RESEARCH ARTICLE

Impact of an Education Intervention on Missouri K-12 School Disaster and Biological Event Preparedness

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ABSTRACT

BACKGROUND: A 2011 nationwide school pandemic preparedness study found schools to be deficient. We examined the impact of a school nurse educational intervention aimed at improving K-12 school biological event preparedness.

METHODS: Missouri Association of School Nurses (MASN) members were e-mailed a survey link in fall 2013 (ie, preintervention), links to online education modules (ie, intervention) in late fall, and a postintervention survey link in spring, 2014. School biological event readiness was measured using 35 indicators, for a possible score range of 0-35. A paired *t*-test compared pre- to postintervention preparedness scores.

RESULTS: A total of 133 school nurses (33.6% response rate) completed a survey; 35.3% of those (*N* = 47) completed both pre- and postintervention survey that could be matched. Pre- and postintervention preparedness scores ranged from 5 to 28.5 ($\bar{x}$ = 13.3) and 6.5 to 25 ($\bar{x}$ = 14.8), respectively. Postintervention scores were significantly higher than preintervention scores for those who watched at least 1 module (*t* = -2.3, *p* < .05).

CONCLUSION: The education intervention was effective at improving school preparedness, though the impact was small. The education intervention needs to be reassessed, especially in regard to providing a longer intervention period.

Keywords: disaster preparedness; school nurses; terrorism; pandemic; influenza.

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Each year, approximately 49.8 million students attend public elementary and secondary schools, and 5 million students attend private schools.¹ Kindergarten to 12th grade (K-12) schools across the United States are charged with the task of educating students in a safe and healthy environment, and therefore, are expected to be prepared for any type of disaster.^{2,3} However, research indicates that most K-12 schools lack disaster preparedness, especially for biological events, such as bioterrorism, outbreaks of emerging infectious diseases, and pandemics.^{4,5}

A 2011 study reported that schools had fewer than half of the assessed pandemic preparedness indicators.⁴ For instance, serious pandemic planning gaps were identified, such as failure to address pandemics in school disaster plans, to stockpile medication and personal protective equipment (PPE), and to incorporate infectious disease scenarios into school disaster drills.⁴ Few researchers have examined school disaster preparedness since, with the exception of studies focusing on the impact of the H1N1 influenza pandemic.^{6,7} One study found planning for

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school closures due to pandemics was insufficient and recommended specific actions, such as deciding on thresholds for closure, on methodologies for distance-based education, and on materials for communicating with parents, staff, and the media.⁷ A second study examined strategies for implementing a school-based vaccination program during pandemics.⁶ It was found that school-based vaccine clinics strengthened the relationship between local health departments and schools. Though this was not specifically addressed, this partnership between public health and schools could lead to better school preparedness for future events.⁶

Taken together, this information suggests that interventions are needed to increase school readiness. One viable option is to train school nurses to improve preparedness in this environment. The purpose of this study was to examine the impact of an educational intervention for school nurses aimed at improving school preparedness for biological events. We hypothesized that this type of intervention would increase school preparedness scores. Another goal of this project was to examine school readiness for biological events other than pandemics, including bioterrorism and outbreaks of emerging pathogens, such as Ebola or Middle East respiratory syndrome coronavirus (MERS Co-V).

METHODS

Participants

Participants included school nurses belonging to the Missouri Association of School Nurses (MASN) during the 2013-2014 school year. A total of 133 school nurses (33.6% response rate) completed a pre-intervention survey, postintervention survey, or both. About one third (35.3%, $N=47$) completed both a pre- and postintervention survey that could be matched; this subsample ($N=47$) was used to assess the intervention's effectiveness.

