School Nurses and the Swine Flu Pandemic of 2009-10

BY

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THESIS

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LIST OF ABBREVIATIONS

CDC	Centers for Disease Control and Health
CI	Confidence Interval
HH	Hand Hygiene
ILI	Influenza-Like Illness
NASN	National Association of School Nurses
NIOSH	National Institute of Occupational Safety and Health
OR	Odds Ratio
OSHA	Occupational Safety and Health Administration
PCR	positive polymerase chain reaction test
PPE	Personal Protective Equipment
QALY	Quality Adjusted Life Years
RNA	Ribonucleic acid
SAS	Statistical Analysis System software
US	United States
VE	Vaccine Effectiveness

SUMMARY

In 2009, an outbreak of the H1N1 strain of influenza spread rapidly across the United States. Health care workers were at higher risk of exposure because they were involved in the direct care of patients who contracted H1N1. Since H1N1 is easily contracted by contact with infected individuals, it spread quickly not only among health care workers, but the general population as well. In order to control the spread of H1N1 in the population, the Centers for Disease Control (CDC) developed guidelines for diagnosis and management of the disease, disease and for the protection of at-risk health care workers. The guidelines focused on the hierarchy of controls: eliminating viral exposures by administering freely available flu vaccines to all health care personnel; controlling the treatment of patients that are experiencing very mild influenza symptoms but are not at risk for complications; and engineering controls, where possible, by utilizing mechanical ventilation in isolated triage areas to prevent the spread of viral particles throughout a facility. The guidelines also included administrative controls, which are not mutually exclusive to any part of the hierarchy and inform all other aspects of the prevention strategy. These controls include a vaccination program among employees specifying high-risk procedures among health care workers that increase the risk of disease contraction; and appropriate countermeasures such as extra personal protective equipment (PPE) and a surveillance program where ill or presenting staff are noticed quickly and sent home if presenting with influenza-like illness (ILI) symptoms and last in the hierarchy of controls, ensuring PPE usage during treatment procedures including gloves, masks, N95 respirators and/or gowns (Interim Guidance on Infection Control Measures 2009).

School nurses were at particularly high risk during the H1N1 (commonly known as swine flu) pandemic because their patients—school-age children—shed a higher viral load than older people (Block et al. 2008). School children are concentrated in close quarters, since the physical plant of schools is not set up to reduce the spread of infectious diseases; and the learning enterprise and childcare needs of working parents work against staying home from school for both students and teachers, thus circumventing quarantine, one of the most effective methods of preventing the spread of infection. To assess the exposure conditions associated with infection as well as the scale and effectiveness of the CDC guidelines in school settings, the (NASN) conducted a cross-sectional study of their membership immediately following the flu pandemic of 2009.

A 64-item survey was emailed to the entire membership of 14,065 nurse members of NASN. Of the total membership, 2,263 (16.1%) of NASN members responded to the survey. After removing respondents who did not work in schools (i.e., were not exposed to children), 2,151 participants remained. This is a descriptive analysis of risk factors for development of ILI, the implementation of CDC guidelines, and the impact of policies on implementation of protective measures in school settings.

The following risk factors were found to be positively associated with ILI status among the respondents: working with children aged kindergarten or younger, a lack of PPE access and usage, and not receiving the H1N1 vaccination; this provides validation of the study, given that exposure to infected individuals without the protection of PPE or vaccination is known to lead to the spread of

SUMMARY (continued)

disease. Having a formalized PPE and respiratory protection program and receiving training on how to use N95 respirators with fit testing has an effect, in some instances as large as fivefold, on the frequency of use; lack of a policy is shown to be associated with H1N1 spread in schools. There is especially a deficiency in PPE usage among nurses tending to students that come in for ILI-related treatments, who present the greatest exposure risk. Nurses that did not receive the H1N1 vaccine primarily cited the risks of side effects as their primary concern; given the ability of school nurses to contract and widely spread infectious diseases during an epidemic, efforts to promote vaccination are paramount, and focused educational activities should be planned for this at-risk population.

I. INTRODUCTION

A. **Background**

From May 2009 to August 2010, there was an outbreak of the H1N1 subtype A strain of influenza that spread across the world and the United States. In 2009, there were an estimated 61 million cases (more than one-fifth of the US population) of H1N1-A infections nationwide that resulted in 12,470 deaths (CDC Estimates of 2009 H1N1 Influenza Cases 2010). Health care workers were at a higher risk of exposure to H1N1 A, as infected patients who presented severely enough often sought medical care.

Out of the infected population, students were a higher concern with respect to respiratory infectious disease due to the fact that younger children are more vulnerable to infectious diseases than adults because of a less developed immune system (Wang et al. 2009), and they shed higher viral loads than adults (Block et al. 2008). Additionally, swine flu is a highly infective strain of flu with a secondary attack rate of 22% to 33%, far above the 5% to 15% secondary attack rate seen in previous seasonal influenza scenarios (Roos 2009). Combining this with the close quarters of school environments, school children are much more likely to pass on the infection to their peers, faculty, and other school support staff, putting school nurses at particularly high risk of contracting the disease.

The Occupational Safety and Health Administration (OSHA) and the CDC released guidelines on assessing and containing the spread of H1N1 within clinical settings that put health care workers at risk of exposure: modes of transmission, ILI symptoms, occupations of higher or lower risk, and work policies to limit overall exposure (including appropriate use of PPE) are comprehensively covered by the guidelines. However, schools as a site of exposure have not been addressed directly in these guidelines.

In order to develop an understanding of exposure circumstances, preventive measures, and the frequency of illness among health care providers in schools during the pandemic, NASN conducted a survey of school nurses that were exposed to H1N1 across their membership. A survey instrument was designed by NASN to query development of ILI, as well as conditions in the work place that foster or prevent contracting the virus among school nurses. It also focused on the factors that the CDC/OSHA cited as important to exposure: whether a comprehensive pan-flu plan is in place, whether nurses follow safe work practices, and PPE.

B. **Problem Statement and Purpose of Study**

The overall goal of this study was to examine the factors in school settings that may have promoted the spread of H1N1 during the pandemic of 2009–2010. Specific objectives were threefold: first, to determine the particular exposure hazards in school settings that contribute to the spread of H1N1 A; second, to determine whether controls and guidelines designed to reduce spread of H1N1 A were in place among the school nurses; and third, to consider guidelines and policies to make them more effective at preventing ILI in schools.

Given the nature of health care, nurses tend to see sicker individuals that present with symptoms that could spread infectious diseases, such as coughing or sneezing. Working with children puts school nurses at increased risk of contracting infectious diseases. Due to an increase in both disease prevalence and incidence, school nurses are at additional risk during pandemics, where more students are infected and are in close proximity to each other, increasing the secondary attack rate. Given the potential for future exposure in pandemic and epidemic situations for school nurses, it is important to carefully examine infection rates, exposure circumstances, and assess the ability to implement preventive measures among this vulnerable segment of the work force.

The CDC's recommendations—in terms of how and whether they are implemented and whether they decrease the spread of disease in a school environment—need to be evaluated. The 2009 H1N1-A swine flu pandemic provides an opportunity to determine how target groups interpret and implement those guidelines, as well as the impact of implementing, or not implementing these interventions—that is, whether implementation actually reduced disease among at-risk occupational groups.

