($p < 0.05$) were included in a multivariable logistic regression model, in which we used a backward elimination method, retaining only those variables significant at $p \leq 0.10$ in the final model. In addition, to assess whether a single intervention or multiple interventions were associated with SRIA, data were analyzed by stepwise grouping of interventions in two sets because of the nature of questions asked in the survey. One set of interventions included tissues, hand sanitizers, soap, and disinfection of surfaces/items having frequent hand contact, and the second set of interventions included cleaning frequency, availability of a sick room, and availability of surgical masks.

3. Results

From the 2248 public schools in Georgia, USA we received 796 (35.4%) unique school surveys. The surveys that could not be matched with school databases to obtain key demographic variables were excluded ($n = 83$). Special education, vocational, and technical schools ($n = 9$) were also excluded because our surveys targeted regular public schools in Georgia, USA. The remaining 704 (31.3%) schools were selected for analysis (Figure 1). In 115 (72.3%) of 159 counties, at least one school participated in the study (Figure 2).

3.1. Comparison between participating and non-participating schools

Participating and non-participating schools were compared on relevant demographic variables. The average number of students, student–teacher ratio, number of full-time equivalent (FTE) teachers, type of school, and gender composition did not differ significantly between participating and non-participating schools (Table 1). However, participating schools had a greater percentage of white non-Hispanic students (49.0%) than non-participating schools (40.8%) ($p < 0.001$) and a lower percentage of black non-Hispanic students (36.3%) than non-participating schools (41.4%) ($p < 0.001$). In addition, primary and middle schools were over-represented, and high schools were under-represented among participating schools ($p < 0.001$) (Table 1).

3.2. pH1N1 preparation and response during spring, summer, and fall 2009

Most (85.1%; $n = 571/671$) reporting schools stated that they were somewhat or very comfortable with their school's preparation in the fall for pH1N1. Only two schools cancelled or postponed activities because of concern about pH1N1. Most (97.7%; $n = 684/700$) schools reported communicating with students and/or parents about pH1N1 at least once during the spring, summer, or fall of 2009. Stratified by time-period, 29.1% ($n = 204/700$) reported communicating in the spring, 11.7% ($n = 82/700$) reported communicating during the summer, 70.4% ($n = 493/700$) reported communicating during the first 2 weeks of the school year, and 75.4% ($n = 528/700$) reported communicating sometime later in the fall. The most common methods reported for communication by schools were letters sent home to parents (84.5%; $n = 595$), followed by posting messages on school, district, or community websites (78.0%; $n = 549$), distributing handouts to students (75.6%; $n = 532$), making school announcements (55.8%; $n = 393$), placing posters on school walls (46.6%; $n = 328$), and sending e-mails to either students or parents (43.2%; $n = 304$). The most commonly reported communication messages were reminders for frequent hand washing (97.7%; $n = 688$), covering coughs (97.0%; $n = 683$), staying home from school when sick (96.9%; $n = 682$), and using hand sanitizer (96.7%; $n = 681$).

