**Distribution Agreement**

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Lauren Satchell Date

Assessment of Teacher Knowledge of Effective Infection Prevention Interventions in an Archdiocesan Elementary School Setting

By

Lauren Satchell
MPH

Executive Master of Public Health

_____ [Chair's signature]
Juan Leon PhD, MPH
Committee Chair

_____ [Member's signature]
Lauren F. Le Goff MS, MLS (ASCP) $^{CM}$, CIC
Committee Member

# Assessment of Teacher Knowledge of Effective Infection Prevention Interventions in an Archdiocesan Elementary School Setting

By

Lauren N. Satchell

B.A
Arcadia University
2007

Thesis Committee Chair: Juan Leon PhD, MPH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Prevention Science
2020

# Abstract


Assessment of Teacher Knowledge of Effective Infection Prevention Interventions in an Archdiocesan Elementary School Setting

By Lauren Satchell

School aged children and teachers miss millions of school days each year due to upper respiratory and gastrointestinal viral infections. As a result, these acute infections can lead to increased time away from work or school, loss of wages, increased healthcare costs, and decreased productivity. With many elementary schools dealing with a shortage of school nurses, students have come to rely on teachers and school administrators for health related concerns and education. Because of this, it has become increasingly important for elementary school teachers to understand upper respiratory and gastrointestinal transmission and basic infection prevention practices in elementary schools. In order to understand what elementary school teachers understand about upper respiratory and viral transmission, we developed and distributed a quantitative survey to Archdiocesan elementary school teachers in Delaware County Pennsylvania, with a focus on Kindergarten through 8$^{th}$ grade teachers. Questions included basic infection prevention practices about hand hygiene, cleaning and disinfection, and viral transmission and one question about influenza vaccinations.

67 out of 281 survey responses were submitted and analyzed. More than half of the respondents (54%) were primary elementary school teachers with at least 11 years of experience. Almost all (93%) of participants had access to hand hygiene products and/or soap and water and sink, tissues, and disinfecting product. Most of the elementary school teachers (99%) were knowledgeable about fomite transmission. However, very few participants (40%) correctly answered questions on proper hand hygiene techniques and also other transmission based questions (17%). Of the teachers who did not receive the flu vaccine, slightly less than half (46%) listed that the flu vaccine will make them sick with influenza or that flu vaccines do not work as their reason for not receiving the influenza vaccine.

There are additional opportunities for education on infection prevention practices and respiratory and gastrointestinal viral transmission for elementary school teachers of grades Kindergarten through 8$^{th}$ grade in Delaware County, PA.

# Assessment of Teacher Knowledge of Effective Infection Prevention Interventions in an Archdiocesan Elementary School Setting

By

Lauren Satchell

B.A
Arcadia University
2007

Thesis Committee Chair: Juan Leon PhD, MPH

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
In partial fulfillment of the requirements for the degree of
Master of Public Health
in Executive Master Public Health
2020

# Contents

# CHAPTER 1: Introduction

## *1. Background and Significance*

In the United States, gastrointestinal viral illness or viral gastroenteritis accounts for 3 to 5 million outpatient visits, approximately 200,000 hospital admissions, and several hundred deaths per year (Cochran, 2017) . Gastrointestinal viral illnesses are also responsible for significant healthcare costs and lost productivity (Sandora, Shih, & Goldmann, 2008). While viral gastroenteritis can occur during any time of the year, approximately 80% are identified from November to April, typically the months that children are traditionally in school (Centers for Disease Control, 2019-a).

Like viral gastroenteritis, respiratory viral infections affect millions of individuals in the United States each year (Monto, 2002). Respiratory infections are categorized into upper and lower respiratory tract infections (Purushothama & Liu, 1996). Upper respiratory tract infections, frequently referred to as the common cold, are infections caused by a group of diseases consisting of several families of virus (Heikkinen T, 2003). Besides the common cold, influenza is another contagious, potentially serious, respiratory virus that is easily spread from person to person (Chunara, Goldstein, Patterson-Lomba, & Brownstein, 2015).

The 2017-2018 influenza season was considered one of the most severe, with a high volume of outpatient and emergency department visits, hospitalizations, and the cause of an estimated 80,000 deaths in the United States alone (Centers for Disease Control and Prevention, 2019-b). Figure 1 shows that in 2017, ILI had the highest percentage of visits in the outpatient setting since the 2009-2010 flu pandemic (Centers for Disease Control, 2018-c).