II. LITERATURE REVIEW

A. **The Biology of H1N1**

Influenza subtype H1N1 A, also known as swine flu, is a novel flu strain that was the dominant flu during the 2009–2010 flu season. The H1N1 A swine influenza strain that triggered the 2009 pandemic was caused by an interaction and consequent genetic reassortment between four types of flu virus: classic swine flu H1N1, human H3N2, avian, and Eurasian swine flu strains (Trifinov et al. 2009). A genetic reassortment is the mixing of chromosomal material between two or more individuals to create a chimera of the previous two genetic parents. Influenza viral replication is a multi-stage process (Bouvier et al. 2008). The influenza virus binds to the host cell using a protein called hemagglutinin to adhere into polysaccharide chains on the cell membranes of epithelial cells located in the nose, throat, or lungs. Once bound, the virus then enters the cell through endocytosis, which is the process by which cells absorb polar molecules (Bouvier et al. 2008). Upon entering the cell, the viral coating is fused to the vacuole membrane and protons enter that break down the viral core into its constituent parts; ribonucleic acid (RNA) and core proteins are then released into the cells' cytoplasm. These trigger the formation of complexes called viral nucleoproteins, which are transported into the cell nucleus; this triggers the transcription of the viral RNA (Bouvier et al. 2008).

As this occurs, the proteins that formed the complex actively inhibit the cell's creation of its own messenger RNA so that the synthesis of the viral RNA is further enabled (Cros et al. 2003). The newly synthesized viral RNA then exits through the Golgi apparatus into a new viral coating that buds on the cell membrane, which is composed of the hemagglutinin and neuraminidase. The budding virus is held in place by the polysaccharide chains on the surface of the cell membrane until the neuraminidase cleaves those chains, thus freeing the virus to infect new cells (Cros et al. 2003). Viral reassortment occurs if several types of genetically compatible viruses bind to the same cell. When the viruses are stripped of their coatings, they swap chromosomes prior to replication, thereby creating novel strains with new properties of both virulence and infectivity (Wong 2011). In the case of influenza, these reassortments occurred over a 20-year period across Europe and Asia, so only very specific surveillance could have caught the emergence of modern H1N1 A (Dhanasekaran et al. 2011).

B. Epidemiology of the Pandemic and Prevalence in North America

The H1N1 swine flu was first recognized in the small community of La Gloria in Veracruz, Mexico in March 2009 and was characterized by a large percentage (28.5%) of the population presenting with acute respiratory infection; the virus had been spreading in epidemic proportions months before being officially recognized due to poor health surveillance (López-Cervantes et al. 2009). This eventually led to clusters of similar respiratory ailments noted across Mexico City, which is Mexico's largest and densest population center, thus compounding the risk for rapid transmission across a large population (Novel Influenza A (H1N1) Virus Infection Mexico, 2009). The Mexican government responded in June by shutting down Mexico City's private and public facilities, but the flu had already spread across the United States and, subsequently, the rest of the world (López-Cervantes et al. 2009). On June 11, 2009, the director general of the World Health Organization, Dr. Margaret Chan, announced that H1N1 had become a global pandemic. By the time of the announcement, there had been 30,000 confirmed cases of H1N1 influenza across 74 countries—a conservative estimate of the true number of cases, largely due to the lack of epidemic surveillance in certain countries (Chan 2009).

The index case in the United States was confirmed via laboratory testing on April 15, 2009, and the second confirmed case on April 17, 2009. By April 26, the CDC had activated their Emergency Response Center to implement the nation's pandemic response plan and by June 19, 2009, all 50 states and United States territories had reported cases of H1N1 infection. It had effectively spread across the entire nation in just over a month (Background on the Situation 2009). By the end of July, more than 40,000 laboratory-confirmed cases with 5,009 hospitalizations and 302 deaths had been identified, which represented only a small fraction of the total (considering undiagnosed) cases that were present. A statistical estimation was conducted using hospital data and applying a probabilistic multiplier. Using this approach, between April and July 2009, it was estimated that every reported case of Pandemic H1N1 2009 represented 79 total cases, with a 90% probability range of 47–148, for a median estimate of 3.0 million, CI 90 (1.8–5.7 million) symptomatic cases of Pandemic H1N1 2009 in the United States. Likewise, every hospitalized case that was reported represented a median of 2.7 million hospitalized persons, CI90 (1.9–4.3 million). This represents a median estimate of 14,000 with a CI90 (9,000–21,000) hospitalizations. Estimates of H1N1 incidence over the first four months of the pandemic in the United States ranged from a median of 107/100,000 in persons 65 years of age and older, to

2,196/100,000 in persons 5–24 years of age. The incidence of hospitalization was estimated to be highest in young children of less than 5 years of age (median 13.0/100,000, 90% range 8.8–20.2 years) (Reed et al. 2009). Notably, H1N1 tends to be more common among younger people, specifically under the age of 25 (Chan 2009). A study (Wang et al. 2009) was conducted to estimate the true prevalence of H1N1 in Beijing, China; cases were counted on a week-to-week basis and ended up totaling 10,844 for 2009. By modifying a CDC program to fit the model parameters of Beijing, investigators extrapolated an estimated prevalence of 1.8 million, CI90 (1.4–2.3 million). According to the Chinese Bureau of Statistics, a 2010 census placed Beijing's population at roughly 19.6 million, meaning that there was an overall prevalence rate ranging between 7% and 11%. Roughly 84.4% of those cases were individuals were 25 years old and younger. This follows a similar trend found in the CDC data where the vast majority of those infected were children and young adults (Estimates of 2009 H1N1 Influenza Cases 2010). Those within the age range of 0–17 years consisted of an estimated 20 million cases or roughly 33% of the affected population (Estimates of 2009 H1N1 Influenza Cases 2010). The 64 and older age group only accounted for 6 million, or roughly 10% of the affected population, despite both groups sharing similar immunity traits and being more susceptible populations. Influenza tended to show an even spread for hospitalization rates across all three age groups: for 0–17 years, 87,000 or 0.45%; for 18–65 years, 160,000 or 0.46%; and for older than 65 years, 27,000 or 0.435%. What is startling is the stark increase in mortality rates for the older age groups; 1/15,625 for 0–17 years, 27/1,000 for 18–65 years and the same for 65 years and older. These present a fourfold increase in mortality rates compared to the youngest age group. Numerous studies point to a vulnerable age group being 25 years and younger (Wang et al. 2009); however, since the CDC split their middle grouping from 18 through 64 years, it is not possible to discern the illness prevalence, hospitalization rates, and mortality rates among the 18- through 25-years-of-age demographic (Estimates of 2009 H1N1 Influenza Cases 2010).

A study conducted in 2004 used age-specific regression to analyze annual average numbers of hospitalizations associated with the circulation of influenza viruses from the 1979–1980 through the 2000–2001 seasons in the United States. The overall average of primary diagnoses of influenza was 94,735 with a range of 18,908–193,561, and the overall average of any patients that presented with ILI while seeking treatment were 133,900 with a range of 30,757–271,529. Estimated rates of influenza associated with hospitalizations were highest during seasons in which Influenza A (H3N2) viruses predominated, followed by Influenza B and A (H1N1) seasons (Thompson et al. 2004). Note that the mean number of hospitalizations aggregated for those 20 years of age is still less than half of the number of hospitalizations that were generated from the 2009–2010 swine flu pandemic year.

