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Reactive School Closure During Increased Influenza-Like Illness (ILI) Activity in Western Kentucky, 2013: A Field Evaluation of Effect on ILI Incidence and Economic and Social Consequences for Families

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Background. School closures are an important mitigation strategy during influenza pandemic: if implemented early in a local outbreak, they can slow the disease spread in the surrounding community. During seasonal influenza epidemics, school closures may occur reactively, after the disease is already widespread in the community. Such reactive closures are often too late to reduce influenza transmission. However, they can provide data to determine under which circumstances they might be effective in reducing influenza-like illness (ILI) transmission.

Methods. We conducted a household survey in a school district in Kentucky. District A closed after high student absenteeism due to influenza-like illness (ILI), whereas adjacent Districts B and C remained open. We collected data on self-reported ILI among household members in these 3 districts 2 weeks before the District A closure, during closure, and 2 weeks after reopening, and we evaluated economic and social consequences of school closure on student households in District A. The difference-in-differences method was applied to compare changes in ILI rates from before to after closure between districts.

Results. Estimated average daily ILI rate decreased less in District A than in District B or C for the entire sample and when stratified by age groups (0–5 years old, 6–18 years old, and above 18 years old). Twenty-five percent of District A households reported ≥1 closure-related economic or social difficulty.

Conclusions. Closing schools after a widespread ILI activity in District A did not reduce ILI transmission but caused difficulties for some households.

Keywords. influenza; schools; school closure; school dismissal.

Children shed more virus and have the highest influenza attack rates, compared with other age groups [1–3]. Because of these biological factors and the congregation that occurs in schools, it is recognized that schools can serve as amplification points of influenza transmission in communities [4]. This is why school closures are an important mitigation strategy during influenza pandemic: when implemented preemptively, ie, before the transmission of pandemic influenza is widespread within the school system or the broader community, school closures can slow influenza transmission until appropriate vaccines and antivirals become available [5]. A range of effectiveness of preemptive school closures has been reported by retrospective studies of regional influenza epidemics [6–8], and modeled simulations of hypothetical pandemics [9–11] have suggested variable effects of school closures

for influenza transmission. The effectiveness of a closure depends on timing of the closure related to disease previously spread in the surrounding community [6, 12] and reductions in the congregation of children [6, 13]. Because preemptive school closures to reduce influenza transmission also entail a range of secondary consequences for schools, students, and their families, they are only recommended as a mitigation strategy for severe influenza pandemics [5]. During seasonal influenza epidemics, school closures are usually implemented in response to high absenteeism of students and/or staff after the disease is already widespread in the community, ie, they are reactive. Such reactive closures are often too late to reduce influenza transmission [12] and may not result in lowered social congregation among students [14]. Likewise, reactive school closures implemented during the fall wave of the 2009 influenza A (H1N1) pandemic were recently reported ineffective [15]. However, timing of reactive closures relative to the spread of local outbreaks may differ from situation to situation. Therefore, field investigations of the reactive closures can provide data to determine under which circumstances they might be effective in reducing influenza-like illness (ILI) transmission.

During the 2012–2013 academic year in the United States, influenza activity peaked in December. In western Kentucky,

influenza appeared to have peaked during the week ending December 8, 2012 [16]. Influenza A (H3N2) virus was predominant throughout the season [16]. Administration of a rural school district in western Kentucky, District A, made a decision to close schools for 4 work days (January 29–February 1, 2013) after substantial drop in student attendance was recorded: 61 (12%) of 524 students in the district stayed home or fell ill with ILI symptoms on Monday, January 28. District A reopened on February 4. We assessed effects of the school closure regarding ILI incidence among student households in District A, compared with 2 adjacent school districts, Districts B and C, that did not close, and determined the recongregation of students in District A during the closure. We also evaluated household difficulties as a consequence of the closure.

METHODS

Data Collection

Household Survey

During March 2013, we conducted a cross-sectional household survey in District A, where a school closure had been implemented, as well as in adjacent Districts B and C, where schools remained open. Teachers distributed paper surveys to all students and instructed students to bring the surveys home to be completed by a parent or guardian and to return completed surveys to the teacher within 1 week. In addition, all households received an automated telephone call from their school district notifying them of the survey and encouraging their participation. Only 1 survey per household was requested even if household had multiple children enrolled in the school district. Names were not recorded on the surveys, and duplicate surveys were identified and removed if school, ages, and genders of adults and children were identical.