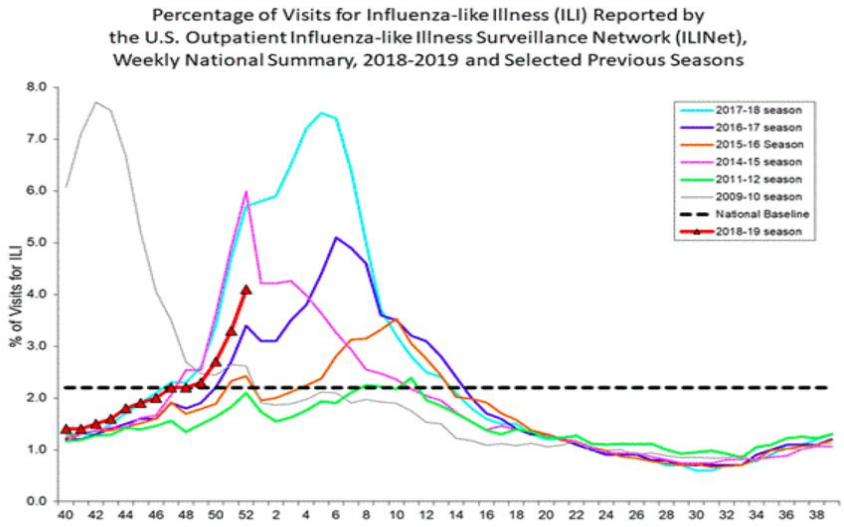


*Figure 1. Percentage of visits for Influenza-like Illness in outpatient settings pulled from Flu View, an interactive data display pulled that is collected and analyzed by the Centers for Disease Control. (Centers for Disease Control, 2018*).

Children are more susceptible to acquiring upper respiratory or gastrointestinal viral illnesses because of their developing immune systems (Walker & Slifka, 2010) . Viruses responsible for upper respiratory infections in children and adults can cause long lasting immunity against the strains responsible for infection. Respiratory viral strains are heterogeneous, meaning both adults and children are susceptible to acquiring multiple viral infections with the same pathogen but different strains (Jacobs, Lamson, St. George, & Walsh, 2013). For example, rhinovirus, a respiratory virus most commonly linked to the common cold is comprised of over 160 types and can lead to different clinical outcomes (Lee, et al., 2012). Children are more likely to be in close proximity with one another for long periods of time either in a school setting or extracurricular activities. As a result, children are therefore more likely to come into contact with infectious secretions and introduce virus into their systems (St. Louis Children's Hospital, 2019). The fall and winter months are known to be peak respiratory and gastrointestinal viral season which also correlates with the time that most traditional primary schools are in session.

Each viral season comes with the increased likelihood that caregivers of school aged children will need to take time off of work to care for their sick child (Wang, Lapinski, Quilliam, Jaykus, & Fraser,

2017). In addition to missed days from work and school, both the caregiver and sick child may experience decreased productivity and time away from other daily activities (Cotton, Innes, Jaspan, Maddie, & Rabie, 2008). Understanding the fundamentals of good respiratory etiquette at home and school is important to learn at a young age and also reduce the risk of acquiring and spreading infection. According to the Centers for Disease Control and Prevention (CDC) and the Association of Professionals in Infection Control and Epidemiology (APIC), practicing good hand hygiene, disinfecting high touch surfaces in the classroom and receiving the flu vaccine are some of the ways to help students and school employees remain healthy and germ free (Association for Professionals in Infection Control and Epidemiology, 2018). Recognizing what teachers know about germ transmission and infection prevention is a key strategy to aid in reducing the risk of spreading respiratory and gastrointestinal viral illness in the classroom. Because of this, there is a need to assess teacher knowledge of respiratory and gastrointestinal infection transmission on a local level. Understanding teacher knowledge in a specific geographic area could inform infection prevention education tailored towards the needs of the schools.

### *1.2 Delaware County, Pennsylvania*

The state of Pennsylvania reported 122,030 cases of influenza during the 2017-2018 Influenza Season (Pennsylvania Department of Health, 2018). The southeast region of the state saw the highest percentage of visits to the emergency department for influenza like illness (ILI) **(figure 2).** Delaware County is one of 67 counties in Pennsylvania and is located in the southeastern region of the state. (Delaware County Pennsylvania, 2017). It is a suburb of and adjacent to Philadelphia County and its major hospitals. Delaware County is also a densely aggregated area and considered the fifth most populated county in one of the smallest geographic regions in the state (Delaware County Pennsylvania, 2017). Delaware County reported 5,470 cases of ILI, one of the highest case counts of ILI in the southeastern region of the state (Pennsylvania Department of Health, 2018).