C. **<u>Signs and Symptoms of H1N1-Induced Illness and Case Definition</u>**

The symptoms of H1N1 tend to be similar to traditional forms of seasonal influenza including, fever, headache, muscle aches, chills, tiredness, cough, and runny nose (Denoon et al. 2010). Most of the time infected people will present with generalized symptoms; however, those who are immunocompromised present with more severe symptoms and signs and are at greater risk for devastating outcomes (Denoon et al. 2010). The CDC released the following symptoms as emergency warning signs requiring immediate medical care for adults: dyspnea, pain or pressure in the lower abdomen, sudden dizziness, confusion, and severe or persistent vomiting (What to Do If You Get Sick

2009). For children, emergency warning signs are fast breathing, bluish skin color, not consuming enough fluids, not waking up or not interacting, irritability, recurring cough, fever that is continually worsening, rash, lack of tears when crying, and inability to eat (What to Do If You Get Sick 2009).

Because of the widespread development of the disease during the US pandemic, it became overwhelming to the health care system to test the blood of every potentially infected person with symptoms for early antibodies to the virus; the amount of resources needed to test every person that presented would be enormous. In the early stages of the pandemic, it was discovered that a very high proportion of suspected and tested cases were positive for the virus. For these reasons, it was important for the CDC to develop a case definition that could be made on a clinical basis rather than relying on laboratory testing, so that case management—treatment, quarantine, and environmental management—could be initiated at an early enough phase to prevent severe morbidity or mortality in individual patients and to prevent the spread of disease in the population. Therefore, the CDC developed a case definition, which it termed “influenza-like illness” (ILI): fever (greater than 100^{o} F) and cough or sore throat in the absence of a known cause other than influenza (CDC 2009). The validity of this case definition needed to be evaluated; during the 1999 flu season, 100 subjects presenting with ILI from three Quebec-based clinics had specimens taken for laboratory confirmation of influenza. A stepwise logistic regression applied to this data set showed that cough and fever (odds ratio [OR] 6.7, CI 95 [1.4–34.1] and OR 3.1, CI 95 [1.4–8.0], respectively were the only factors positively associated with a positive polymerase chain reaction test (PCR) for influenza (Boivin et al. 2000).

D. **Means of Transmission in Health Care Settings**

There are several means of transmission of influenza: direct contact with presenting individuals who are coughing or sneezing, contact with fomites on contaminated surfaces or objects, and, inhalation of virus-laden aerosols (Interim Guidance on Infection Control Measures 2009). Infectious droplets are produced by coughing, sneezing, or talking, or by therapeutic manipulations such as suctioning or bronchoscopy, and their main routes of entry are through the conjunctiva of the eye or the mucus membranes of the mouth and nose (Interim Guidance on Infection Control Measures 2009). Smaller airborne droplets can be captured by air currents and travel significant distances to penetrate deep into the lungs (Interim Guidance on Infection Control Measures 2009). Both sizes of droplets can result in the creation of fomites (contaminated surfaces), which could result in contact transmission. Contact transmission can be direct or indirect; direct contact transmission occurs when infected skin touches skin—by shaking hands or, in the health care setting, during direct patient care activities; indirect transmission describes infected material from a patient being deposited on surfaces in the environment (Methods of Disease Transmission 2007). There is limited information on how well influenza A and B viruses survive outside of the human host. One study, conducted by Bean et al. (1982) suggests that if a heavily infected person contaminated a stainless steel surface at a relative humidity of 35%–40% most favorable to viruses), there might be enough viable viral particles remaining after 2–8 hours to allow contact transmission. Further investigation is needed to elucidate the role of contact transmission for viruses and the effect of environmental conditions. Given the infection pathways that viruses use, control methods have been developed to prevent the infection of health care workers and the general public.

E. **Centers for Disease Control and Prevention's Influenza Prevention Criteria**

The hierarchy of controls is an approach outlined by the CDC that can be used to limit infection in a clinical environment. Note that the hierarchy of controls is intended to create a framework for solutions and each category is not mutually exclusive. The hierarchy of controls can be roughly summarized by the following five categories listed from most to least protective: elimination, substitution, engineering controls, administrative controls, and personal protective equipment. Table I compiles general CDC recommendations per their listed hierarchy controls to prevent transmission of flu:

TABLE I

EXAMPLES OF USE OF A HIERARCHY OF CONTROL TO PREVENT INFLUENZA TRANSMISSION

Elimination of Infection Sources	Foregoing elective treatment of patients that are presenting with ILI. Encouraging clinical staff that are presenting with ILI to stay at home to mitigate the risk of spreading illness.
Engineering controls	Installing of physical barriers, partitions and local exhaust ventilation systems (LEVS) in treatment or triage areas to minimize staff exposure to fomites or other contaminated particulates. Installing and promoting the usage of hands-free systems for: soap and hand-sanitizer dispensers, sinks, towel dispensers, and trash receptacles to minimize direct contact with potentially contaminated surfaces. Ensuring that the HVAC has proper general air flow throughout the facility and uses HEPA filtration to capture fugitive virus particles.
Administrative controls	Actively vaccinating all clinical staff. Determining if select patients and/or visitors are presenting with ILI and isolating them appropriately. Implementing respiratory hygiene/cough-etiquette programs. Adhering to appropriate isolation precautions such as allowing for at least six feet of space between patients if possible. Encouraging proper hand hygiene (HH), and respiratory etiquette among visitors or presenting patients by making tissues, facemasks, and hand sanitizer readily available in triage and waiting areas. Establishing a robust housekeeping program during flu seasons that ensures frequently contacted surfaces are regularly cleaned (such as railings, table surfaces, door handles, elevator buttons).
PPE	Enforcing the usage of appropriate PPE, such as gloves, gowns, facemasks, respirators/surgical masks, and eye or face shields, while treating presenting patients.

(Interim Guide on Infection Control Measures 2009).

The most effective response is neutralizing infection risk by administering flu vaccines among the potentially exposed population. Flu vaccines, both seasonal and otherwise, are comprised of weakened or dead virus (depending on the delivery system used) of the predicted strain for that season (Key Facts About Seasonal Flu Vaccine 2010). When a flu virus enters the human body, lymphocytes, also called “T-cells,” detect the proteins on the surface of the viral coating as foreign to the body (Roscoe 2009). As the virus infects cells and circulates through the lymphatic system, T-cells bind to those viral proteins and trigger the production of new T-cells specifically geared to attack that viral protein (Roscoe 2009). Memory T-cells are created post-infection, and are geared to fighting that specific antigen. This can subsequently hasten the immune response should the antigen reenter the body (Roscoe 2009). A vaccine triggers a small-scale immune response with the production of antibodies geared to fighting those particular strains, whether they are injected or inhaled. The vaccine needs time to take effect after the inoculation; the body usually needs a period of two weeks’ time to build up an appropriate amount of antibodies to combat an infection and an individual is still at risk for infection in this window (Key Facts About Seasonal Flu Vaccine 2010). In addition to vaccinations, a series of drugs called neuraminidase inhibitors (NIs) are frequently prescribed to treat symptomatic influenza. These drugs, such as oseltamivir, or Tamiflu, work by fitting into the active site pocket on the virus where neuraminidase would normally be bound on the cell membrane, thereby not allowing the neuraminidase to cleave the virus free from an infected cell (Moscona 2005). If prophylaxis is started early enough, the infection can be contained, since newly replicated viruses cannot spread (Moscona 2005). The CDC recommends the following groups for vaccination: pregnant women, household caregivers, health care workers, all people aged between 6 months and 24 years, and persons aged 25 through 64 years that have health conditions that may lead to medical complications if exposed to influenza (2009 H1N1 Vaccine Recommendations 2009). The effectiveness of the vaccine was put to question: could it effectively prevent infection at a statistically significant higher rate when compared to an unvaccinated control group of similar demographics.