Instrumentation

Data on school preparedness for natural disasters and biological events was collected using a 72-item questionnaire. The questionnaire was developed based on the instrument used in the 2011 school preparedness study,⁴ though it was greatly expanded to provide a more comprehensive analysis of school readiness. The original questionnaire consisted of 17 school biological event preparedness indicators. We added 18 new items by incorporating standards outlined in recent Federal Emergency Management Agency (FEMA)⁸ and US Department of Agriculture (USDA)⁹ planning documents. Most additions focused on school culture and policies related to infectious disease management, food biosecurity plans, and the

incorporation of psychological needs into the school plan. The instrument included 15 questions related to all-hazards school disaster preparedness and 35 measured biological event preparedness (13 of the disaster preparedness indicators plus 22 unique to infectious diseases). Twenty-nine of the 35 biological event preparedness indicators were dichotomous and scored either 0 or 1 point, depending on whether the school met the criteria or not. Examples include having a written policy that encourages students to stay home when ill, having a designated sick room without pass through, and having a plan that addressed biological events (all scored as "yes" = 1 point; "no" = 0). Six of the 35 biological event preparedness indicators could be partially met and were assigned 1, 0.5, or 0 points, depending on the extent to which the school met the criteria. One example was the indicator "respiratory hygiene training for staff," which could be completely met (all staff trained: 1 point), partially met (some staff trained: 0.5 point), or not met at all (no staff trained: 0 points). Table 1 outlines the preparedness indicators and how each was measured or scored. Psychometric testing conducted on the instrument has been described previously in research utilizing the questionnaire.⁴

Procedure

We used a pre- and postintervention methodology to assess the effectiveness of an educational intervention on school emergency management plans at the start and end of the 2013-2014 school year. Missouri Association of School Nurses members were e-mailed a link to an online survey in the fall of 2013 (ie, pre-intervention), sent links to online education modules (ie, intervention) in late fall, 2013, and e-mailed a link to a second online survey in spring of 2014 (ie, postintervention). The online surveys were administered through Qualtrics® (an online survey platform). Follow-up recruitment e-mails were distributed 2 and 4 weeks after each initial e-mail to maximize response rates. Nurses were told that completion of the online survey(s) and/or intervention implied consent to participate in the study.

Intervention

The intervention consisted of a series of 6 online education modules. Module content was created and edited by the research team; content was developed based on standards and recommendations from multiple planning organizations, including the National Association of School Nurses (NASN), the US Centers for Disease Control and Prevention (CDC), FEMA, and USDA. Planning documents used to develop intervention content included NASN's Disaster Preparedness Guidelines for School Nurses,¹⁰ CDC's Bioterrorism & Emergency Preparedness Competencies,¹¹ and the

Table 1. Pre- Versus Postintervention General and Biological Event Preparedness Scores

	Those Who Completed Both a Pre- and Postintervention Survey N = 47			Those Who Completed Both a Pre- and Postintervention Survey N = 47		
	Preintervention Score Mean (SD)	Postintervention Score Mean (SD)	Pre- vs Post [†]	Preintervention Score Mean (SD)	Postintervention Score Mean (SD)	Pre vs Post [†]
General preparedness	6.4 (2.4)	6.3 (2.7)	NS	Modules watched		
Biological event preparedness	13.3 (4.2)	14.8 (4.6)	2.9**	None N = 19	13.2 (3.6)	14.7 (4.7) NS
				≥1 N = 28	13.3 (4.6)	14.9 (4.6) -2.3*

*p < .05, **p < .01.

SD, standard deviation; NS, nonsignificant.

[†]Determined by the paired *t*-test.

USDA's Biosecurity Checklist for School Foodservice Programs.⁹

Content for the 6 modules consisted of the following modules: (1) an introduction to bioterrorism, pandemic, and infectious disease preparedness for schools (description of the epidemiology and threat of infectious diseases and importance of school biological event preparedness); (2 and 3) components of a school disaster plan (role of school nurses in disaster planning, staff and student disaster planning training needs, disaster supplies needed by schools, mental health needs related to disasters, infection prevention in school settings, etc); (4) syndromic surveillance—school and public health partnerships (definition and description of syndromic surveillance, syndromic surveillance indicators schools may collect/report, how syndromic surveillance data is used by public health officials, and how the data may be used internally by school officials to quickly identify an event); (5) partnering with regional agencies, disaster exercises, and legal issues (importance of disaster exercises involving an infectious disease scenario, impact on school plans from coordination with local response partners, and public health laws to protect workers during disasters); and (6) case studies of successful school disaster preparedness programs (interviews with school nurses actively involved in their school disaster planning committee, best practices learned through work experience, and discussion of perceived advantages to being involved in disaster planning). Each module lasted approximately 20 minutes, and could be paused, fast-forwarded or rewound at any time. Nurse participation in any or all of the modules was optional. Module participation was measured through self-report.