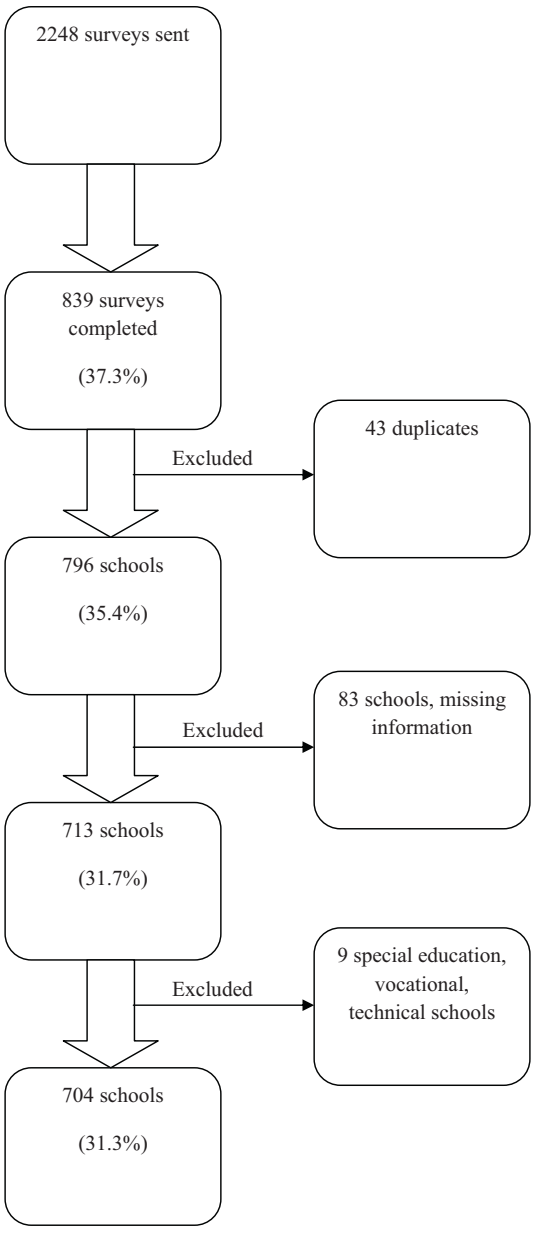

Figure 1. Flow diagram showing the Georgia schools in the United States that participated in the 2009 pandemic influenza A H1N1 survey.

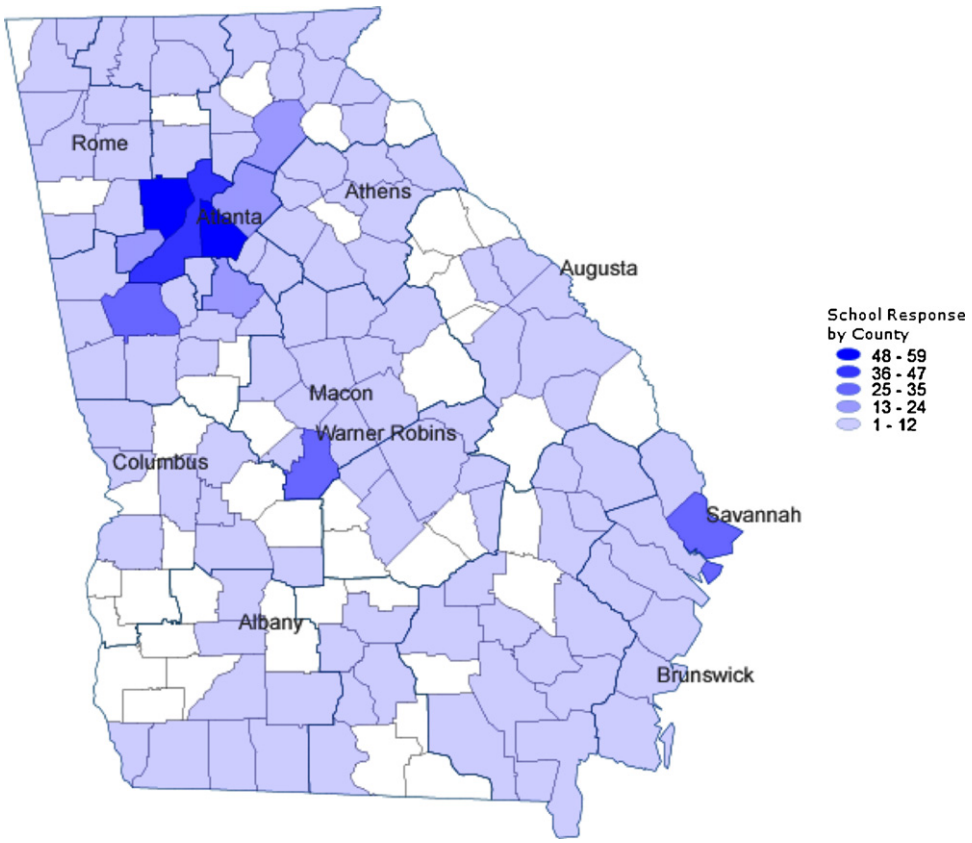

Figure 2. Distribution by county of the public schools participating in the 2009 pandemic influenza A H1N1 schools survey, Georgia, USA.