F. **Influenza Vaccine Effectiveness**

A study conducted in the United States across 24 public schools assessed the effect a school-based vaccination program had on the ILI status among the students households. Twenty-eight schools were grouped into 11 clusters and characterized by geographic location, socioeconomic status, number of students, and ethnic makeup. Students from each school were matched on each of these variables, and then randomly assigned to either an intervention group that received live-attenuated virus (LAV) based vaccines or a control group, which received placebos. Of the 5,840 students, 2,717 were in "intervention" schools and the remainders were in control (placebo) schools (range 30%–56%). After reducing the number of eligible students to 1,535, 95% received a second dose. Of the vaccinated students, 73% had received no previous influenza vaccination. Students in schools that did not receive LAV had an OR of 10.9 for experiencing ILI, CI 95 (8.4–13.3) when compared to students that were inoculated. Schools that received the vaccine had almost half the absenteeism when compared to schools that received the placebo; peak-week vaccinated absentee rates were 4.04 per thousand compared to control rates, which were 7.20 per thousand with a p-value of 0.002. Flu vaccination programs have an appreciable effect on health and attendance of students (King et al. 2006).

A group of California-based doctors conducted a meta-analysis that researched the effectiveness of receiving the swine flu vaccine from an opportunity cost standpoint: did receiving the vaccine between October and November 2009 result in not only lower infection rates, but also lower overall costs to the health care system? Specific outcome measures for the study included infections and deaths averted, overall costs, quality adjusted life years (QALYs) and incremental cost-effectiveness. Applying a model based on homogenous distribution of cases, a hypothetical population of 8.5 million and a secondary infection rate of 1.5, the following was concluded regarding vaccine effectiveness: vaccinating 40% of the population in October averted 2,051 deaths, gained 69,679 QALYs, and saved $469 million. With vaccinations in November, the hypothetical population averted 1,468 deaths, gained 49,422 QALYs, and saved $302 million when compared to the 60% that did not receive the vaccination (Khazani et al. 2009).

A cross-sectional study conducted in Germany measured the effectiveness of a single dose of monovalent AS03-adjuvanted vaccine at preventing incidence of swine flu among the inoculated population. A computer-assisted telephone survey was carried out by randomly selecting a representative sample of 1,000 individuals 14 years of age or older. During the vaccination campaign, the study participants were interviewed at two-week intervals, using a standardized questionnaire, to elicit the following: demographic information, influenza vaccination status, and knowledge of and attitude toward pandemic influenza vaccination. Vaccine effectiveness (VE) was then calculated using the following formula: VE = (PPV-PCV) / PPV (1-PCV) x 100%, where PPV is the proportion vaccinated in the population and PCV the proportion of vaccinated cases. The results demonstrated high VE in persons aged 14–59 years, 96.8%, CI 95 (95.2–97.9) and slightly lower VE in those 60 years or older

83.3%, CI 95 (71–90.5). The VE may have been overestimated since vaccinated patients presenting with ILI may have been tested less frequently than unvaccinated patients who presented with symptoms as well (Wichmann et al. 2010).

Per a study conducted in 2009, trivalent inactivated influenza vaccine (TIV) had its efficacy assessed against laboratory cultured, confirmed cases of influenza A and B strains over the 2006–2007 flu seasons. In a double-blinded clinical trial, 7,653 individuals that presented with ILI participated in the study; 5,103 were administered the TIV and the remaining 2,549 participants were given a placebo. Based on the number of vaccinated individuals that presented with ILI, the vaccine's efficacy to any strain of influenza (not antigenically matched to the vaccine) was 61.60% CI 95 (46%–72.8%) $P<0.001$. GlaxoSmithKline Biologicals funded the research, so there may be bias in the presentation of the research findings (Beran et al. 2009).

A study was conducted in the Guangxi province of China by researchers from the Shantou University Medical College, who sampled blood serum and looked for antibodies as proof positive for a prolonged immune response to H1N1 in 4,043 samples taken. None of the 583 older subjects (aged 60 or older) showed any indication of H1N1, whereas those younger than 60 produced 70 positive results (Chen et al. 2009). This indicates that individuals that had received series of influenza vaccinations in years previous seemed to display higher levels of immunity with regards to H1N1. Thus, participants that eschewed flu vaccinations entirely or were too young to receive their protective effects were more vulnerable to developing more severe symptomatic illness when exposed to H1N1 (Chen et al. 2009). Most elementary schools consist of individuals that have not gone through multiple rounds of vaccinations; the younger the child, the more likely that is true. This creates an environment where individuals that are particularly susceptible to H1N1 study in close quarters, increasing risk of exposure to infection from others in that environment.

G. **Centers for Disease Control and Preventions Policies and Personal Protective Equipment Effectiveness**

According to the industrial hygiene hierarchy of controls, preventive measures would best be accomplished through engineering controls; in the case of respiratory pathogens, improving ventilation systems and spacing infected individuals far away from health care workers would be optimal. In addition, respiratory protection using a National Institute of Occupational Safety and Health (NIOSH)-certified N95 or higher respirator would reduce exposure (Protect Workers from Pandemic Influenza 2011). However, this solution requires availability of PPE and capital investment in engineering controls, respirator fit and pulmonary function testing, fitness for use testing, and a willingness on the part of the health care worker to use PPE controls.

A randomized trial was conducted during the 2009 pandemic to assess whether surgical masks or respirators were more effective at preventing infection in a hospital setting. A total of 446 nurses from eight hospitals were randomly assigned to using either surgical masks (225 nurses), or N95 respirators (221 nurses) when working with patients over a period of four months. All respirators were fit tested and frequent audits were conducted to ensure proper usage. At the end of this period, 23.6% of the surgical mask group and 22.9% of the N95 respirator group came out with laboratory-confirmed cases of influenza, thus demonstrating that there is almost no appreciable difference in the effectiveness of the N95 respirator over the surgical mask (Loeb et al. 2009). The absolute risk difference between the two was -0.73% CI 95 (-8.8%–7.3%) and a p-value of 0.86 (Loeb et al. 2009). One limitation of the study is that no control group could be established where workers used no respiratory PPE whatsoever; therefore, it was not determined if the attack rate would have been higher or lower without PPE.

Another study conducted in Sydney, Australia assessed the effect of using surgical masks in homes as a means of stemming the transmission of the avian flu and ILI in households; specifically, those with ILI-presenting children were recruited. It found that reported mask use significantly reduced the risk for ILI-associated infection among other members of the household, OR 0.26 CI 95 (0.09–0.77); however, fewer than 50% of participants wore masks most of the time. It was concluded that home use of face masks is associated with low adherence and is ineffective for controlling seasonal respiratory disease (McIntyre et al. 2009).

In terms of skin contact, hand washing with effective disinfecting agents is critical. Regulatory agencies, such as OSHA, recommend that all health care workers take the following precautions during patient handling: usage of gloves, proper contact hygiene by cleaning hands before and after any interaction with a patient, and proper cleaning and disinfectant procedures of equipment and surfaces that have been touched by an ILI patient (Influenza Preparedness and Response Guidance 2008).