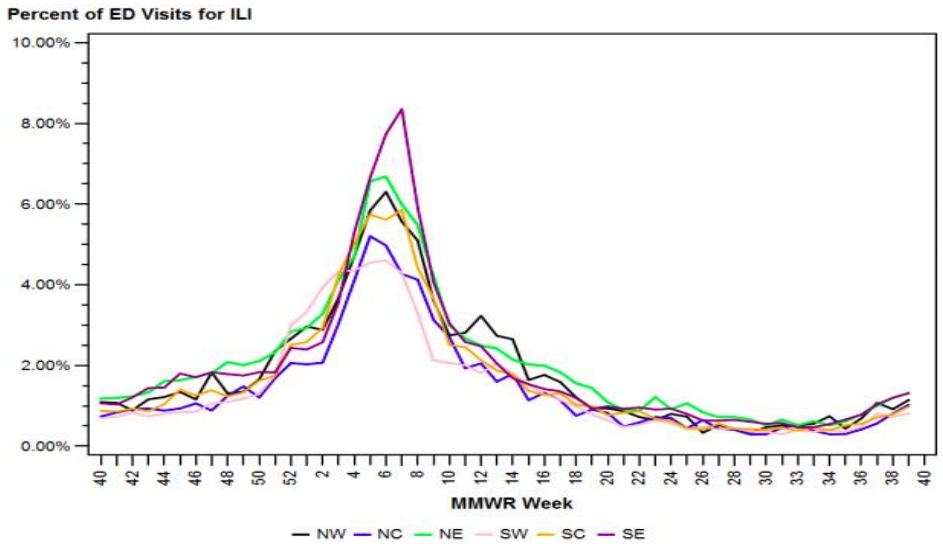


***Figure 2 Percent of Emergency Department Visits with Influenza-Like Illness (ILI*) As Reason for Visit*** (Pennsylvania Department of Health, 2018)

The Philadelphia Department of Public Health (PDPH) implements syndromic surveillance in local emergency departments within Philadelphia County (Philadelphia Department of Public Health, 2019). Syndromic surveillance is a method of detecting illness with the purpose of being able to identify clusters early without needing confirmatory testing (Mandl, 2004). Philadelphia area pediatric ambulatory clinics submit data to the PDPH for analysis (Philadelphia Department of Public Health, 2019). The cases listed are not exclusive to Philadelphia residents and represent patients who were seen in the pediatric ambulatory setting. Figure 3 represents the percentage of total visits to a pediatric emergency department or pediatric clinic in Philadelphia. Similar to the data nationwide, the number of visits were higher during this past flu season than the 4-year average.

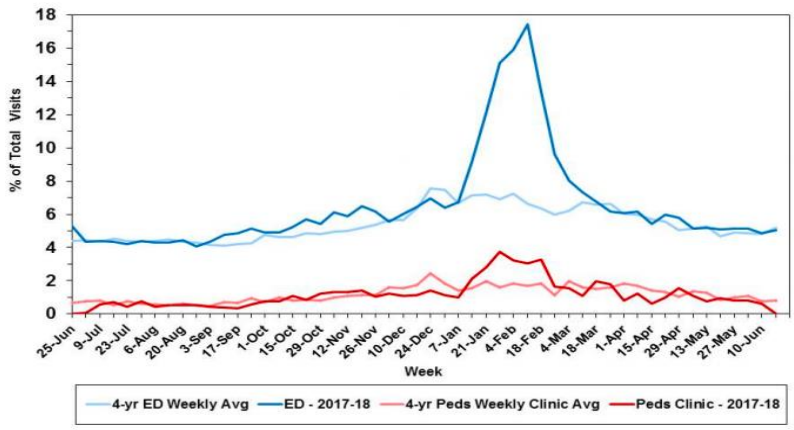


***Figure 3 Influenza-like illness at emergency departments and pediatric ambulatory clinics in Philadelphia, PA from 6/25/17 to 6/16/18*** (Philadelphia Department of Public Health, 2019)