In all 3 school districts, the survey collected demographic data and documented history of ILI symptoms for each household member during the 2 weeks before the school closure in District A (January 14–28), during the closure (January 29–February 1), and during the 2 weeks after schools in District A reopened (February 4–17; data on 2 weekend days after school closure [February 2–3] were included in this time period). Influenza-like illness was defined as self-perceived fever with a cough or sore throat.

In addition, in District A, the survey included questions about perception of difficulties related to the school closure, child care arrangements, adult employment and income interruptions, missed subsidized school meals during the closure, and estimated additional costs incurred for child care. To evaluate recongregation patterns during the school closure, we inquired about (1) places that each child in household who attends K–12 school visited and (2) activities that he/she participated in while schools in District A were closed.

The study was approved by the institutional review board of the Kentucky Department for Public Health; it was also reviewed by the Centers for Disease Control and Prevention for human subject protection and determined to be nonresearch.

Study Population

At the time of the survey, District A enrolled 524 students in elementary or middle (pre-kindergarten [PK]–8th grade) and high (9th–12th grade) schools located in the same building [17]. All students were eligible for free or reduced price school lunches as part of the subsidized school meal program.

District B is located in the same county as District A and at the time of the survey enrolled 425 students in elementary (PK–5th grade) and middle or high (6th–12th grades) schools located in the same building; all students were eligible for free school lunches [17]. During 2010, the county where Districts A and B are located had a population of 6813 with a median annual household income $34 545, and 39% of families with children aged <18 years were living below the federal poverty level [18]. Approximately 73% of the county population was white and 24% was black. Seventy-nine percent had at least a high school diploma and the average household size was 2.7 persons [18].

District C is located in the county adjacent to Districts A and B and enrolls 810 students in elementary or middle (PK–6th grade) and high (7th–12th grade) schools, with elementary and middle school located in the same building and high school in a separate building; 67% of students were eligible for the subsidized school lunch program [17]. The county population during 2010 for District C was 4902 persons, with a median annual household income of $37 535, and 21% of families with children aged <18 years living below the federal poverty level. Eighty-eight percent of the county population self-identified as white and 6% as black, with an average of 3.2 persons per family. Seventy-eight percent had at least high school diplomas [18].

Community Influenza-Like Illness

We requested Kentucky Medicaid Services data to evaluate community ILI rates during the months adjoining the closure. Kentucky Medicaid Services provided data regarding billing claims related to ILI for enrollees with billing addresses located in zip codes assigned to school Districts A, B, and C during January 1–February 28, 2013. *International Classification of Disease, Ninth Revision* codes related to ILI (eg, acute respiratory illness, acute tonsillitis, acute nasopharyngitis, and influenza) were queried as follows: 460.0, 462.9, 463, 463.9, 464, 464.1, 464.11, 464.2, 464.21, 465, 465.9, 475, 478.9, 487.0, and 487.1.

Data Management and Analysis

Household survey data were entered into a Microsoft Access 2010 database (Microsoft Corporation, Redmond, WA); data were double-entered for quality control. Medicaid and school attendance data were received and cleaned in Microsoft Excel (Microsoft Corporation). All statistical analyses were performed by using SAS 9.3 (SAS Institute Inc., Cary, NC); an alpha level of 0.05 was used to assess statistical significance for all analyses.

We used data on self-reported ILI obtained from surveys to calculate average daily ILI rates for all 3 school districts to adjust for 3 different time periods: before school closure (January 14–28), during closure (January 29–February 1), and after school reopening (February 4–17, including weekend after the closure [February 2–3]) in District A. We conducted pairwise comparison for school District A vs B, A vs C with the null hypothesis of equal average daily ILI rate for a given time period. To assess the impact of school closure on rate of self-reported ILI, we applied difference-in-differences (DiD) method [8] with formula described below:

$$DiD = (ILI_{District\ A\ before} - ILI_{District\ A\ after})$$
$$- (ILI_{District\ B\ or\ C\ before} - ILI_{District\ B\ or\ C\ after})$$

Difference-in-differences measured difference between the changes in daily ILI rate from time period before school closure to after school reopening in District A (first parenthesis) and Districts B or C that remained open (second parenthesis). We applied Wald test to examine whether this difference in changes equals zero. All of the pairwise comparisons and DiD analyses were conducted for overall sample and by age groups (0–5 years old, 6–18 years old, and above 18 years old).