Table 1
Comparison of responding and non-responding public schools in the 2009 pandemic influenza A H1N1 schools survey, Georgia, USA

Variables	Responding schools[a] (survey schools)		Non-responding schools[a]		*p*-Value
	Mean proportion	SD	Mean proportion	SD	
Total students[b]	743.3	406.5	755.7	486.9	0.552
Race[c]					
American Indians	0.2	0.3	0.1	0.2	0.001
Asian	2.1	3.2	2.5	4.6	0.032
Black (non-Hispanics)	36.3	29.7	41.4	31.5	<0.001
Hispanic	9.0	13.6	9.1	12.9	0.935
Multiracial	3.3	2.1	3.0	1.9	0.002
White (non-Hispanics)	49.0	29.5	40.8	29.7	<0.001
Sex[c]					
Male	51.4	3.1	51.6	6.2	0.362
Female	48.6	3.1	48.4	6.2	0.362
Student–teacher ratio[b]	14.0	1.8	14.3	6.9	0.214
FTE teacher[b]	51.9	23.9	52.2	30.1	0.826
	n	%	*n*	%	
Type of school[b]					0.139
City	113	16.1	301	19.3	
Suburban	228	32.4	520	33.3	
Town	102	14.5	189	12.1	
Rural	261	37.1	550	35.3	
School instructional level[b]					<0.001
Primary schools	349	59.7	879	57.5	
Middle schools	138	23.6	330	21.6	
High schools	95	16.2	255	16.7	
Others[d]	3	0.5	64	4.2	

SD, standard deviation; FTE, full-time equivalent.
[a] Special education, vocational, and technical schools were excluded from responding and non-responding schools.
[b] Source: National Center for Education Statistics, 2007 (non-responding schools = 1560; responding schools = 704).
[c] Source: Georgia Department of Education, 2009 (non-responding schools = 1586; responding schools = 704).
[d] Regular schools that do not fall into primary, middle, and high schools.

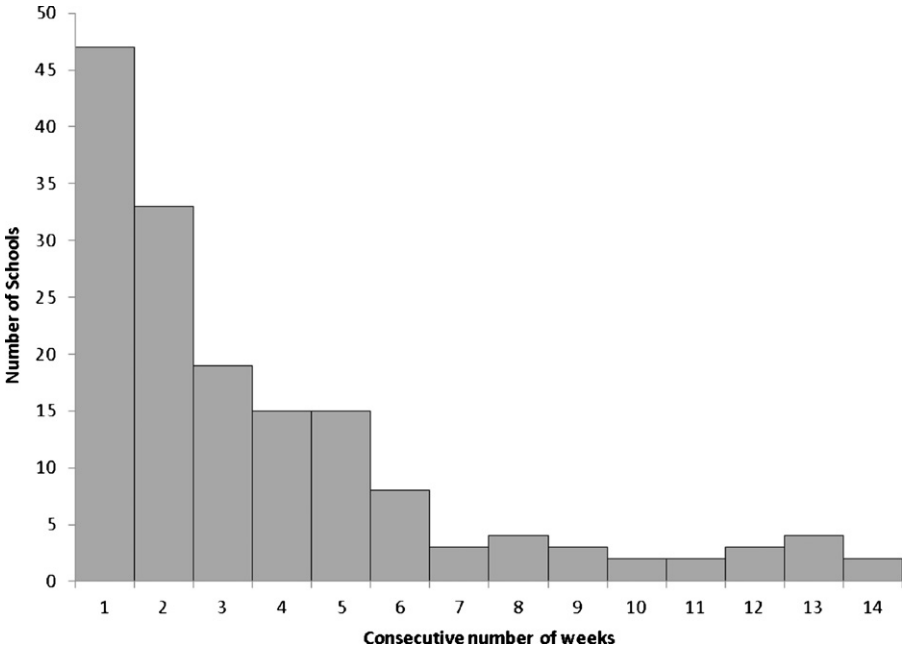

Figure 3. Distribution of schools ($N = 160$) with consecutive significant respiratory illness and absenteeism (SRIA), August 3–November 13, 2009.

3.3. Factors associated with significant respiratory illness and absenteeism (SRIA) in schools

Of the 704 schools that participated in the survey, 160 (22.7%) reported at least 1 week of SRIA; of these, 47 (29.4%) reported only 1 week of SRIA and the remainder reported between 2 and 14 weeks of SRIA during the study period (Figure 3). Among schools that were SRIA-positive, the initial week of SRIA most commonly occurred during the 4th week following the opening of the school for the fall term (Figure 4). When looking at the progression of SRIA per week among schools that experienced SRIA, there was a rapid increase in the proportion of schools reporting SRIA during August 10–September 4, with a peak during the week of September 14–18 (Figure 5). A similar pattern was observed over time in relation to the proportion of Georgia emergency department visits attributable to respiratory illness (Figure 5).