## *1.3 Problem Statement*

School aged children (aged 5-13 years) are at a high risk of developing respiratory infections and gastrointestinal illness, commonly caused by poor hand hygiene, and contact with increased secretions (Sandora, Shih, & Goldmann, 2008). The number of upper respiratory viral illnesses is inversely proportional to age (Heikkinen T, 2003). Adults on average have 2-3 colds per year, while children develop on average 6 to 8 colds per year (Stanford Children's Health, 2019). Children are more likely to transmit virus since they most often come into contact with infected secretions that may contain virus from other school-aged children (Pappas DE, 2011). If the same children subsequently touch their mouth, nose, or eyes, transmission of the virus will likely continue (Kirkpatrick, 1996). Another mode of transmission is through air droplets (Pappas DE, 2011). Children can become infected by inhaling droplets coughed or sneezed by an infected person in close proximity (Eccles R. , 2005). The likelihood of transmission is further increased when many children are gathered together in a semi-closed setting like a school classroom or daycare (Stempel, Martin, Kuypers, Englund , & Zerr, 2009). Children are also less likely than adults to adhere to adequate hand hygiene and respiratory etiquette, which makes them more likely to spread viral infections to others (Lau, et al., 2012). One published study reviewed hand hygiene practices in middle and high school students. In this study, the authors identified that only fifty eight percent of females and forty eight percent of males washed their hands with water after using the

restroom, and only thirty three percent of females and eight percent of males used soap and water (Guinan ME, 1997).

Complications of respiratory viral infections include ear infections, pneumonia, and increased risk of asthma attacks (Revai, et al., 2007). For children diagnosed with influenza, the complications can be more severe and lead to hospitalization (Poehling KA, 2013). Figure 4 highlights the increase in the number of children nationwide with hospitalization due to laboratory confirmed influenza hospitalizations.

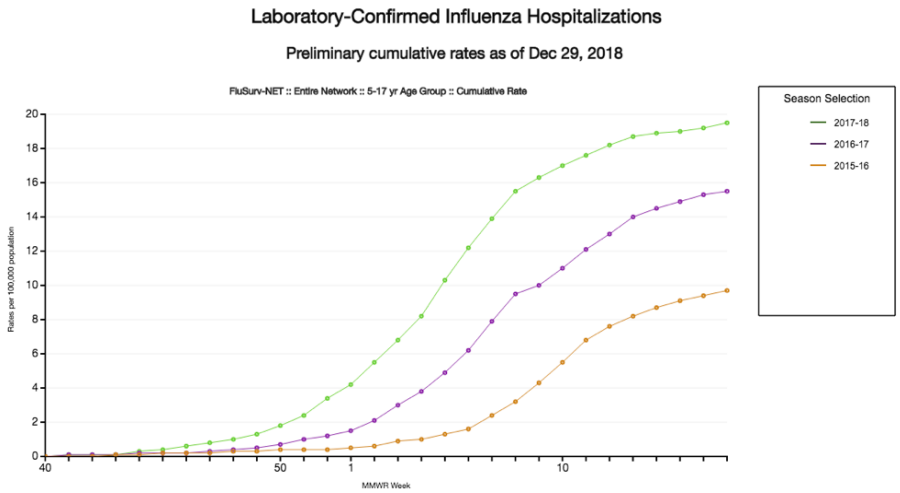


*Figure 4 Laboratory-Confirmed Influenza Hospitalizations* (Centers for Disease Control, 2018-c)

According to the CDC, approximately 60 million days of school are missed each year due to the common cold or influenza (Association for Professionals in Infection Control and Epidemiology, 2018). These data do not include gastrointestinal illnesses, which, as mentioned previously, are considered highly contagious. Acute respiratory and gastrointestinal illnesses are among the most common causes of student absences from school and developing either type of these infections can ultimately lead to increased risk of complications, office visits, absenteeism from school, and parental leave from work (Wang, Lapinski, Quilliam, Jaykus, & Fraser, 2017). In addition, missed days of school can lead to unfavorable educational outcomes for the affected child (Willmott et al., 2016). Another complicating

factor is that on average, teachers are absent from school more days than students due to illness, which can also impact student learning (Centers for Disease Control and Prevention, n.d.).

Unfortunately, many schools faced with budget constraints are reducing the number of school nurses. Less than half the schools in the country employ a full-time school nurse (Camera, 2016). Many of these schools do not have a full-time nurse on staff and rely on one or two nurses provided by the school district where they are located and therefore receive school nursing services only once a week. As a result, teachers and administrative staff are handing out medications (ex. aspirin, albuterol) for both acute and chronic conditions and tending to student health concerns (Klein, 2014). With school nurses in short supply, it is essential that teachers are knowledgeable about germ transmission and basic infection prevention measures. In turn, teachers will be able to share this knowledge with their students and have an increased understanding of their role in keeping themselves and their students free from viral illness in the classroom, and their respective communities.

### *1.4 Purpose statement*

The purpose of this study is to understand teacher knowledge of gastrointestinal and upper respiratory viral transmission; focused on Archdiocesan elementary school teachers in Delaware County, PA. In the Philadelphia area, the Archdiocese of Philadelphia consists of over 140 parochial Schools spanning Philadelphia, Montgomery, Bucks, Chester, and Delaware counties (Archdiocese of Philadelphia).