Data Analysis

All analyses were conducted using Statistical Package for the Social Sciences (SPSS®) 21.0. Two primary outcome measures were assessed: (1) school

disaster preparedness (15 indicators, each scored 0-1 point); and (2) biological event readiness (35 indicators, each scored 0-1 point). School disaster and biological event preparedness scores could range from 0 to 15 or 0 to 35, respectively. McNemar tests were conducted as univariate analysis to compare pre- to postintervention changes in the percentage of schools reporting each of the preparedness indicators. A paired *t*-test compared pre- to postintervention preparedness scores. Chi-square tests were conducted to compare stockpiling across schools with versus without on-site health care coverage. An independent samples *t*-test was conducted to compare public versus private schools in terms of the number of drills conducted annually. A critical *p*-value of .05 was used for all analyses.

RESULTS

Almost all participants were women (99.2%, N = 132) and white (95.5%, N = 127). Almost half (48.9%, N = 65) were 51-60 years old, and another 23.3% (N = 31) were aged 41-50. Overall, 39.1% (N = 52) had a bachelor's degree and another 22.6% (N = 30) had an associate's degree. Only 1 was a nurse practitioner (0.8%). Nurse respondents were almost equally divided between being a school nurse (those who do not have administrative authority over other nurses; 58.6%, N = 78) versus a lead nurse (those who have administrative authority over other nurses; 41.4%, N = 55). A majority (51.9%, N = 69) were on their school disaster planning committee. Most (63.2%, N = 84) cover 1 school, though some cover multiple schools (range: 1-17). Many schools (42.9%, N = 57) were large (501 or more students); 24.8% (N = 33) were small (300 or fewer). School representation spanned all K-12 levels, with 49.2% (N = 65) elementary, 22.7% (N = 30) middle, and 28.0% (N = 37) high school. The vast majority (94.7%, N = 126) were public schools; their locations included suburban (45.6%, N = 61), rural (41.4%, N = 55), and urban (12.8%, N = 17).

School Preparedness Intervention

The intervention consisted of online education modules related to school disaster planning. Nurse participants were e-mailed links to the modules approximately 1 month after they completed the fall, 2013 preintervention survey. A link to a second (postintervention) online survey was e-mailed at the end of that school year in spring 2014. Only nurses who completed an end-of-the-school year survey ($N=81$) were asked about education module participation, because the modules were not released until after data were collected at the beginning of the school year. Of the nurses who completed a postintervention questionnaire ($N=81$), just under half (45.7%, $N=37$) watched at least 1 module; 54.3% ($N=44$) did not watch any. Of those who watched at least 1 module ($N=37$), the mean number of modules watched was 4, with a range of 1-6. About 24.3% ($N=9$) of those who watched at least 1 module only watched 1 module; 48.6% ($N=18$) watched all 6. The most frequently watched modules included the first 2 and last modules (ie, 75.7%, 73%, and 83.8%: introduction to planning, components of a school plan, and case studies of successful programs, respectively). Similar to the overall demographics of the study, approximately half of the nurses who watched at least 1 module indicated that they were a member of their school disaster planning committee (54.1%, $N=20$).

Nurses who watched at least 1 module ($N=37$) were asked 3 perception questions about the modules: (1) if they perceived them to be useful; (2) if they perceived them to be interesting; and (3) if they were able to use information in the module to prepare their school better. Approximately 78.4% ($N=29$) reported that the module(s) were useful and interesting. Just under half (45.9%, $N=17$) indicated that they were able to apply module information to improve their school plan. Nurses were significantly more likely to report that the modules were useful than able to be integrated into plans ($\chi^2=4.6$, $p<.05$).