A number of differences were found when comparing schools that experienced SRIA to those that did not experience SRIA (Table 2). In bivariate analyses, schools with a longer school day ($p = 0.004$), a larger proportion of students taking the bus to school ($p < 0.001$), and a higher student–teacher ratio ($p = 0.027$) were more likely to experience SRIA during the study period. Also, the likelihood of experiencing SRIA varied by school instructional level (high, middle, primary) ($p = 0.004$) and type of school (city, suburban, town, rural) ($p = 0.014$). Schools that communicated influenza information to parents and students during spring ($p = 0.028$) or summer

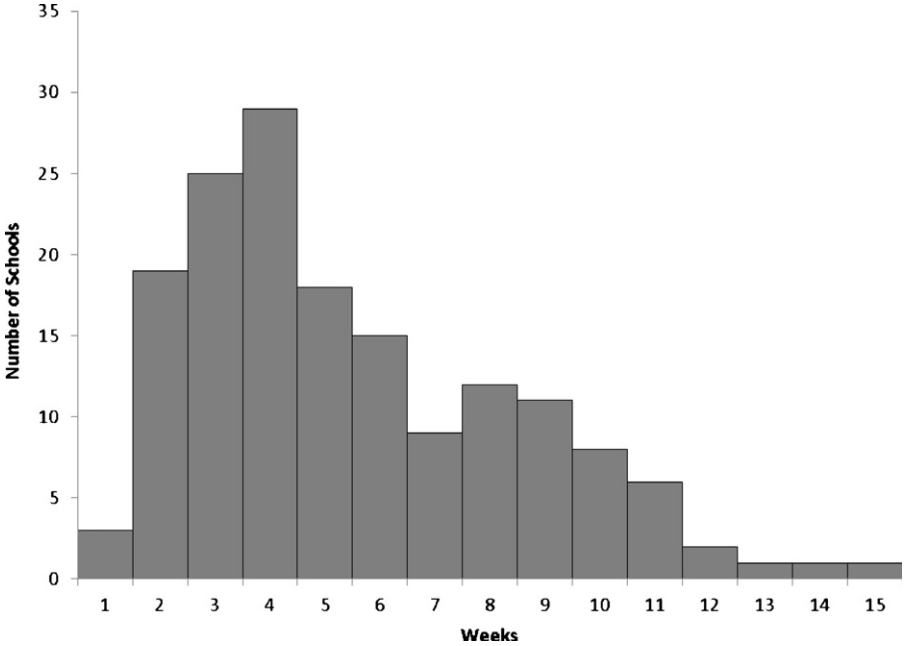

Figure 4. Distribution of schools by number of weeks between start of school and first week of significant respiratory illness and absenteeism (SRIA), August 3–November 13, 2009.