The study quantitatively surveyed teachers of children in Kindergarten through 8$^{th}$ grade parochial elementary schools in Delaware County. The objectives of this study were to 1) assess teacher knowledge of respiratory and gastrointestinal viral transmission 2) measure teacher knowledge of respiratory etiquette and hand hygiene 3) evaluate teacher knowledge of cleaning and disinfection in the classroom and 4) explore infection prevention best practices used by elementary school teachers and ancillary staff in Archdiocesan schools in Delaware County, Pennsylvania by understanding what

teachers are currently implementing to reduce the spread of upper respiratory and gastrointestinal illness in the classroom. These objectives will be met by surveying teachers and staff using a brief online survey. Example survey topics include proper hand hygiene, respiratory etiquette, flu vaccination, and cleaning and disinfection of the classroom environment.

During the past 5 viral seasons, Delaware County experienced a high number of laboratory-confirmed flu cases (Centers for Disease Control, 2018-c). Current literature on infection prevention practices in elementary schools focus on hand hygiene and respiratory etiquette in students and teachers to reduce transmission and absenteeism (Association for Professionals in Infection Control and Epidemiology, 2018). However, prior studies that focused specifically on teacher knowledge of transmission of gastrointestinal and upper respiratory viral illness, cleaning disinfection, and respiratory etiquette in the classroom are minimal.

The survey data collected from the participants will be analyzed using descriptive statistics. The results will guide future opportunities for education of basic infection prevention practices, including the importance of hand hygiene. Quantitative methods were used in this study to analyze survey results.

### *1.5 Research questions:*

1. What do elementary school educators understand about germ transmission?
2. What do elementary school educators understand about respiratory etiquette?
3. What do elementary school educators understand about proper hand hygiene techniques?
4. What do elementary school educators understand about proper cleaning and disinfection in the classroom?
5. What do elementary school educators understand about receiving influenza vaccinations?

### *1.6 Theoretical framework*

Successful public health interventions are rooted in evidence based-theoretical concepts designed to understand what aspects of individual, community, and environment influence behavior change and how to transition those concepts to promote healthy behaviors (Schensul, 2009). Implementing appropriate theory for effective interventions is crucial since many studies utilize

behavior change models within infection prevention practices (Zeigheimat, Ebadi, Rahmati-Najarkolaei, & Ghadamgahi, 2016). There are many models with similar concepts that could be integrated to develop an intervention plan to increase infection prevention practices (Kretzer & Larson, 1998). Individuals' knowledge and perception of the importance of the core elements of infection prevention like hand hygiene are varied. Proper hand hygiene is considered fundamental to the practice of infection prevention, yet many articles suggest that individuals find it challenging to identify the link between hand hygiene practices and germ transmission. For example, one publication on handwashing by healthcare workers described factors like perception of risk, and pressures from workload and colleagues as elements that influence whether or not individuals will be compliant with washing their hands (Lee, Burnett, Morrison, & Ricketts, 2014). When it comes to decision making and health behavior, evidence supports interventions that focus on risk perceptions in order to influence behavior change (Ferrer & Klein, 2015). A factor not mentioned in the above study is the notion that hand washing is important to prevent the spread of infection. Another study about hand hygiene in healthcare contends that understanding what motivates an individual to perform a specific behavior in a specific situation is necessary for designing effective interventions (Allegranzi & Pittet, 2009). The role of education in infection prevention is paramount to the success of prevention of germ transmission.

Because behaviors are a result of a complex interplay of factors that contribute to the health and health behavior of an individual, using one theoretical framework will not be adequate in some instances. Recommendations when developing and implementing infection control interventions involve using a multifaceted approach that include constructs of both the Health Belief Model and the Social Ecological Model.

## The Health Belief Model

The Health Belief Model (HBM) is one of the most utilized frameworks for designing effective programs in health education and health promotion. The goal of the HBM is to understand health

behavior and behavior modification (Glanz, Rimer, Viswanath, & Orleans, 2008). The model suggests that an individual is more likely to make a health-related behavior change to prevent illness if they believe they are at risk for acquiring the illness, there are serious consequences as a result, and they feel they have the resources to avoid the illness or increase the chance of having a positive health outcome (Jones, et al., 2015). There are six constructs of the Health Belief model; perceived susceptibility, perceived severity, self-efficacy, perceived barriers, cues to action, perceived benefits (Lewis & Thompson, 2009). Figure 5 provides a brief overview of the 6 constructs from Lewis and Thompson (Lewis & Thompson, 2009). The HBM is commonly applied in public health and healthcare. In the context of infection prevention, the HBM can be used to understand the perception of risk of being susceptible to acquiring an infection.