A study was conducted to test the efficacy of soap and water versus an alcohol-based hand rub on live H1N1 virus on the hands of humans. Twenty health care workers were exposed to 1mL of 10^7 tissue culture infectious dose of live H1N1. They were then selected to undergo one of five hand cleaning protocols: no hand cleaning (control group); soap and water; 61.5% ethanol gel, 70% ethanol plus 0.5% chlorhexidine solution; or 70% isopropanol plus 0.5% chlorhexidine solution. Marked antiviral efficacy was noted for all four cleaning protocols, on the basis of culture results (14 of 14 had no culturable H1N1), with soap and water being statistically superior to all three alcohol-based hand rubs, although the actual difference was only 1–100 virus copies/mL. There was minimal reduction in H1N1 after 60 minutes without hand hygiene (HH) (Grayson et al. 2009). Thus, proper hand cleaning and hygiene should lead to a marked decrease in the potential spread and infection of H1N1 and, specifically, soap and water is not only effective but is the ideal means of cleaning. Hand hygiene carries over to the students as well: a randomized control trial conducted in Egyptian schools studied the effects that proper washing and drying of hands twice a day for 45 seconds had on the impact of ILI. In a 12-week period, the hand washing students experienced 40% lower incidence of ILI and a 47% lower incidence of lab confirmed influenza when compared to the control group (Talaat et al. 2011).

Contact hazards are mitigated by proper glove usage and the aforementioned hygiene precautions (Influenza Preparedness and Response Guidance 2008). One such study assessed 49 workers in the swine industry and compared them to 79 non-exposed controls across a variety of control factors. The study found that workers who sometimes or never used gloves were significantly more likely, OR 30.3, CI 95 (3.8–243.5), when compared to non-exposed controls (Ramirez et al. 2006).

H. School Nurses and Exposure to Infectious Diseases

School nursing is a specialized practice that was established to protect the school population from infectious diseases and to promote health and safety among the student body In a single-blinded randomized control trial conducted during the 1996–1997 flu season, day-care children were administered inactivated flu virus to determine if there would be an appreciable reduction in influenza-related infection and morbidity to their household contacts. Influenza vaccine was administered to 60 children with 162 contacts at home, while hepatitis A vaccine was administered to 67 age-matched children with 166 contacts at home as a control. Unvaccinated home contact (n=120) of children that received the influenza vaccine experienced 42% fewer instances of ILI (P=0.04) compared with unvaccinated household contacts from the control group. Among household contacts that were between 5 and 17 years of age, there was an 80% reduction of ILI among contacts of vaccinated children (n=28) versus household contacts in the control group (n=31). The study summarily concluded that flu vaccine was effective at reducing infection among household contacts (Hurwitz et al. 2000).

School nurses help improve the overall health of the school and promote positive student responses to normal development by intervening in the face of actual and potential health problems, providing case management services for chronic health conditions, and actively collaborating with other nurses and teachers to further build the student body's capacity for adaptation, self-management, self-advocacy and learning (Murray et al. 2008). According to Murray and Dilaura, there are seven core roles that refine the above definition into specific tasks that school nurses should be able to perform, including the provision of direct care, which involves the care of injuries and acute and chronic illness; support and leadership of school-wide health services, which involves emergency planning and confidential communication of student health information; the screening and referral of health conditions; promotion of a healthy school environment by providing for the environmental and physical safety of students; the promotion of overall health by educating the student body about proper nutrition, exercise, and hygiene; leadership on health policies and programs; and a liaison between school personnel and health care professionals. This definition of care functions has been adopted by NASN as goals for its membership. In addition to the characteristics of a trade and advocacy organization, NASN is a charitable foundation that is based on developing education and careers of registered school nurses. It works with numerous affiliates such as NIOSH to perform and fund studies on the quality of health care that is provided by its members and provides congressional testimony on school health services and initiatives.

III. METHODS

A. Study Population

The study population was the 2009–2010 membership of the NASN. Per a census conducted by the Bureau of Labor and Statistics in 2010, an estimated 2,737,400 registered nurses were employed in the United States. Based on a 2010 Department of Health and Human Services registered-nurse survey publication, an estimated 73,607 of that total, or 2.7%, worked specifically as school nurses. The total NASN membership at the time of survey administration was 15,000 nurses, or 20% of registered nurses that worked in school settings. At the time of the survey 14,065 had not opted out of receiving emails from the national network. A membership survey was compiled for a board of directors meeting by the head of research of NASN and was sent out to the general membership via email in early 2011.

B. Survey Instrument

The survey instrument was developed by members of the NASN in conjunction with researchers from the CDC to assess the factors associated with the development of ILI among members of the association. It consists of 64 items that query the presence of ILI (dependent variable) and a number of independent variables, including exposure hazards and scenarios; treatment of sick students; total number of students treated; age of students treated; types of treatment that would put the nurse in close proximity of the students' breathing zones, such as suctioning, administration of nebulizing medications, and acquisition of nasopharyngeal samples; and whether perfect attendance was incentivized. They were queried about barriers to taking protective actions, including reasons for not taking days off work when they had symptoms of ILI; and rationale for why PPE was not used during the treatment of students with symptoms associated with ILI. Additionally, factors that potentially mitigate exposure were queried, including involvement in the development of a formalized flu-response plan as well as adherence to the plan; whether they set up or assisted in setting up a vaccine clinic for students; their educational efforts to inform staff and students on flu prevention; if and how often active screenings are performed for the student body and responses to those that test positive; whether health offices are available to school nurses and whether they contain sinks for hand washing and isolation areas for symptomatic staff and students; whether information pertaining to ILI is reported to district officials and what specifically is reported; whether a PPE-usage policy exists with regards to ILI; whether gloves, gowns, surgical masks, and N95 respirators are used during treatment; and whether the nurses are properly trained in their usage and are fit tested. Lastly, the health of the nurses themselves was queried: did they present with ILI during the pandemic flu season and what symptoms did they experience, did they seek treatment and receive Tamiflu or oseltamivir, did they receive either seasonal or swine flu vaccinations and if they chose not to, why not? The 64 questions can be partitioned into a total of 174 separate variables. These questions consist of multiple choice, written response, and numerical-coded responses. Of these variables, 140 are dichotomous or Likert-scale categorical responses, 7 are quantitative (numerical), and 27 are short answer. For the context of the survey, ILI is defined in the study as fever (temperature of 100°F [37.8°C] or greater) and a cough and/or a sore throat in the absence of a known cause other than influenza; this is based on the CDC case definition of ILI.

C. **Data Collection**

The survey was sent out over the course of a month via three mass emails to the entire network of NASN in mid to late April of 2010. Survey responses came in between April 29 and May 27. The study covers the time frame of pandemic surveillance for H1N1 swine flu, which the CDC concluded in early April 2010 (2009 H1N1 Flu U.S. Situation, 2010) The survey was completed by 2,263 NASN members, resulting in a response rate of 18.9% out of 14,063 nurses on the email list. The survey was conducted through Zoomerang; a survey software program that creates online formatting and organizes completed surveys into a CSV file for analysis. We were provided with an MS Excel file of all of the responses for analysis in SAS by NASN

D. **Inclusion Criteria**

While most of the survey respondents work in school settings and have direct exposure to students, some do not. The analysis was restricted to registered nurses that were exposed to students on a day-to-day basis during the 2009 H1N1 swine flu pandemic. Three questions were used as a means to determine if nurses were exposed to students on a daily basis per the schematic diagram in Figure 1.