To calculate rates of community ILI, we analyzed data from healthcare visits billed to Kentucky Medicaid Services. A personally unidentifiable identification number was used to clean the data such that each person would count as an ILI observation only once during a 7-day period (eliminating or reducing the multiple billing codes returned for a single visit or illness). The resulting visits were summed by date and divided by the total number of plan-eligible participants in each district to create an average daily rate of ILI. Seven-day rolling averages are presented to smooth the data created by limited sample sizes and fewer clinic visits on weekends.

Evaluation of Economic and Social Consequences, and Student Recongregation in the School District A

For household economic and social difficulties, we calculated descriptive statistics for alternative child care options, adults missing work or reduced income, and loss of free or reduced price school lunches. Recongregation was defined as visiting a location outside of home (eg, grocery store or restaurant) or visiting with >1 nonhousehold member during the school closure. Recongregation data was summarized by age for District A. We used linear regression to assess the association among the number of recongregation activities and student's age.

RESULTS

We distributed 1759 survey questionnaires to an estimated 296 households in District A, 241 estimated households in District B, and 384 estimated households in District C. Of them, 321 questionnaires were completed and returned as follows: 99 (33%) households in District A, 96 (39%) households in District B, and 126 (33%) households in District C. Table 1 summarizes

primary demographic characteristics of respondent households by school district.

A total of 115 ILI cases were reported through the household survey in District A and 392 in Districts B and C combined. In District A, 53 (54%) households reported ≥1 ILI episode before, during, or after the school closure, compared with 64 (67%) and 77 (60%) in Districts B and C, respectively. The average daily rate of illness was higher among school-aged children than adults in all districts during all 3 periods (Table 2). Compared with the 2 weeks before closure, the average daily rate of ILI

Table 1. Characteristics of Survey Respondents and Responding Households in 3 School Districts in Western Kentucky, March 2013

Characteristics of Survey Respondents and Responding Households	District A	District B	District C
January 29–February 1 School Status	Closed	Open	Open
Number of Responding Households	n = 99	n = 96	n = 129
Annual household income,[a] n (%)			
<$25 000	45 (45)	52 (54)	34 (26)
$25 000–$49 999	24 (24)	15 (16)	31 (24)
$50 000–$74 999	7 (7)	3 (3)	19 (15)
≥$75 000	11 (11)	2 (2)	15 (12)
No answer	12 (12)	24 (25)	30 (23)
Education level of primary survey respondent,[a] n (%)			
Grades 1–11	10 (10)	8 (8)	15 (12)
High school graduate	42 (42)	39 (41)	25 (19)
1–3 y of college	26 (26)	31 (32)	36 (28)
College graduate or graduate school	18 (18)	12 (12)	45 (35)
No answer	3 (3)	6 (6)	8 (6)
Race of primary survey respondent,[a] n (%)			
White, non-Hispanic	64 (65)	46 (48)	114 (88)
Black, non-Hispanic	30 (30)	44 (46)	8 (6)
Hispanic	0	0	1 (1)
Multiple races	4 (4)	2 (2)	5 (4)
No answer	1 (1)	4 (4)	1 (1)
Number of children per household,[a] n (%)			
1	37 (37)	36 (38)	32 (25)
2	35 (35)	42 (44)	50 (39)
≥3	27 (27)	17 (18)	47 (36)
No answer	0 (0)	1 (1)	0 (0)
Number of adults per household,[a] n (%)			
1	27 (27)	30 (31)	18 (14)
2	63 (64)	52 (54)	100 (78)
≥3	7 (7)	13 (14)	10 (8)
No answer	2 (2)	1 (1)	1 (1)
Number of People in Responding Households	n = 371	n = 364	n = 550
Household member age[b] distribution, n (%)			
0–5 y	44 (12)	20 (5)	53 (10)
6–14 y	132 (36)	124 (34)	202 (37)
15–18 y	27 (7)	46 (13)	44 (8)
≥19 y	168 (45)	174 (48)	251 (46)

[a] The denominator for percentage calculations is the number of responding households.
[b] Child's age is determined based on school grade level as follows: Head Start, 3 years old; Pre-Kindergarten, 4 years old; Kindergarten, 5 years old; 1st grade, 6 years old; 2nd grade, 7 years old; 3rd grade, 8 years old; 4th grade, 9 years old; 5th grade, 10 years old; 6th grade, 11 years old; 7th grade, 12 years old; 8th grade, 13 years old; 9th grade, 14 years old; 10th grade, 15 years old; 11th grade, 16 years old; 12th grade, 17–18 years old.