Multiple quantitative studies used the HBM to assess individual behaviors in infection prevention in order implement appropriate interventions. In this study, the perception of risk would be whether a teacher believes they are susceptible to becoming ill or spreading respiratory or GI viral illness in the classroom because of lack of knowledge of viral transmission. An example of a perceived benefit of the study is whether an educator will take action if they are empowered enough to know that they can take steps to reduce their risk of spread of respiratory or gastrointestinal illness in the classroom by following infection prevention practices. In this case, the negative health consequence would be acquiring a gastrointestinal illness or respiratory infection and spreading infection to other students or elementary school staff.

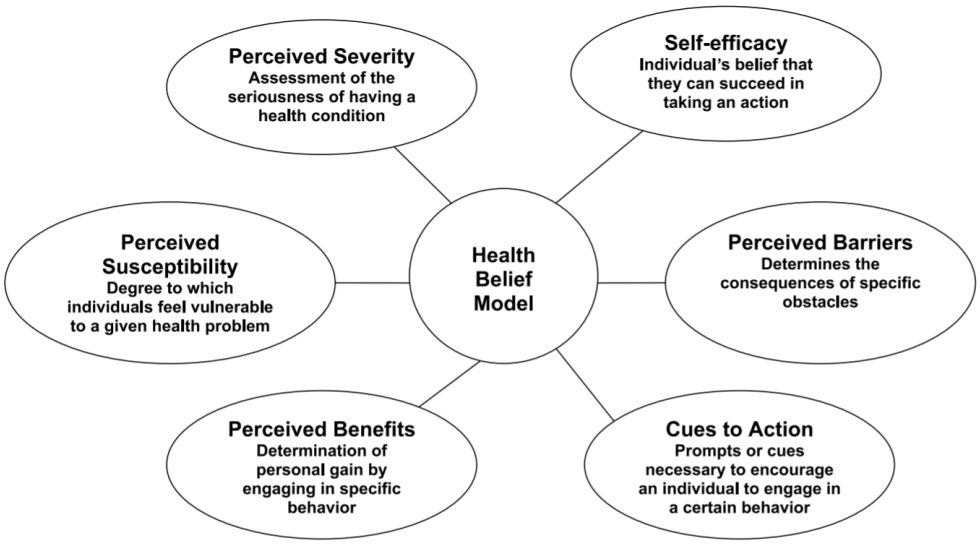


*Figure 5 Six Constructs of the Health Belief Model* (Lewis & Thompson, 2009)

### *Ecological model*

In order to consider changing behavior, the focus of the intervention should not rest solely on the individual. The individual's environment must also be considered.

The Ecological model (**figure 6**) is based on multiple layers that focus not only on the individual but also consider the community and population when developing interventions. This model contends that public health issues occur within the community and are not just shaped by experiences at the individual level (Golden, McLeroy, Green, Earp, & Lieberman, 2015). The Ecological perspective is a useful framework for understanding the range of factors that influence the health and well-being of individuals and is ideal for incorporating components of other theoretical models (Schensul, 2009). Many infection prevention interventions do not target individuals alone, but look at interventions targeted toward a group, and scaled up to the organizational level (Kretzer & Larson, 1998). The Social Ecological Model (SEM) is one example of ecological models mentioned in literatures. The SEM attempts to describe the complex interactions between individuals and factors that may influence behavior that include relationships within the community and the environment (Golden, McLeroy, Green, Earp, & Lieberman, 2015). The SEM l is a multi-layered model-with "rings of influence". Designing an

intervention would incorporate acting on all factors at the same time. The principles of the SEM suggest that in order for behavior change to occur, an intervention would need to consider creating an environment conducive to change to make it easier to adopt the health positive action.


*Figure 6 Social Ecological Model* (Office of Behavioral and Social Sciences Research, 2014)

Frameworks involving behavioral change integrate models that describe ways to influence behavior and involve a collective approach to understanding why a person may or may not practice health positive behaviors. Studies have shown that public health initiatives are more likely to be successful if they incorporate a multi-level or ecological approach that focus on individual, interpersonal, community, and population levels. Developing interventions that produce a desired health change towards a positive health outcome are best implemented when understanding and skillfully applying the behavioral change theories in research and public health practice. (Glanz, Rimer, Viswanath, & Orleans, 2008).