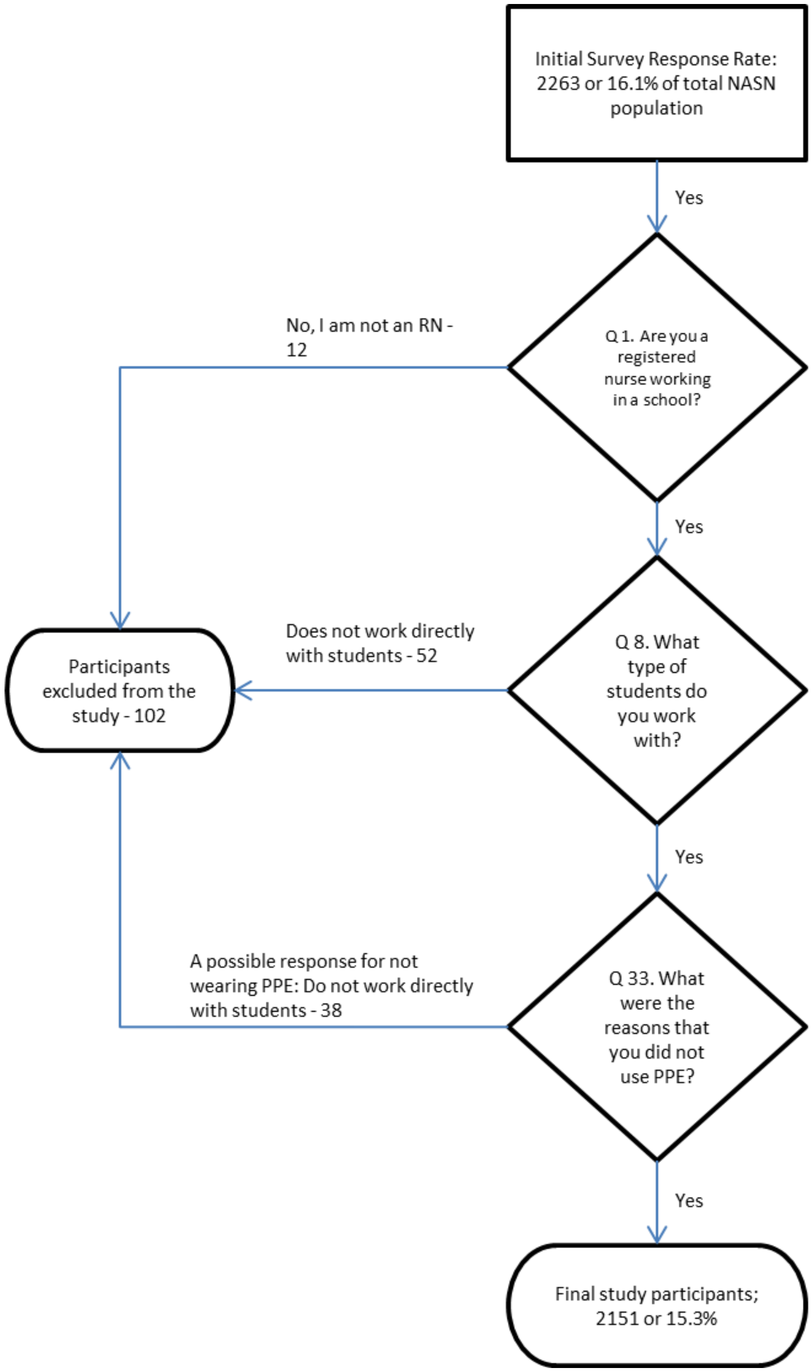

Figure 1: Filtering process to determine participation eligibility.

Total response rate: 2,263 / 14,065=16.1%; Filtered response rate: 2,151 / 14,065=15.3%

E. **Data Analysis**

Data were cleaned and then analyzed using both MS Excel and SAS. Questions that responded with “Yes” or “No” were converted into 1 and 0 because SAS interprets numerical assignments more clearly than character assignments. Questions answered in a checklist format were coded so that checks defaulted as 1s and empty spaces were considered 0s for the same reasons; SAS needs to calculate OR with dichotomous outcomes and a space character is not considered an outcome. The following questions were removed from the analysis as the NIOSH researchers deemed them scientifically unreliable: what percentage of classrooms have sinks in the school; in the last week have the school bathrooms run out of soap, paper towels, or alcohol-based hand cleaners; do students and staff have access to alcohol-based hand cleaners; does the school educate on proper sneeze and cough etiquette; do students have access to tissues; is there a source of fresh air in the health office; what reasons were infection control practices not implemented?

Frequencies were calculated for each variable. The presence of ILI was determined by a response of “yes” to the question: “Were you sick with fever AND either sore throat or cough at any time between August 2009 and January 2010?” Odds ratios were determined for questions that assessed either exposure or protective circumstance by relating question 40 responses and the aforementioned factors. Statistically significant OR are reported.

F. **Tests of Internal and External Validity**

In order to check for internal validity, I evaluated the association between questions that would be expected to elicit similar results. For example, question 40 in the survey asks about ILI status based on a list of very specific symptoms, whereas question 41 lists symptoms and asks respondents to check the ones that apply. Since “fever” is part of the case definition for “ILI,” anyone who answers “Yes” to question 40 should have checked “fever” and either sore throat or cough in question 41. Questions 40 and Question 41 were concordant by 55% of respondents.

Questions 7 and 17 ask what grade levels the school nurses are responsible for and so should ideally reflect one another identically. These questions lacked concordance when compared across grade levels: 24.6%, 44.9%, and 8.6%, respectively, for elementary up to high school.

The next questions were used to filter out nurses that did not work directly with students. Question 8 poses; “What type of students do you currently work with?” One of the responses is that they do not work directly with students. Question 33 asks the reasons for not wearing PPE when dealing with students (one of the responses was they do not work directly with students). Initial filtering based on question 8 eliminated 54 potential respondents from the survey. While all 54 nurses who responded to question 8 responded to question 33, an extra 38 respondents (a total of 92 eliminations) were found eliminated from the study by the latter question. Utilization of isolation areas by both faculty and students are assessed in question 28: there were two parts, each asking if either students or faculty had access to an isolation area in the school. There were 2,085 respondents to the student isolation question and 2,079 respondents to the staff isolation question. Of those responses, 1,707 or roughly 82% in both instances were concordant.

The presence of health offices are assessed by questions 27 and part of question 64. Question 64 asks “What are the reasons for not implementing infection control strategies in the school?” One of the response choices is a lack of a health office. Question 27 shows that 63 out of 2,136 respondents lack a health office. Question 64 indicates that 44 respondents lack a health office. There are 10 concordant answers between the two questions.

IV. RESULTS

A. The National Association of School Nurses Population

A demographic survey conducted via email was sent to the entire NASN membership, out of which 3,138 members or 22.3% responded. Of the respondents, 2% held doctorates, 3% were advanced practice registered nurses, 28% held master's degrees, 50% held bachelor's degrees, and 9% held associate's degrees. The remaining 4% held either a high school diploma or a graduate equivalency degree and were not qualified to sit for state board examinations to certify them as registered nurses. The majority of the respondents, 81%, work for public primary or secondary schools, 6% work in private or parochial school settings, and the remaining 13% listed other, which includes collegiate or organizational level work.