Table 2. Average Daily ILI Rates From Self-Reports in School Districts A, B, and C Before School Closure, During Closure, and After School Reopened[a]

ILI	Before Closure January 14–28					During Closure January 29–February 1					After Closure February 2–16					DiD[d], A vs B, Before to After School Closures	P Value[b]	DiD[c], A vs C, Before to After School Closures	P Value[b]
	District A	District B	District C	P Value[b], A vs B	P Value[b], A vs C	District A	District B	District C	P Value[b], A vs B	P Value[b], A vs C	District A	District B	District C	P Value[b], A vs B	P Value[b], A vs C				
All Ages[c]	1.00%	1.51%	1.43%	.535	.562	3.62%	3.70%	3.75%	.95	.92	0.68%	0.95%	0.90%	.682	.711	−0.24%	.624	−0.21%	.638
0–5 y	1.83%	3.81%	2.16%	.674	.92	7.50%	8.93%	4.06%	.87	.52	1.17%	0.95%	1.26%	.944	.968	−2.19%	.522	−0.23%	.912
6–18 y	1.20%	1.89%	1.94%	.617	.569	4.35%	4.37%	4.00%	.99	.87	0.79%	1.20%	1.07%	.711	.779	−0.27%	.741	−0.46%	.582
19+ y	0.67%	1.02%	0.84%	.401	.849	2.22%	2.80%	3.57%	.73	.43	0.51%	0.75%	0.68%	.779	.826	−0.12%	.826	−0.01%	>.999

Abbreviations: DiD, difference in differences; ILI, influenza-like illness.

[a] Difference-in-differences (DiD) analysis for average daily ILI rate in school District A vs school Districts B and C from before school closure in District A to after school reopened.

[b] P values of pairwise comparison and DiD analysis were calculated by Wald test.

[c] Unless specified, child's age is determined based on school grade level as follows: Pre-Kindergarten, 4 years old; Kindergarten, 5 years old; 1st grade, 6 years old; 2nd grade, 7 years old; 3rd grade, 8 years old; 4th grade, 9 years old; 5th grade, 10 years old; 6th grade, 11 years old; 7th grade, 12 years old; 8th grade, 13 years old; 9th grade, 14 years old; 10th grade, 15 years old; 11th grade, 16 years old; 12th grade, 17–18 years old.

[d] Difference in differences were calculated based on average ILI daily rate using formula below:

$$DiD = (ILI_{District\ A\ before} - ILI_{District\ A\ after}) - (ILI_{District\ B\ or\ C\ before} - ILI_{District\ B\ or\ C\ after}).$$

during the 2 weeks after the closure was 0.32% lower in District A, 0.56% lower in District B, and 0.53% lower in District C. The DiD was −0.24% (P = .624) and −0.21% (P = .638), which is not a statistically significant difference in decrease of daily ILI rates from before to after the school closure in District A compared with Districts B and C, respectively (Table 2).

Using claims from Kentucky Medicaid Services, the 7-day rolling average ILI rate in District B peaked approximately 5 days before the District A community. The District C community had multiple limited ILI rate peaks during early January rather than 1 distinct peak (Figure 1).

Evaluation of Economic and Social Consequences, and Student Recongregation in the District A

Twenty-five percent of households in District A reported experiencing a difficulty related to the school closure (Table 3). Making alternative child care arrangements, students missing meals because of lost access to subsidized school lunches, and reduced income from missed work were the most frequently reported reasons for these difficulties. Child care during the school closure was most frequently provided by an adult who lives in the household, including 41 (41%) by a nonworking adult and 20 (20%) by an adult who works outside the home (Table 3). Among 95 households that provided adult employment information, ≥1 adult worked outside the home in 75 (79%) households and all adults worked outside the home in 44 (46%) households (Table 3). Eight (10%) of 79 households indicated that the lost access to the free school lunch program during the school closure was difficult.