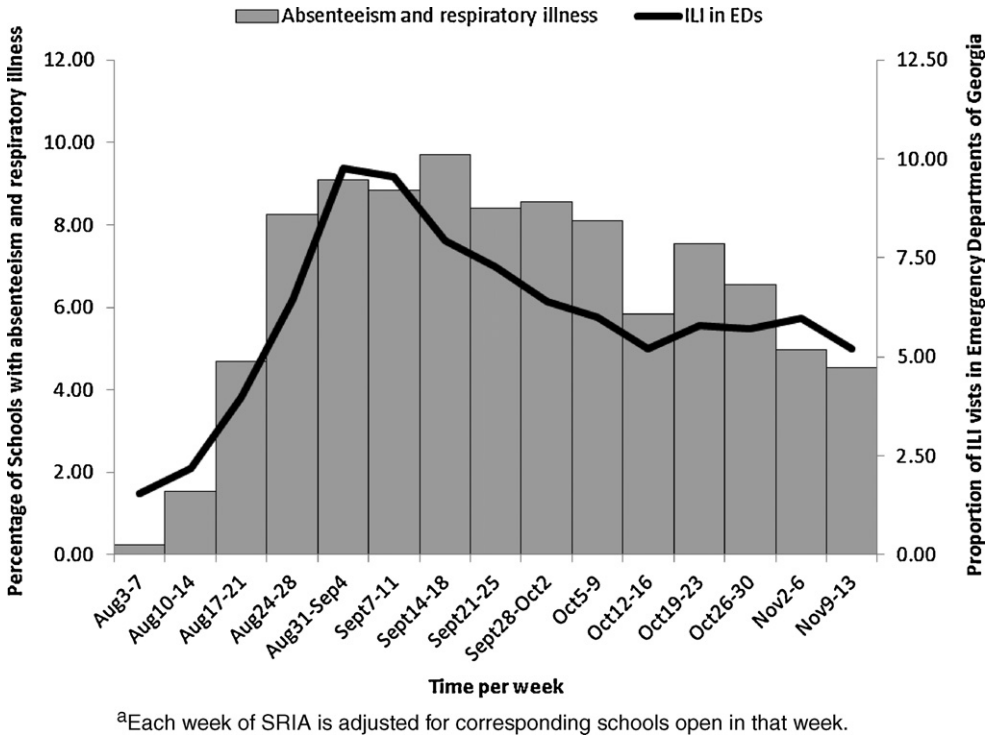

Figure 5. Percentage of schools reporting significant respiratory illness and absenteeism (SRIA),[a] and proportion of influenza-like illness (ILI) in the emergency departments of Georgia hospitals in the United States, August 3–November 13, 2009.

($p < 0.001$), and schools that communicated influenza prevention messages to parents and students during spring ($p = 0.004$) or summer ($p = 0.012$) were less likely to experience SRIA (Table 2). We also examined the frequency of communications with parents, but found no significant associations with SRIA (data not shown). To assess whether a single intervention or multiple interventions were associated with SRIA, in the first set of interventions (tissues, hand sanitizers, soap, and disinfection), none of any stepwise groupings of interventions was statistically different among schools that were SRIA-positive and SRIA-negative ($p > 0.05$). Similarly, in the second set of interventions (cleaning frequency, sick room availability, and surgical mask availability), none of any stepwise groupings of interventions was statistically different among schools that were SRIA-positive and SRIA-negative ($p > 0.05$).

In the final multivariable regression model, three factors remained significantly associated with SRIA. First, schools with a longer school day (≥7.5 h) were more likely to report SRIA compared to schools in session less than 6.5 h (adjusted odds ratio (AOR) 2.41; $p = 0.002$); second, schools that communicated with parents and students about influenza in the summer were less likely to report SRIA compared to those schools that did not communicate with parents and students during the summer (AOR 0.23; $p = 0.011$); third, urban schools were less likely to report SRIA as compared to rural schools (AOR 0.37; $p = 0.027$) (Table 3). Two additional factors approached statistical significance in predicting a greater likelihood of reporting SRIA. Schools having a greater proportion of students taking the bus to school (≥76%) (AOR 2.96; $p = 0.050$) and schools with a higher student–teacher ratio (AOR 4.64; $p = 0.051$) demonstrated a trend towards being more likely to experience SRIA.

4. Discussion

Georgia was one of the first states in the U.S. to be heavily affected by pH1N1 during the fall of 2009. However, our survey found that most schools felt prepared for pH1N1, were actively engaged in communicating with students and parents about pH1N1, and used a variety of NPIs in response to pH1N1 during the fall that were consistent with CDC recommendations.[13] We found that a significant proportion of Georgia schools in the United States reported ≥1 week of SRIA during the fall, when pH1N1 was circulating in Georgia, USA; however, few schools cancelled or postponed activities related to concern about pH1N1. Communicating with parents during the summer, shorter school days, and being in an urban setting were significantly associated with a lower likelihood of SRIA. Other factors, including a greater proportion of children taking the bus and a higher student–teacher ratio appeared to be associated with increased levels of SRIA, although these associations did not reach statistical significance ($p > 0.05$).

In our study, communication during the summer was associated with a lower likelihood of SRIA in schools. Despite limited literature on the effectiveness of strategic communication for influenza control in schools, one study found that early communication about prevention with parents and children through mass media and pamphlets was beneficial during the pH1N1 pandemic.[17] Strategic communication about influenza may serve not only to improve hygiene and other protective behaviors, but also may decrease the fear associated with pandemic influenza. Still, early communication about influenza with students and their parents may only be a proxy for a school's overall preparation to combat pH1N1. More research is needed before concluding that this is an important and effective mitigation strategy.

Our findings also suggest that children spending more time together in school may allow for greater spread of respiratory illness. Consistent with this finding, previous research suggests that social contact patterns differ considerably when comparing weekdays to the weekend, and regular to holiday periods, mostly because of the reduction in work and/or school contacts.[18,19] Further, previous studies have found lower respiratory disease transmission during school breaks.[6,20] Similarly, a shorter school day may result in decreased respiratory illness and therefore less SRIA.