B. Exposure Characteristics Tables

The following tables were assembled from questions in the survey that described exposure risks for nurses working in school settings. Table II describes treatment procedures that expose them to airborne infectious agents or fomites, including influenza.

TABLE II

TREATMENT METHODS EMPLOYED BY SCHOOL NURSES

Have you performed any of the following treatments on students?	**Counts**
Administration of nebulizing medications	1244
Suctioning	144
Acquisition of nasopharyngeal sample	20
None Listed	743

As shown in Table III, exposure to children of pre-school and kindergarten age increased the odds of ILI presentation among participating school nurses. Note that all listed ORs below, (Tables III through XI) should be considered crude, or unadjusted. Personal protective equipment, such as surgical masks, N95 respirator, gloves, and gowns were not often used in administering treatment to children, as shown in Table IV.

TABLE III

ASSOCIATION BETWEEN EXPOSURE TO SELECT AGES OF CHILDREN AND INFLUENZA

Student Exposures Related to ILI	**Odds Ratio**	**CI95%**
Primarily Exposed to Preschool students	1.3	(1.06, 1.59)
Primarily exposed to Kindergarten students	1.24	(1.02, 1.51)

TABLE IV

ODDS OF USING PERSONAL PROTECTIVE EQUIPMENT WHEN ADMINISTERING TREATMENT TO STUDENTS

		Administered Treatment to Students? Yes	No	Odds Ratio	CI95%
Surgical Mask Used	*Yes*	617	402	1.12	0.94, 1.33
	No	635	463		
N95 Respirator Used	*Yes*	239	149	1.14	0.91, 1.43
	No	995	708		
Gloves Used	*Yes*	1132	770	0.13	0.10, 0.16
	No	1172	101		
Gowns Used	*Yes*	72	31	0.34	0.25, 0.46
	No	132	831		

C. Nurse Health—Influenza-Like Illness and Vaccine Status Tables

Sixty-seven point nine percent of participating school nurses reported receiving the H1N1 vaccine. Those that were unvaccinated were much more likely to contract swine flu than those that were vaccinated, as shown in Table V below.

TABLE V

INFLUENZA-LIKE ILLNESS AND VACCINE STATUS AMONG THE SCHOOL NURSE RESPONDENTS

	Counts	
Respondents That Presented with ILI between August 2009 and January 2010	555	
Respondents that Received the H1N1 Swine Flu Vaccine	1460	
Respondents that had a Physician recommend they be Vaccinated	1314	
Odds Ratio: Chose not get H1N1 flu vaccine vs. ILI presentation	**OR**	**CI95%**
	1.42	1.15, 1.74

TABLE VI

REASONS WHY SCHOOL NURSES CHOSE NOT TO VACCINATE

Why did you not get the H1N1 vaccine?	Counts	Percentage
Concerns about side effects or sickness	216	33.28%
I already had H1N1 flu	90	13.87%
Denied the vaccine	80	12.33%
Vaccination is not needed	49	7.55%
Allergic to the vaccine	40	6.16%
Think vaccines do not work	9	1.39%
Costs too much to get the vaccine	1	0.15%
Other (specify)	92	14.18%
Not available	72	11.09%
Total	649	

Concerns about side effects or sickness were major reasons for not getting the vaccine. Almost 9% of the respondents feel that vaccination is not needed or that vaccines do not work. Common other responses: “aging out,” or the perception that they were part of an older age group that did not need vaccination against swine flu (12 respondents); 18 respondents fell into the category of just not wanting the vaccination with no other explanation given; the rest preferred natural immunity or were listed as “too busy” to get the vaccination.

D. **Personal Protective Equipment Policy and Utilization Tables**

The odds of developing ILI were increased due to lack of PPE use, as shown below in Table VII.

TABLE VII

PERSONAL PROTECTIVE EQUIPMENT UTILIZATION AND AVAILIBILITY VERSUS NURSE PRESENTATION OF INFLUENZA-LIKE ILLNESS

Associated with ILI status	**Crude Odds Ratios**	**CI 95%**
PPE was not available in the office and classrooms	1.64	(1.29, 2.06)
Using PPE interferes with providing care	1.62	(1.01, 2.61)
Lack of Glove Usage	1.41	(1.02, 1.97)
I did not know the student had ILI, which resulted in lack of PPE usage	1.32	(1.04, 1.68)
The school did not provide PPE	1.31	(1.02, 1.67)

The presence of a policy on use of specific types of PPE, including respiratory protection was associated with reported use of PPE, as shown in Tables VIII, IX and X.

TABLE VIII

ODDS OF PERSONAL PROTECTIVE EQUIPMENT USAGE VERSUS PRESENCE OF FORMAL UTILIZATION POLICY

PPE Policy Presence		**PPE Policy +**	**PPE Policy -**	**Crude Odds Ratio**	**CI 95%**
Glove Usage	*Yes*	1006	112	1.28	(0.96, 1.72)
	No	896	121		
Gown Usage	*Yes*	83	1018	4.01	(2.44, 6.59)
	No	20	985		
N95 Usage	*Yes*	303	85	4.11	(3.173, 5.32)
	No	791	912		
Surgical Mask Usage	*Yes*	688	331	3.38	(2.83, 4.04)
	No	418	680		

TABLE IX

ODDS OF RESPIRATORY PERSONAL PROTECTIVE EQUIPMENT USAGE VERSUS PRESENCE OF RESPIRATORY PROTECTION PROGRAM

		Presence of a Respiratory Protection Program?			
		Policy +	***Policy -***	*Odds Ratio*	CI 95%
Surgical mask usage	*Yes*	234	778	1.58	(1.27, 1.96)
	No	179	940		
N95 Respirator Usage	*Yes*	154	229	3.87	(3.03, 4.93)
	No	259	1489		

Nurses who were fit-tested for and trained in the use of the N95 respirator were much more likely to use it than those who were not, as shown in Table XI.

TABLE X

PRESENCE OF TRAINING AND FIT TESTING OF N95 RESPIRATOR AND USAGE

		Training on the usage of the N95 Respirator			
		Received Training	*Did not Receive Training*	*Odds Ratio*	CI95%
N95 Respirator Usage	*Yes*	207	179	5.20	(4.11, 6.57)
	No	317	1426		
		Fit Tested on the N95 Respirator			
		Fit tested	*Not Fit Tested*	*Odds Ratio*	CI95%
N95 Respirator Usage	*Yes*	104	282	3.01	(2.30, 3.96)
	No	191	1563		

V. DISCUSSION

A. **Why School Nurses Are at Increased Risk**

The results of this study suggest that there is an increased odds of developing ILI with exposure to younger children (kindergarten and preschool school age) versus older children. Table III shows that nurses exposed to preschoolers and kindergartners are 1.30 to 1.24 times more likely to present with ILI than nurses who were exposed to older grade levels. This result is supported by the literature. A study found H1N1 titers indicating that half of all school age children in Hong Kong were infected during the initial spread of the pandemic flu (Wu et al. 2012). Both studies seem to indicate that younger children are not only more prone to influenza infection, but are also more likely to infect others with whom they are in close contact. In addition to physiological traits that may make children more infective, such as an increased viral shedding rate due to their inexperienced immune systems (Block et al. 2008), they also may not use appropriate hygiene habits such as washing hands consistently. An Egyptian study found that appropriate HH habits reduced the incidence of ILI by more than 40% in school environments (Talaat et al. 2011).