## *1.7 Significance Statement*

Gastrointestinal and respiratory viral illnesses remain a health and economic burden. Assessment of teacher knowledge of basic infection prevention practices will help identify opportunities to educate on basic cleaning and disinfection practices, respiratory etiquette, proper hand hygiene practices, and the importance of influenza vaccinations. Teachers are critical in disseminating information to students in the classroom. They are a trusted source of information and next to a school

nurse, would be a viable alternative to school nursing to relay and practice important infection prevention practices in the classroom.

Delaware County's proximity to Philadelphia, a major metropolitan area, and accessibility to county level ILI data were two contributing factors that helped to identify Delaware County as a geographic region of focus for this project. The count of ILI cases alone in Delaware County highlights the need of elementary schools to identify knowledge gaps in how highly infectious upper respiratory and GI viral pathogens are transmitted. This study aims to identify future educational opportunities for infection prevention education for Archdiocesan Elementary School teachers in Delaware County through analysis of survey results.

### *1.8 Definition of terms*

GVI-Gastrointestinal Viral Illness

ILI-Influenza-like Illness

RSV-Respiratory Syncytial Virus

SCT-Social Cognitive Theory

HBM-Health Belief Model

GE-Gastroenteritis

Immunosuppressed- suppression of immune system which impacts its ability to fight infection.

Asymptomatic-individual carrier of disease who is not experiencing any symptoms

Carrier- individual infected with a pathogen showing no signs or symptoms

Viral Shedding-when an individual infected with a virus begins secreting virus through secretions, droplets

Incubation Period-time from acquiring infection to exhibiting symptoms of illness

# CHAPTER 2: Literature Review

## *2.1 Overview of respiratory and gastrointestinal illnesses*

### *Gastrointestinal Illness*

Acute gastroenteritis remains a significant cause of global morbidity and mortality in children in developing countries (Robert E Black, 2010). In developed countries like the United States, gastroenteritis is a frequent cause of visits to primary care, and emergency departments due to dehydration - a common complication of GI illness (Elliott, 2007). Most healthy people recover from acute viral gastroenteritis in days without any complications. However, viral gastroenteritis can be deadly in infants, older adults, and immunosuppressed individuals.

Gastroenteritis is caused by inflammation of the intestines that results in clinical symptoms like diarrhea, abdominal pain, nausea, and vomiting (Minnesota Department of Health, 2019). Acute gastroenteritis, or gastrointestinal illness is defined as a sudden increase in both frequency and output of stool above baseline with or without the existence of abdominal pain, fever, nausea and/or vomiting within a 24 hour timeframe (King, Glass, Breese, & Duggan, 2003). Most cases of acute viral gastroenteritis are self-limiting (Stuempfig & Seroy, 2019). Symptom duration of acute gastroenteritis is less than 14 days, with the average time until symptom resolution being 1-3 days (Sattar, 2019). Acute gastroenteritis can be viral, bacterial, or parasitic infections (Chow, Leung, & Hon, 2010).

Viral infections, like norovirus, make up between 70 to 90 percent of gastrointestinal illness (Elliott, 2007). Bacterial infections, like *Escherichia coli* make up 10 to 20 percent, and parasitic infections like *Giardia intestinalis* and *Cryptosporidum* are 5 percent of gastrointestinal infections (Churgay, 2012). This study is concentrated on teacher knowledge of acute viral gastroenteritis.

### *Gastrointestinal Viral Illness*

Organisms causing acute viral gastroenteritis are highly communicable, and are most often the cause of outbreaks in community settings like schools and healthcare facilities (Stuempfig & Seroy, 2019). Approximately half of adults and children infected with common gastrointestinal viruses like rotavirus and adenovirus are asymptomatic, meaning they do not exhibit GI viral symptoms (Musher & Musher, 2004). While asymptomatic carriers are still able to shed virus, the role that asymptomatic carriers play in transmission of enteric viruses is unknown. Symptomatic cases can transmit virus prior to onset of symptoms as well (Wu, et al., 2019). Symptoms of GI Illness can develop a short time after exposure- from 12 hours to five days (Schreiber M.D, Blacklow, MD, & Trier, 1973).