Recongregation of children in District A households during this 4-day school closure was reported for 197 children of all ages. Forty-six (23%) children reported no recongregation activities (ie, they did not go outside the home or visit with >1 nonhousehold member). Children who recongregated participated in a mean of 2 activities (interquartile range, 1–4), including going to a mall or department store (107, 54%), going to the grocery store (100, 51%), attending religious services (64, 32%), visiting family (64, 32%), and going to restaurants or sports activities (48, 24%). Older age was associated with more activities (P = .002) (Figure 2).

DISCUSSION

Although coordinated preemptive school closures remain a key community mitigation strategy in response to severe influenza pandemics [5], school closures implemented reactively, in response to high student absenteeism after the disease is widespread in the community, will have limited or no effect on disease transmission. In our study, we found that reduction in ILI daily rates from before to after the 4-day school closure in District A was not significantly different from the reduction in adjacent school Districts B and C that did not close during the same periods. District A closed schools after high student
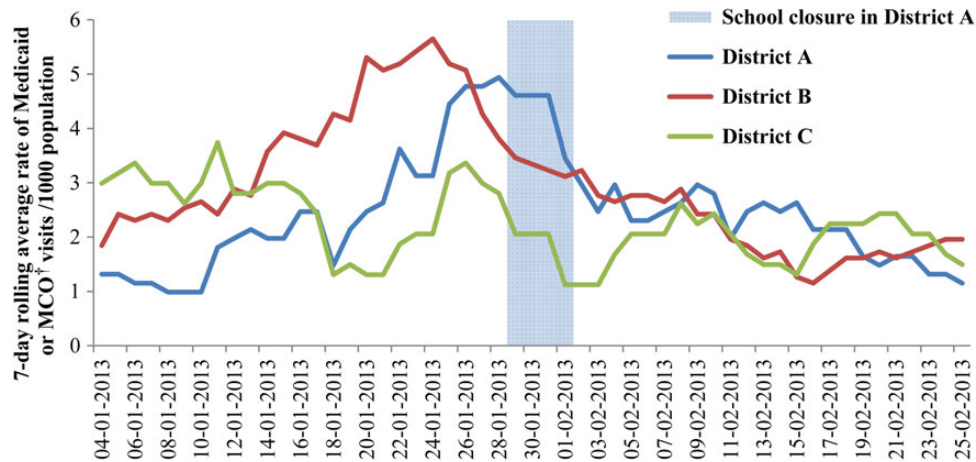
Figure 1. Daily influenza-like illness rates by school district, Kentucky, January–February 2013. Data are from the Kentucky Department of Medicaid Services for enrollees from zip codes of School Districts A, B, and C. Enrollees with influenza-like illness were identified by using the *International Classification of Disease, Ninth Revision* codes as follows: 460.0, 462.9, 463, 463.9, 464, 464.1, 464.11, 464.2, 464.21, 465, 465.9, 475, 478.9, 487.0, and 487.1. †Managed care organization (MCO).

absenteeism (12% of the students reported ill on a day before the school closure), and Medicaid billing data indicated that ILI activity was already peaking in the community when schools closed. Influenza-like illness activity in Districts B and C peaked several days before District A; thus, the 2 weeks before the closure were the height of ILI in all 3 school districts.

Our findings are consistent with multiple studies that demonstrate that school closures implemented too late in the epidemic are inefficient in reducing influenza attack rates [19, 20]. In contrast, it was suggested in modeling studies [8–10], as well as demonstrated in observational studies [4, 8, 20, 21], that closing schools earlier in the epidemic, before influenza transmission is widespread in the community (ie, preemptively), can effectively reduce influenza and ILI transmission in surrounding communities. Hence, preemptive, coordinated school closures can be recommended as a mitigation strategy to slow down transmission of influenza in communities during an influenza pandemic [5]. However, optimal timing of these preemptive closures relative to the level of influenza activity in schools and communities remains unclear. Some modeling studies suggest that delaying to close schools until a certain number of influenza cases is reached in a community may be most effective [22]. Although that is attractive from the standpoint of minimizing secondary consequences of school closures for students and families, in practice it may be difficult to achieve because it depends on timely recognition and diagnosis of influenza in the community in an early stage of local outbreak, which may not be feasible given intricacies related to influenza surveillance [23]. As shown by our study, however, waiting too long to close schools is unlikely to have an effect on the disease transmission. In addition, although optimum timing of school closure may depend on its duration, according

to modeling studies, very late closures (like the one in our study) were consistently found to be relatively ineffective [24].