B. **Importance of Personal Protective Equipment and Factors that Affect Usage**

Given the unpredictable nature of the school enterprise, PPE usage becomes more important since it is often the only control accessible both financially and practicably by the school nurse. Literature supports the usage and effectiveness of PPE as a means of reducing the transmission risk of influenza. A CDC resource on infection control practices related to H1N1 listed PPE on its hierarchy of controls (Interim Guidance on Infection Control Measures 2009). A study referenced in the literature review found that the usage of surgical masks within households had a preventive effect on the transmission of ILI (McIntyre et al. 2009). Another study conducted in Canada in 2009 found surgical masks to be as effective at preventing the presentation of ILI as N95 respirators within a clinical setting; 23.6% of the surgical mask group compared to 22.9% of the N95 respirator group presented with ILI (Loeb et al. 2009). Lastly, a study assessing the impact of glove usage within a clinical setting among health care workers found that infrequent usage lead to the presence of elevated H1N1 blood titers (Ramirez et al. 2006). As seen in Table VII, the lack of glove usage was positively associated with ILI status among the respondent population with an OR of 1.41, CI 95 (1.02–1.97).

Other PPE usage, referring specifically to the usage of N95 respirators, gowns, and surgical masks while treating ILI-presenting students, was not significantly associated with reductions in ILI exposure. However, reasons given for not using PPE in general were also positively associated with ILI status. Table VII gives the following reasons for not wearing PPE and positively associates them with ILI status: PPE being unavailable in classroom or nursing offices; PPE usage interferes with provision of care; uncertainty regarding the students ILI status; and, the school not providing the appropriate PPE. Going further with this, the association between PPE usage and the presence of a written PPE program and respiratory protection program are shown in Tables VIII, IX, and X. Though glove usage was not significantly associated with a formalized PPE policy, other equipment seemed to be strongly associated with a written policy, including gowns, surgical masks, and N95 respirator usage. When a respiratory policy was in place, receiving training and fit testing on the usage of N95 respirators was strongly associated with an increase in usage while administering treatment. The cross-sectional design of this study does not allow us to know whether the use of PPE was due to having a formalized

PPE program or was a causal consequence of simply having access to it, even though having access is more likely with a program in place. The OSHA CFR 1910.934 specifies that employers are required to provide respirators when hazards are present, and although OSHA standards are not enforceable, governmental employees (nurses in public school settings), they do provide a basis for protecting these workers, as well.

C. **Vaccination Status and Self-Care of Nurses**

As can be seen in Table VI, the limited vaccination of school nurses is a surprising finding. Even more surprising is their belief that the vaccine's side effects put them at greater health risk than an infection. These vaccinations have been demonstrated to be quite safe, and school nurses have the education to be able to understand study findings on this issue. Although personal beliefs are important in making decisions on an individual level, there is room for delivering a stronger and clearer message about this, particularly to a workforce that has the potential to spread infection to the most vulnerable age group. Furthermore, a nurse or any health care practitioner that is not inclined to receive the vaccine, may also not support its distribution. In our sample, 25.4% of nurses reported ILI at some point during the pandemic season, compared with an estimated 20% of the US population during the pandemic.

D. **Study Limitations**

There are many limitations to this study. The nature of the cross-sectional study design limits the ability to draw conclusions about causation, in this case, between respondents' exposure and ILI status as outcome variables. The reasoning for this is chronological occurrence; it cannot be established that the exposure happened prior to the nurse developing ILI. Thus, a causal relationship cannot be established.

The ILI case status is a clinical definition that specifies a set of symptoms in the absence of a known cause other than influenza. A variety of diseases and allergies could present similarly to influenza, thereby overestimating the actual number of influenza cases.

External validity determines the ability to generalize results of the study to the population from which the sample was drawn. In this case, that would be NASN or school nurses in general. The initial response rate was 2,263 out of 14,065 nurses that are on NASN's LISTSERV. This equates to a response rate of almost 17%. After filtering out nurses that are not registered and do not interact directly with students, it decreases to a 16% response rate. Self-selection may favor nurses who were symptomatic during the pandemic. This could overestimate ILI in this population. Recall bias among the respondents could have affected the responses to many of the questions. For example, respondents may have associated any upper respiratory infection with ILI. Additionally, if they got sick, they may remember risk factors differently.

Finally, in the demographic survey described in chapter IV, nine survey questions were redundant and answers that should have been identical were different based on how the question was framed. Percent differences in response rates by question varied from 8% to 50% or more. This compromises the study's internal validity or reliability.

VI. CONCLUSIONS

The purpose of this study was to determine first, what exposure factors may have contributed to the presentation of ILI; second, what controls and guidelines meant to reduce the spread of swine flu were in place among the NASN population per CDC guidelines; and third, what changes could be made to the current guidelines to make them more effective at preventing the presentation of ILI in school nurses. The following risk factors were found to be positively associated with ILI status among the respondents: working primarily with preschool or kindergarten students; a lack of PPE access and usage, and not having received the H1N1 vaccination. Having a formalized PPE and respiratory policy program and receiving training on how to use N95 respirators with fit testing has an effect on the frequency of use. There is especially a deficiency in PPE usage among nurses tending to students that come in for ILI-related evaluation, who present the greatest exposure risk. While adhering strictly to CDC policies and recommendations may not be possible in a school environment, adherence to at least some of them would reduce exposure and should be encouraged. CDC could create online resources or webinars that address the salient issues in school settings: making available and promoting usage of appropriate PPE with regards to ILI-presenting students; dispelling misconceptions regarding vaccine safety; and determining which populations should receive the vaccination.

APPENDIX

<u>CDC Guidelines Evaluated by Survey</u>

The pertinent guidelines that are relevant to the school and assessed by the survey are as follows; involvement in the setup of a vaccine clinic, presence of a comprehensive pandemic response flu plan, social distancing applied and educational efforts made to inform both staff and students about influenza control strategies.

TABLE XI

NURSE PARTICIPATION/INVOLVEMENT IN VACCINE CLINICS

Nurse Participation/Involvement in Vaccine Clinics	**Counts**	**Percent**
Assisting others (i.e., health department, local authorities) with setting up	1183	55.00%
No involvement in vaccine clinic(s)	618	28.73%
Administered H1N1 vaccine to students: how many students?	511	23.76%
Solely responsible for setting up immunization clinic	226	10.51%
Other	150	6.97%

TABLE XII

FLU PLAN AND EDUCATIONAL MEASURES

Flu Plan and Educational Measures	**Counts**	**Percent**
Number of School Nurses that Have a Formalized Pandemic Flu Plan in Place	1573	73.13%
Types of social distancing measures implemented	**Counts**	**Percent**
Nothing was implemented	1355	62.99%
Spacing students desks apart	424	19.71%
Separating students in different classrooms	63	2.93%
Cancelling classes	35	1.63%
How did you educate students or staff about flu prevention?	**Counts**	**Percent**
Posters	1928	89.63%
Staff meetings	1624	75.50%
Classroom instruction / demonstration	1355	62.99%
Brochures	1278	59.41%
Parent Teacher Organization Meetings	490	22.78%
I have not educated students or staff on flu prevention	53	2.46%

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