The intervention impact was assessed using data from the school nurses who completed both a pre- and postintervention survey ($N=47$). Preintervention school general preparedness scores ranged from 0 to 14, with a mean score of 6.4. Postintervention general preparedness scores ranged from 2 to 12.5, with a mean score of 6.3 (Table 1). Preintervention biological event preparedness scores ranged from 5 to 28.5 points, with a mean score of 13.3. Postintervention biological event preparedness scores ranged from 6.5 to 25, with a mean score of 14.8 (Table 1). There was no significant change in general preparedness scores from beginning to end of year (ie, pre- vs postintervention), but postintervention biological event preparedness scores were significantly higher than preintervention scores ($t=-2.9$, $p<.01$; Table 1). Furthermore, there was no significant change in

biological event preparedness scores for those who did not watch any of the education modules, but postintervention biological event preparedness scores were significantly higher than preintervention scores for those who watched at least 1 module ($t=-2.3$, $p<.05$; Table 1). The mean change in score from pre- to postintervention for the nurses who completed both surveys ($N=47$) was 1.5. There was no dose response in regards to the intervention; preparedness score increases were not associated with the number of modules watched or with participation in any particular module.

Table 2 outlines the frequency with which schools reported having each of the preparedness indicators in the pre- and postintervention time period for the 47 nurses who completed both a beginning and end-of-year survey. On univariate analyses, 2 biological event preparedness indicators increased significantly from pre- to postintervention: (1) reporting syndromic surveillance data ($p<.001$); and (2) having a PPE stockpile or memorandum of agreement (MOA) to obtain supplies postevent ($p<.05$). In addition, 2 preparedness indicators decreased significantly from pre- to postintervention: (1) conducting a fire drill monthly ($p<.05$); and (2) having a written policy that encourages sick employees to stay home ($p=.01$).

School and Nurse Participation in Exercises and Drills

Nurses were asked about participation in 8 types of school drills—fire, earthquake, tornado, interior lockdown, exterior lockdown, shelter in place, infectious disease, and bus evacuation. One point was given for each type of drill conducted at least once per year, for a possible score range of 0-8. All nurses reported that their school conducted at least 1 exercise per school year, and almost all (94%, $N=125$) conducted an interior lockdown exercise annually. However, less than one third (30.8%, $n=41$) reported meeting the Missouri standard that the school conduct a fire drill at least once per month. The type and frequency of drill participation is outlined in Table 3. Public schools conducted significantly more types of drills annually compared with private schools (5.7 vs 4.1 annual average, $t=3.3$, $p=.001$). There were no other significant differences between school demographics and the number of drills conducted annually. Nurse participants also were asked whether their school had participated in a regional exercise in the last 2 years; just under one fourth (24.1%, $N=32$) had done so. Only 5.3% ($N=7$) had used an infectious disease scenario in a school drill in the last year (Table 3), and only 3.8% ($N=5$) planned to use one in an exercise in the next 2 years.

Nurse participation in school disaster exercises was high. They reported participating in 2-8 types of drills annually, with a mean of 5.6 types conducted each

Table 2. School Preparedness Indicators for Biological and Nonbiological Events at the Beginning and End of the 2013-2014 School Year*