Although schools are closed, children may recongregate in other, nonschool, settings. Such recongregation may undermine school closure effort. Previous studies have reported 89% of students participated in a public outing during school closures [25]; 1 study in eastern Kentucky reported a high frequency of student outings to strip malls or Walmart (43%), visit family (43%), grocery shopping (39%), restaurants (33%), visit friends (30%), religious (29%), sports (24%), and public gatherings (18%) [26]. In our study, 77% of children participated in recongregation activities while schools were closed. Although schools in the District A community were closed reactively, in preemptive school closures recongregation can reduce the desired effect of closures for disease transmission [6, 27].

School closures may cause substantial difficulties to households, including difficulty providing food because of disruption of access to the US Department of Agriculture National School Lunch Program and School Breakfast Program [28, 29] and difficulties arranging for alternative child care [29]. We found that approximately one quarter of households with students experienced difficulties during this unplanned school closure in District A. Making child care arrangements and loss of access to the school lunch program were the most common difficulties reported during unplanned school closings in this study, similar to previous studies [25, 26]. Similar to previous surveys, child care provided by nonworking adult was the most frequently reported choice [30]. However, twice as many households reported a problem with providing food in our study compared with a previous study in eastern Kentucky [25]. Thus, reactive school closures during an ongoing influenza outbreak are not only unlikely to help reduce spread of influenza in the communities, but they also pose a socioeconomic burden on student families.

Table 3. Costs and Consequences of School Closure for Household in School District A, Kentucky, 2013

Reported Difficulties and Arrangements	Households (n = 99) No. (%)
Perception of difficulty of school closure	
Not difficult	74 (75)
Difficult	25 (25)
Reasons for difficulty	
Making child care arrangements	13 (13)
Student missed school meals	5 (5)
Reduced income because missed work	4 (4)
Expense of child care arrangements	3 (3)
Unsure of length of closure	3 (3)
Respondent perception of difficulty of hypothetical 1 month school closure (n = 97)	
Major difficulty	3 (3)
Medium difficulty	4 (4)
Minor difficulty	10 (10)
Not a problem	67 (69)
Unsure	13 (13)
Child care arrangements (multiple selections permitted)	
Adult who does not work who lives in home	41 (41)
Adult who lives in home and works outside the home	20 (20)
Other adult	20 (20)
Child old enough to care for themselves	8 (8)
Older sibling aged >18 y	7 (7)
Adult who lives in the home and works from home	4 (4)
Child care program	1 (1)
Household incurred additional child care expenses	16 (16)
Median expenses $100 (range, $31–$150)[a]	
Household employment characteristics and impact	
Any adult works outside the home	75 (79)
All adults work outside the home	44 (45)
Any adult missed work during closure	16 (18)
Any adult with reduced income during closure	10 (10)
Difficulty providing food because of lost access to subsidized school meals (n = 79)	
Difficult	8 (10)
Not difficult	71 (90)

[a] Based on data from 9 households that reported a specific dollar amount.

Figure 2. Children reporting ≥1 recongregation activity during school closure by age group in District A—Kentucky, March 2013. Recongregation was defined as having >1 person visit the home or visiting a location outside of the home (eg, grocery store or restaurant).

Therefore, it is important that schools and public health authorities plan ahead for school closures that may occur due to local outbreaks of seasonal or pandemic influenza or other emergencies. These plans might consider pre-established communication and collaboration between schools and community organizations to identify alternative sources for meals (such as prepacked sack lunches) as well as safe, low-cost, child care options (such as small group day care) that prevent recongregation of students in other settings while schools are closed.