Table 2
Comparison of participating public schools with and without significant respiratory illness and absenteeism (SRIA) in the 2009 pandemic influenza A H1N1 schools survey, Georgia, USA November 18–December 18, 2009

	Schools with SRIA		Schools without SRIA		*p*-Value
	n (column %)	Row %	*n* (column %)	Row %	
Length of school day					0.004[a]
≤6.5 h	49 (30.8)	32.0	104 (28.3)	68.0	
>6.5 h to <7.5 h	59 (37.1)	23.8	189 (51.4)	76.2	
≥7.5 h	51 (32.1)	40.5	75 (20.4)	59.5	
Proportion of students taking bus					<0.001[a]
≥76%	62 (39.7)	35.6	112 (30.9)	64.4	
51–75%	70 (44.9)	35.2	129 (35.6)	64.8	
26–50%	20 (12.8)	17.4	95 (26.2)	82.6	
≤25%	4 (2.6)	13.3	26 (7.2)	86.7	
Capacity of school					0.259
Overcrowded	13 (8.2)	22.4	45 (13.0)	77.6	
At capacity	85 (53.5)	32.2	179 (51.7)	67.8	
Below capacity	61 (38.4)	33.3	122 (35.3)	66.7	
Availability of healthcare professionals					0.417
5 days/week	13 (8.9)	25.0	39 (11.3)	75.0	
<5 days/week	133 (91.1)	30.4	305 (88.7)	69.6	
Larger than expected number of students with influenza in spring 2009					0.051
Yes	21 (13.7)	44.7	26 (7.4)	55.3	
Don't know	18 (11.8)	35.3	33 (9.3)	64.7	
No	114 (74.5)	27.9	294 (83.3)	72.1	
Interventions in spring 2009[b]					0.014[a]
Yes	66 (41.2)	25.3	195 (52.8)	74.7	
No	94 (58.8)	35.1	174 (47.2)	64.9	
Influenza information to parents or students in spring 2009[c]					0.028[a]
Yes	37 (23.1)	23.6	120 (32.5)	76.4	
No	123 (76.9)	33.1	249 (67.5)	66.9	
Influenza information to parents or students in summer 2009					<0.001[a]
Yes	9 (5.6)	13.2	59 (16.0)	86.8	
No	151 (94.4)	32.8	310 (84.0)	67.2	
Influenza information to parents or students in first 2 weeks 2009					0.694
Yes	110 (68.8)	29.7	260 (70.5)	70.3	
No	50 (31.2)	31.4	109 (29.5)	68.6	
Prevention messages to parents or students about influenza in spring 2009[d]					0.004[a]
Yes	61 (38.1)	24.2	191 (51.8)	75.8	
No	99 (61.9)	35.7	178 (48.2)	64.3	
Prevention messages to parents or students about influenza in summer 2009					0.012[a]
Yes	16 (10.0)	19.0	68 (18.4)	81.0	
No	144 (90.0)	32.4	301 (81.6)	67.6	
Prevention messages to parents or students about influenza in first 2 weeks 2009					0.543
Yes	121 (75.6)	29.6	288 (78.0)	70.4	
No	39 (24.4)	32.5	81 (22.0)	67.5	
Increased provision of tissues, hand sanitizers, soap, and disinfection during spring 2009[e,f]					0.155
Yes	43 (26.9)	26.1	122 (33.1)	73.9	
No	117 (73.1)	32.1	247 (66.9)	67.9	
Increased provision of tissues, hand sanitizers, soap, and disinfection during summer 2009[e,f]					0.062
Yes	16 (10.0)	21.3	59 (16.0)	78.7	
No	144 (90.0)	31.7	310 (84.0)	68.3	
Increased provision of tissues, hand sanitizers, soap, and disinfection during first 2 weeks 2009[e]					0.245
Yes	96 (60.0)	28.5	241 (65.3)	71.5	
No	64 (40.0)	33.3	128 (34.7)	66.7	
Frequency of cleaning					0.631
Daily/more than once	146 (95.4)	30.2	337 (94.4)	69.8	
Weekly/every 2–3 weeks	7 (4.6)	25.9	20 (5.6)	74.1	
Sick room for ill students					0.329
Yes	123 (78.8)	28.9	302 (82.5)	71.1	
No	33 (21.2)	34.0	64 (17.5)	66.0	
Don't know	0 (0.0)	-	0 (0.0)	-	
Provision of surgical masks to ill students and staff					0.301
Yes	56 (39.2)	27.2	150 (44.2)	72.8	
No	87 (60.8)	31.5	189 (55.8)	68.5	
Type of school					0.014[a]