	Fall 2013 N = 47 Has Component % (n)	Spring 2014 N = 47 Has Component % (n)
Preparedness indicator for nonbiological event		
Conducted at least 1 exercise during school year [†]	97.9 (46)	100 (47)
Conducted an interior lockdown exercise in last year [†]	97.9 (46)	95.7 (45)
Conducted fire drill at least once a month [†]	36.2 (17)	21.3 (10)
Preparedness indicator for biological event		
Nurse offered seasonal influenza vaccine [†]	97.9 (46)	87.2 (41)
Written policy that encourages sick students to stay home [†]	85.1 (40)	85.1 (40)
Perfect attendance award for students [†]	83.0 (39)	87.2 (41)
School collects syndromic surveillance data [†]	80.9 (38)	89.4 (42)
Students provided infection prevention training at least once per year [†]	76.6 (36)	74.5 (35)
Written policy that encourages sick employees to stay home [†]	59.6 (28)	48.9 (23)
Number of staff provided respiratory hygiene training [‡]		
All school staff trained	53.2 (25)	68.1 (32)
Some school staff trained	25.5 (12)	14.9 (7)
No staff trained	21.3 (10)	17.0 (8)
Designated sick room with no pass-through [†]	48.9 (23)	61.7 (29)
School reports syndromic surveillance data [†]	36.2 (17)	51.1 (24)
School culture encourages sick employees to continue working [†]	38.3 (18)	23.4 (11)
Plan addresses biological event [†]	36.2 (17)	40.4 (19)
Policy for transportation of contagious kids [†]	21.3 (10)	40.4 (19)
PPE stockpile or MOA to get PPE during a disaster [†]	19.1 (9)	38.3 (18)
Perfect attendance reward/recognition for staff [†]	17.0 (8)	21.3 (10)
Liberal sick leave policy for outbreaks [†]	17.0 (8)	21.3 (10)
Foodservice staff trained on biosecurity [‡]		
All foodservice staff trained	8.5 (4)	12.8 (6)
Some foodservice staff trained	6.4 (3)	4.3 (2)
No foodservice staff trained	85.1 (40)	93.0 (39)
School has a foodservice biosecurity plan [†]	6.4 (3)	14.9 (7)
School used an infectious disease scenario in drill in the last year [†]	6.4 (3)	2.1 (1)
Disaster plan for psychological services addresses bioterrorism [†]	4.3 (2)	2.1 (1)
Plan to use infectious disease scenario in drill in the next 2 years [†]	2.1 (1)	6.4 (3)
School has a medication stockpile [†]	2.1 (1)	6.4 (3)
School nurse mandated to receive seasonal influenza vaccine [‡]		
School nurse mandated to get vaccinated	0	2.1 (1)
School nurse encouraged to get vaccinated	85.1 (40)	85.1 (40)
School nurse neither mandated nor encouraged to get vaccinated	14.9 (7)	12.8 (6)
Preparedness indicator for biological and nonbiological events		
School written disaster plan [†]	87.2 (41)	93.6 (44)
School has a communications platform for disasters [†]	83.0 (39)	87.2 (41)
School plan coordinated with regional agencies [†]	53.2 (25)	55.3 (26)
Frequency with which plan is reviewed and updated [‡]		
Every year	36.2 (17)	38.3 (18)
Every 2 years	4.3 (2)	4.3 (2)
Every 3 years or less	59.6 (28)	57.4 (27)
Number of school staff trained on the disaster plan [‡]		
All staff trained	36.2 (17)	36.2 (17)
Some staff trained	29.8 (14)	42.6 (20)
No staff trained	34.0 (16)	21.3 (10)
School nurse encouraged to have personal disaster plan [†]	34.0 (16)	42.6 (20)
Participation in regional exercise in the last 2 years [†]	23.4 (11)	25.5 (12)
School has an established ICS [†]	23.4 (11)	29.8 (14)
Plan addresses low income students who rely on school food for daily meal [†]	19.1 (9)	19.1 (9)
Psychological services addressed in school disaster plan [†]	17.0 (8)	21.3 (10)
Parents are involved in school disaster planning [†]	14.9 (7)	14.9 (7)
School ICS evaluated to see if compatible with public health ICS [†]	2.1 (1)	6.4 (3)
Plans in place for distance-based education for school closure [‡]		
Plan is in place	0	4.3 (2)
Plan is in development, but it is not in place yet	4.3 (2)	14.9 (7)
No plans are being made or discussed	95.7 (45)	80.9 (38)

PPE, personal protective equipment; MOA, memorandum of agreement; ICS, Incident Command Structure/System.

*Only schools that completed both a beginning and end of year survey are included in this table (N = 47).

[†]Indicator was scored zero or 1 point.

[‡]Indicator was scored zero, 1-half, or 1 point.