Results of this study are subject to several limitations. First, because surveys were distributed approximately 6 weeks after the closure, recall bias might have influenced responses, with a possible different effect in District A than Districts B and C, given the school closure as a milestone. Second, household survey response rates were relatively low, al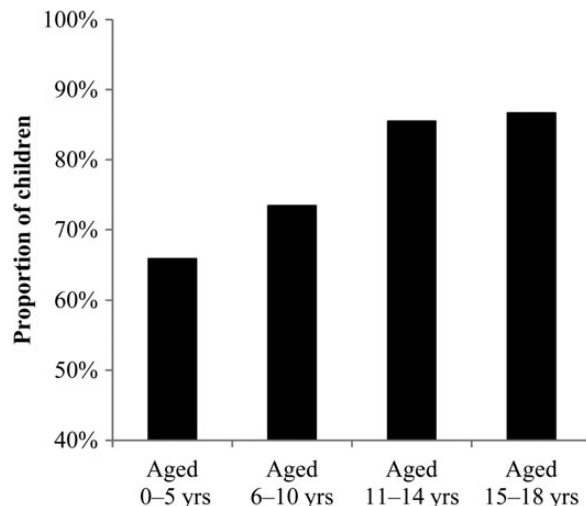though they were similar to those of previously conducted school-based surveys [14, 25]. This low response rate may have caused a bias in ascertaining ILI incidence in households in all 3 districts. Although it is not possible to determine how participating households may have differed with regard to ILI incidence from those that did not respond to the survey, the Medicaid billing data were analyzed for all 3 districts to provide insights about community-wide ILI activity before, during, and after school closures in District A and in comparison Districts B and C that did not close schools. Third, the outcome measure was based on self-reported ILI and not on laboratory-confirmed influenza, which may undermine accuracy of ILI daily rates. However, this bias is likely universal in all 3 school districts. Finally, to facilitate a streamlined survey, both the self-reported ILI data and the data about difficulties were collected for the days of unplanned school closure only. Influenza-like illness data for the weekend after school closure was collected as a part of the period after school closure because we viewed weekend as a planned school closure rather than unplanned. This may bias estimation of ILI rates in each of the investigated periods with direction of the bias depending on actual ILI activity in the area and where on epidemic curve school closure was implemented. In an ideal setting, if the daily ILI data were collected for each of the study periods (before the school closure, during the closure, and after the school reopened) across all 3 school districts, we would be able to conduct sensitivity analysis of whether including these 2 weekend days in the period during rather than after school closure would change our results. However, because the study was conducted 6 weeks after the school closure, in an effort to reduce the recall bias, we only requested to report summary ILI that occurred within each of the study periods rather than for each day separately. In addition, the DiD estimator removes

some bias in comparison over time between the school closure district and control districts that could be the result of previously existing differences between them [8]. We did not evaluate the use of other influenza mitigating measures in any of these school districts.

CONCLUSIONS

In conclusion, our evaluation of reactive school closures implemented in a western Kentucky school district in response to high ILI-related student absenteeism during the 2012–2013 influenza season did not find that closing schools reduced ILI transmission in the community in comparison to communities around adjacent school districts that did not close. Further research into seasonal influenza/ILI transmission in schools, patterns of influenza-/ILI-associated student absenteeism, and their comparisons with influenza/ILI activity in surrounding community may help provide new insights into optimal timing to close schools during an evolving influenza pandemic before virus transmission in schools and surrounding communities becomes widespread.

Reactive school closures such as the one we report about here occur not only during outbreaks of seasonal influenza but also in conjunction with influenza pandemics. During the 2009 H1N1 influenza pandemic, 1947 schools closed between August 3, 2009 and December 18, 2009, at least in part, due to ILI [31]. These closures affected 623 616 students and 40 521 teachers, and a total of 1 565 321 student-days of school were lost [31]. Therefore, it is important to recognize that despite the lack of effect on slowing or reducing influenza/ILI transmission in communities, reactive school closures will most certainly cause difficulties to families. The costs should be weighed against the benefits, and if schools are closed plans should be developed to help address secondary consequences of closures for students and their families with regard to continued learning options, alternative arrangements for child care, and alternative supplemental food options in the absence of the school-based lunch programs. Further evaluation and economic analysis of costs and consequences of school closures, regardless of whether they were implemented reactively or preemptively, is needed to provide necessary evidence base for prepandemic planning.

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