Table 2 (*Continued*)

	Schools with SRIA		Schools without SRIA		*p*-Value
	n (column %)	Row %	*n* (column %)	Row %	
City	16 (10.0)	18.2	72 (19.5)	81.8	
Suburban	59 (36.9)	35.1	109 (29.5)	64.9	
Town	18 (11.3)	24.7	55 (14.9)	75.3	
Rural	67 (41.9)	33.5	133 (36.0)	66.5	
School instructional level					0.004[a]
High	10 (7.7)	14.1	61 (19.7)	85.9	
Middle	29 (22.3)	31.5	63 (20.4)	68.5	
Primary	91 (70.0)	33.0	185 (59.9)	67.0	
	Mean (SD)		Mean (SD)		
Female proportion	48.4 (2.3)		48.8 (2.4)		0.078
Black proportion	31.8 (30.1)		37.0 (29.8)		0.066
Total population	709.5 (337.6)		748.9 (425.2)		0.314
Student–teacher ratio	13.8 (1.6)		14.2 (1.9)		0.027[a]
Proportion of students eligible for free lunch	51.5 (24.2)		50.9 (26.5)		0.800
Number of classrooms used regularly in a school	44.3 (1.8)		46.2 (1.2)		0.396

[a] $p < 0.05$.
[b] School interventions include: school closure, daily monitor for ill students and staff, isolation of ill students and staff.
[c] Influenza information to parents or students includes: letters, school-wide handouts, parent meeting, open-house or special student assembly, announcements, school-mandated lesson plan, poster campaign, e-mail, school/district/community website, twitter/facebook/social networking sites, mass text messaging system, automated phone messaging system.
[d] Prevention messages to parent or students about influenza include: covering cough, washing hands, using hand sanitizer, staying home when sick, eating healthy food, adequate rest, seeing school nurse if having flu-like symptoms, seeing primary care provider if having flu-like symptoms.
[e] For 'yes' category, the schools have to have at least one (tissue, hand sanitizer, soap, and disinfection).
[f] Considered a proxy for school's preparedness to combat pH1N1.

In our study, urban schools were less likely to report SRIA. It is unclear what factors may influence this finding, and it warrants further study. Additional factors in the multivariate analysis also approached, but did not reach, statistical significance. In addition, the trends suggesting that a greater proportion of children taking the bus and a higher student–teacher ratio are associated with SRIA are consistent with previous research indicating that greater crowding and/or more extensive contact between students can play a role in increased risk of infection.[12]

Table 3
Factors associated with schools having significant respiratory illness and absenteeism (SRIA) in the 2009 pandemic influenza A H1N1 schools survey, Georgia, USA November 18–December 18, 2009

	Multivariate regression model	
	Adjusted OR[a]	*p*-Value
Length of school day		
≤6.5 h	Ref.	
>6.5 h to <7.5 h	1.08	0.130
≥7.5 h	2.41	0.002[b]
Proportion of students taking bus		
≥76%	2.96	0.050[c]
51–75%	2.85	0.066[c]
26–50%	1.45	0.379
≤25%	Ref.	
Communication to parents or students about flu in summer 2009		
Yes	0.23	0.011[b]
No	Ref.	
Type of school		
City	0.37	0.027[b]
Suburban	1.04	0.113
Town	0.83	0.702
Rural	Ref.	
Student–teacher ratio	4.64	0.051[c]

OR, odds ratio; Ref., reference.
[a] Adjusted for gender, race, total population, school's instructional level, proportion of students eligible for free lunch, number of regularly used classrooms, capacity of school, healthcare professionals, larger than expected number of students with influenza in spring 2009, interventions in spring 2009, frequency of cleaning, sick room for ill students, and provision of surgical masks to staff and ill students. In addition, the following variables were also adjusted relative to the time-period in which they were implemented (spring, summer, or first 2 weeks of the fall semester): methods of communication and type of messages to parents or students about influenza, canceling and postponing school activities, and increased provision of tissues, hand sanitizers, soap, and disinfection.
[b] $p \leq 0.05$.
[c] $p \leq 0.10$.