Table 3. Frequency of School Drill Participation Across Multiple Types of Exercise Scenarios

Type of Drill	Frequency of Drill Participation N = 133					
	Once a Month % (n)	Once a Quarter % (n)	Once a Semester % (n)	Once a Year % (n)	Every 2 Years % (n)	Less Than Every 2 Years % (n)
Fire	30.8 (41)	33.8 (45)	24.1 (32)	11.3 (15)	0	0
Tornado	9.8 (13)	30.8 (41)	41.4 (55)	18.0 (24)	0	0
Earthquake	6.0 (8)	18.8 (25)	36.8 (49)	30.8 (41)	0	7.5 (10)
Interior lockdown	4.5 (6)	24.8 (33)	41.4 (55)	23.3 (31)	0	6.0 (8)
Exterior lockdown	3.8 (5)	19.5 (26)	26.3 (35)	18.8 (25)	0	31.9 (42)
Shelter in place	0.8 (1)	11.3 (15)	13.5 (18)	15.0 (20)	0.8 (1)	58.6 (78)
Infectious disease	0	0	0.8 (1)	4.5 (6)	2.3 (3)	92.5 (123)
Bus evacuation	0	4.5 (6)	20.3 (27)	35.3 (47)	0	39.8 (53)

year. Even when participation in fire and tornado drills was excluded, many school nurses reported taking part in multiple school exercises each year. The majority (62.4%, N = 83) reported being part of 3 or more exercises annually in addition to all fire and tornado drills.

School Stockpiling of and/or Access to Infection Prevention Supplies

Nurse participants were asked whether their school stockpiled infection prevention supplies and whether the school had implemented a pre-event MOA (ie, a formal written agreement from a vendor) that would provide access to supplies after a disaster occurs. The frequency of stockpiling supplies is outlined in Table 4. Schools that had a health professional available on-site during all school hours were significantly more likely to report stockpiling of infection prevention supplies compared with schools that shared health care provider coverage and did not always have a professional at the school (37.2% vs 20.5% stockpile, respectively; $p < .05$; Table 4). There were no differences in stockpiling practices between schools that have been or will be a point of dispensing (POD), school size or location, public versus private schools, or other school demographics.

DISCUSSION

Findings from this study indicate that the online biological event preparedness educational intervention had a statistically significant impact, though it was only a small increase in biological event preparedness. In addition, there was no change in school preparedness for natural disasters following the intervention, though that was not unexpected as the education modules focused primarily on preparedness for infectious disease events rather than on other types of disasters. Only one other study could be found that examined the impact of emergency preparedness training for school nurses. That study used online educational modules about emergency preparedness and found

that the school nurses' knowledge increased from pre- to post-training, but their confidence in their ability to perform the tasks did not change.¹² That study only assessed school nurses' emergency preparedness knowledge and skills and did not examine the impact of training on school preparedness.

In our study, school preparedness for biological events increased from beginning to end-of-year among those who watched at least 1 module, but did not increase among those who did watch any. However, the increase in preparedness was not proportional to the numbers of modules watched and the reasons for the absence of dose response are unclear. It is possible that a single school year may not have provided a sufficient amount of time for nurses to implement numerous changes to their school disaster plans, regardless of how much useful information they obtained from the education intervention. Disaster planning is a relatively slow, laborious process involving development of a written plan, assessment of the plan through drills or exercises and/or comparing the written plan to published guidelines, identifying planning gaps, and implementing interventions to improve the plan.¹³ Numerous obstacles can arise during the planning process, such as differing priorities between administrators and the disaster planning committee, the need to get multiple individuals or groups to agree on proposed plan changes, and the necessity of identifying funding to pay for potentially costly interventions. Planning obstacles may have been amplified in this population because many of the nurses covered multiple schools, thereby making implementation of changes much more complicated. Given more time, the nurses may have the opportunity to integrate more of the information into their school plans, despite the challenges of having multiple schools to serve. Future studies should consider a longer intervention and data collection period to see if the educational module impact can be improved with additional time.

Another reason for the modest impact of this educational intervention could be a concurrent but unrelated decline in disaster preparedness in the

Table 4. Frequency of School Stockpiling or Having Access to Infection Prevention Supplies

Infection Prevention Product/Item	All Schools N = 133 Stockpiled % (n)	Onsite vs No Onsite Health Provider N = 133		Onsite vs Not Onsite p Value*
		Onsite Provider N = 94 Stockpiled % (n)	No Onsite Provider N = 39 Stockpiled % (n)	
Stockpile of any product	32.3 (43)	37.2 (35)	20.5 (8)	<.05
MOA to obtain supplies	5.3 (7)	4.3 (4)	7.7 (3)	NS
Gloves	31.6 (42)	36.2 (34)	20.5 (8)	NS
Surgical or medical mask	21.8 (29)	25.5 (24)	12.8 (5)	NS
Alcohol-based hand rub	18.8 (25)	21.3 (20)	12.8 (5)	NS
Eye protection	15.8 (21)	17.0 (16)	12.8 (5)	NS
Isolation gown	4.5 (6)	4.3 (4)	5.1 (2)	NS
N-95 respirator or equivalent	1.5 (2)	1.1 (1)	2.6 (1)	NS

MOA, memorandum of agreement; NS, nonsignificant.

*Determined by the chi-square test.

schools during the same time frame. For example, significantly fewer schools reported having conducted a fire drill each month on the postintervention survey compared with the preintervention survey. This could be because the nurses anticipated at the beginning of the school year that the school would meet the Missouri standard of conducting a fire drill at least monthly,¹⁴ but realized at the end of the school year that the school had not actually met the standard. Another preparedness indicator that decreased significantly from beginning to end of the year was the existence of a written policy encouraging sick employees to stay home. This change may have been due to the school nurse having assumed such a policy existed when she/he completed the pre-intervention survey, but found out some time during the school year that such a policy did not in fact exist. It is also possible, though less probable, that the school district changed the attendance policy for staff during the course of the 2013-2014 school year. It is difficult to discern whether some of the schools actually became less prepared in some areas or if the postintervention survey was simply a more accurate reflection of school preparedness. Regardless, these negative changes from pre- to postintervention may have resulted in the intervention appearing less effective than it truly was.

Nurses in this study reported that their schools had fairly active disaster exercise programs internally, and many of the nurses indicated that they had personally participated in 3 or more drills in the last year, in addition to fire drills. However, almost all of the exercises conducted were school rather than regional drills. Regional disaster exercises are critical to evaluate community resilience. These need to include schools, particularly for bioterrorism and other infectious disease related events, because children spend so much of their day in the school setting and disease spread can be amplified in this setting.^{15,16} Another limitation to drill programs in individual

schools is that they primarily consist of fire, tornado, and interior lockdown (ie, active shooter) scenarios. Other types of disaster drills are much less common, and even the schools' number of fire drills did not meet the Missouri standard.¹⁴ Few schools have conducted an exercise in the last year involving an infectious disease scenario, and even fewer plan to use one in the next 2 years. This is consistent with the findings of a 2006 study involving Missouri nurses that found that over 80% had not participated in a bioterrorism-scenario drill.¹⁷ It is vital that schools incorporate more infectious disease scenarios into their disaster exercises, because researchers have indicated that hosting exercises increases the ability to respond to a real event. Klaiman et al⁶ reported that pre-event mass vaccination exercises in schools made deployment of actual school-based vaccination clinics easier during the H1N1 influenza pandemic. Cauchemez et al⁷ asserted that schools need to host a drill to discuss policies and practices related to school closures during pandemics.

Similar to previous research,^{4,18,19} this study found that few schools have stockpiled disaster-related supplies. This study focused on assessing availability of resources needed to respond to an infectious disease disaster, such as PPE or infection prevention supplies, and found that few schools stockpiled this type of resource. Past studies,¹⁹ including a 2011 nationwide study of school preparedness for biological events,⁴ have reported similar results. These findings imply that schools have not made much progress toward having access to PPE during disasters. The reasons for lack of progress in this area are unknown. Costs associated with stockpiling PPE, the need to have adequate storage space for the supplies, and personnel time required to maintain the inventory, are likely to be the primary causes of this deficiency.²⁰ There may also be a lack of awareness or priority for PPE stockpiling among school administrators who make

decisions about funding allocation, though this has not been assessed.

Limitations

This study did not involve the measurement of nurses' knowledge, so it is not known whether the intervention resulted in increased knowledge regarding school preparedness. Furthermore, the study did not mandate intervention participation or control for the number of modules watched. Module participation was collected via self-report, which may not be accurate. Although the intervention was not consistent across participants in terms of the number of modules watched, the data analysis process assessed dose response (ie, impact from watching more modules) and none was found. Although the overall response rate was similar to other online surveys,²¹ few nurses completed both a pre- and postintervention survey, resulting in a small sample size for assessing the impact of the intervention. This may have made it more difficult to detect a significant change resulting in a lower than actual impact from the intervention, or conversely, it may mean that only those nurses who were most interested in disaster preparedness took the time to participate in both surveys resulting in an outcome biased toward higher improvement. Furthermore, this study involved only Missouri school nurses who belonged to the MASN, which could limit generalizability.