There were no associations found with reported greater provision of soap, hand sanitizer, or tissues. However, an overwhelming proportion of schools reported making these available, including schools with and without SRIA, making it difficult to find an association in our analyses.

Education and hygiene interventions are less disruptive than social distancing measures, such as school closures. However, most previous studies have also had difficulty demonstrating reductions in respiratory disease transmission resulting from these measures alone.[21] Although higher rates of compliance with these interventions among children have been shown in a study, appreciable reductions in respiratory disease could not be demonstrated.[22] A recent study demonstrated the effectiveness of a hand hygiene campaign in significantly reducing laboratory-confirmed influenza in schools in Egypt.[23] This study illustrates the importance of hand hygiene and suggests that although effective, efforts to enhance hand hygiene in the USA may not be fruitful. Perhaps baseline hand hygiene in the USA is quite high, possibly providing an explanation for why USA-based studies have difficulty finding an effect. Given that hygiene interventions and health education are well accepted by communities and likely provide some benefit, these NPIs should be implemented and considered standard practice in schools to prevent the spread of communicable diseases. Additionally, stressing the importance of these NPIs as measures that persons can take to protect themselves during a pandemic is important in the absence of an influenza vaccine. Given the very high susceptibility associated with pandemic influenza, multiple NPIs, including social distancing measures, are likely necessary to appreciably affect spread.[5]

Our study is subject to several limitations. First, this study is cross-sectional so it is not possible to assess the temporal precedence of the outcome variable (absenteeism/respiratory illness) relative to factors that may have influenced the likelihood

of SRIA in schools. While school officials provided information on their efforts to prevent the spread of influenza, these reports may be biased as a result of being retrospective and self-reported. In specific, most schools started collecting information on respiratory illness during pH1N1, which makes it difficult for schools to compare the illness with past year. Also, it is important to consider whether the outcome variable, SRIA, is an adequate proxy for an outbreak of pH1N1 in a school. The decision to ask school officials about absenteeism at a level of 10% or more was selected because the GADPH had previously implemented a voluntary reporting system among schools in response to pH1N1, asking schools to report when they had 10% or greater absenteeism. The unitary cutoff used in defining SRIA did not take into account the variation between schools' baseline levels of absenteeism and respiratory illness. Schools with a high baseline level of absenteeism or respiratory illness may have been misclassified as experiencing a significant increase in SRIA, while schools with a low baseline absenteeism or respiratory illness level may have been misclassified as not having experienced a significant increase in SRIA. Nevertheless, this type of measurement error is likely to have decreased the likelihood of significant findings, biasing towards the null. However, we did find some evidence supporting the use of our SRIA case definition as a valid measure of pH1N1 effect on a school. First, Figure 5 indicates that the proportion of emergency department visits attributable to respiratory illness in Georgia hospitals in the United States tracked SRIA rates among schools during the study period. This comparison suggests that SRIA was likely a reliable indicator of the burden of illness experienced by schools during the spread of pH1N1 in Georgia, USA. In addition, data suggest that during the time of the study, the pH1N1 strain of influenza was in circulation throughout Georgia and the southern USA, and was responsible for much of the respiratory associated illness being seen in emergency departments.[24] As a result, this observation suggests that the illness reported in our study as SRIA was attributable to pH1N1. Urban schools may have been affected by the first wave of pH1N1 and less likely to have SRIA because of immunity during the time of our study. Variables such as length of school bus ride could have been confounded by factors we did not consider in our analysis. For instance, length of school bus ride may be a proxy for rural living and more likely to be impacted later as disease spreads first in the urban areas. It would have been useful to describe ILI syndromic surveillance data in more detail, but only 51% of all emergency department visits statewide were included in the ILI syndromic surveillance data, and therefore is unlikely to be comparable. Further, loss of data from bivariate analyses to final multivariate model may have influenced the findings. One final limitation is that there were some differences between participating schools and non-participating schools, and these differences suggest some caution is needed with regard to the generalizability of our findings.

This study identified factors that may have contributed to a reduction in transmission of pH1N1 in a school setting. We found that public schools were generally well prepared and that early and timely communication with parents and children, as well as minimizing the length of school days, may be effective in limiting the spread of disease among school children during the early phase of an influenza pandemic. Further research is needed to better identify and quantify the impact of NPIs that can mitigate the effect of an emerging influenza pandemic in school settings.

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