Conclusions

School preparedness for natural disasters and biological events is critical, but remains poor. Effective interventions are needed to increase school preparedness. This study examined an online educational intervention that was found to have had a small impact on biological preparedness. The educational intervention developed for this study needs to be reassessed, especially in regards to providing a longer intervention period. Additionally, other interventions need to be designed and implemented to increase school preparedness for biological events.

IMPLICATIONS FOR SCHOOL HEALTH

The potential negative ramifications of poor school preparedness are huge, including having an impact on community resilience. School disaster preparedness needs to become a bigger priority for community emergency management. One way to accomplish this is for school districts to partner with local public health officials to pursue funding opportunities for disaster preparedness. Previous research has found that schools that had designated disaster planning funds were significantly more likely to perceive their schools as being prepared, had more coordination

with external agencies, and had stockpiled more emergency equipment and supplies than schools that lacked disaster planning funding.²² Funding streams for school preparedness vary from state to state. However, there has been a general decreasing trend in available funds. For instance, federal funding provided through the US Department of Education's Readiness and Emergency Management for Schools grant was stopped after fiscal year 2010.²³ Many schools lack funding for vital educational initiatives and disaster planning may be a lower priority than other school needs, such as books or technology. Schools may seek disaster planning funding through state and local emergency management planning agencies, school-based fundraisers, and private foundation grants or donations.²² The US Department of Homeland Security (DHS) provides resources for school funding at their School Safety website;²⁴ school administrators and disaster planners can apply for DHS funding to cover staff training and planning efforts.

Disaster planning funding can be used to purchase much-needed supplies. An important finding from this study is that having full-time on-site health professional coverage is associated with more stockpiling of supplies. Perhaps schools that invest in medical care provision at school also prioritize PPE as a method of protecting health care personnel working at the school. Even without funding, schools can increase their preparedness for biological events by prearranging access to PPE through the development of an MOA. During a biological event, access to PPE will be essential to protect school nurses and other school staff from being exposed to contagious students. Gaining access to PPE will be more challenging for schools during biological events, because most vendors have a 6-9-month backorder for PPE and PPE from regional and federal stockpiles is likely to be prioritized to hospitals and other acute care facilities.^{20,25} If schools hope to obtain PPE from regional or federal stockpiles, this needs to be coordinated through the community emergency management plan before a disaster occurs. Stockpiled supplies and/or existing MOAs will enable the school to access PPE, which could result in decreased disease spread in the school setting. Confidence in personal safety, such as making PPE available to health care personnel during pandemics and other biological events, has also been associated with increased willingness to report to work, which would increase school and community resilience.^{26,27} US Department of Homeland Security funding is also available for the purchase of disaster supplies, including PPE.²⁴

Schools need to increase disaster exercise participation, especially as it relates to biological preparedness. Incorporating an infectious disease scenario into a school drill is not complicated and could highlight areas of school preparedness that are sorely lacking, such as the need for distance-based education plans or

policies for transporting potentially contagious children. Hosting an infectious disease-based school exercise will allow nurses the opportunity to demonstrate their ability to respond to biological emergencies, a competency outlined by the CDC for all public health clinical staff.^{5,11} Using a biological scenario can also strengthen the relationship between schools and public health by hosting a multi-agency drill aimed at assessing community and school preparedness for infectious diseases. For example, schools can host a tabletop exercise to discuss school closures for a future pandemic or response plans for a foodborne bioterrorism attack. Another option is to host an open- or closed-POD exercise to distribute vaccines to students and school staff during influenza season. This would improve readiness for future large-scale infectious disease disasters as well as build resilience for seasonal influenza.

Human Subjects Approval Statement

The Saint Louis University Institutional Review Board approved this study (protocol # 23654).

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