Norovirus is the leading cause of viral gastroenteritis in the United States. It is highly contagious, with as few as 18 virus particles thought to be sufficient to cause infection (Teunis, et al., 2008). Norovirus is also considered one of the primary causes of vomiting and diarrhea in the United States (Centers for Disease Control and Prevention, 2018-d). It is transmitted primarily through the fecal-oral route, either by direct person to person spread, or contaminated food (Teunis, et al., 2008). In the United States, norovirus is estimated to be the cause of approximately 19 to 21 million gastroenteritis cases each year, representing approximately 60% of all acute gastroenteritis cases from known enteric pathogens (Hall, et al., 2013). Since patients with mild cases typically do not present to a health care provider, the number of approximate cases is most likely most likely an underestimate. Annually, norovirus is responsible for 1.9 million outpatient visits, 400,000 emergency department visits and 570 to 800 deaths, mostly among children and elderly (Centers for Disease Control, 2018-a). In children, norovirus contributed to 56,000 to 71,000 hospitalizations and attributed to nearly 1 million pediatric medical care visits annually (Payne, et al., 2013). Since the introduction of the rotavirus vaccine, norovirus is also the most prevalent viral gastroenteritis among young children in the United States (Cochran, 2017). Other causes of viral gastroenteritis include astrovirus, rotavirus, enteric

adenovirus, sapovirus, and while is it common for individuals to be co-infected with a combination of viral enteric organisms, the effect is unknown (Velazquez, et al., 1996). While all of these viruses can occur during any time of the year, there is a seasonality to these viruses in temperate climates (Borrows & Turner, 2014).

Most gastrointestinal viral illnesses are asymptomatic, however, asymptomatic individuals can still shed virus, leading to increased likelihood of viral transmission to other individuals in close contact (Barclay L., 2014). Because of the high secondary attack rate of most acute viral illnesses, knowledge of estimated incubation periods is essential to reduce secondary transmission-especially in semi closed settings (Lee RM, 2013). Lee et. al performed a systematic review of literature detailing the incubation periods of enteric viruses, including astrovirus, norovirus, rotavirus, and sapovirus. Two hundred fifty six publications included estimates of incubation periods of GI viral pathogens with public health implications. Pooled mean analysis was performed for data pulled from thirty three articles where individual level data was provided (Lee RM, 2013). Through their metanalysis of published incubation periods of the 5 most commonly identified viruses, Lee et al was able to provide further support to the importance of improving infection prevention practices in settings that are considered high risk for viral transmission like schools (Lee RM, 2013).

### *Bacterial and Parasitic gastrointestinal illness*

Gastrointestinal illness due to bacteria or parasites comprise approximately 30% of acute gastroenteritis cases in children in resource rich countries like the United States (Elliott, 2007). Differences in symptomology for bacterial or parasitic gastroenteritis versus viral gastroenteritis include high fever, and gross blood or mucous found in the stool (Boyce, 2019). Bacterial, parasitic, and viral enteric pathogens cause symptoms that make it difficult to distinguish between acute causes of gastroenteritis, with the exception of severe symptoms, like diarrhea (Cohen, 1991). Most often, adults and children will not present to their healthcare provider for mild symptoms. In a study looking at 173

previously healthy adults who presented to their healthcare provider with severe diarrhea, 87 percent had a bacterial enteric organism identified from stool (Dryden MS, 1996). There is often an exposure component-whether it be international travel to resource limited areas, occupation, exposure to contaminated poultry or processed meat, or other food product (Cedars Sinai, 2019). Bacterial gastroenteritis sources include *Escherichia coli*, Salmonella, Shigella, and Campylobacter jejuni. Example of parasitic causes include giardia, cryptosporidium, microsporidia and cyclospora (Musher & Musher, 2004).

### *Influenza*

Influenza is a respiratory virus that causes acute infection (Dolin, 2018). It is responsible for seasonal epidemics worldwide (World Health Organization, 2018). In temperate climates like the United States, more cases and clusters are identified in the winter months (Grohskopf LA, 2018). While most influenza cases resolve without complications, individuals with influenza can increase the burden on healthcare resources (Dolin, 2018). Those resources include increased visits to the emergency department, outpatient or urgent care settings, and primary care physicians (Cope RC, 2018). Symptoms of influenza can involve both the upper and lower respiratory tract and can vary in severity depending on age and underlying conditions (Centers for Disease Control and Prevention, 2018-b). While the impact to an individuals' health is mostly minimal, it is associated with significant morbidity and mortality, especially in high risk populations (Lucero-Obusan C, 2018).

Influenza is highly transmissible and is spread when a healthy person comes into contact with respiratory secretions of someone with influenza, touching surfaces contaminated with influenza virus, or coming into contact with air droplets (Brankston, Gitterman, Hirji, Lemieux, & Gardam, 2007). How much virus is shed by a person with influenza is variable, with peak shedding occurring 24 to 48 hours after start of illness (Ip, et al., 2016). Findings from Lau et. al suggests that the amount of virus shed is determined by the severity of symptoms. The more symptomatic the person is, the more virus is shed

(Lau, et al., 2010). In addition, the duration of viral shedding is longer in children and immunocompromised individuals than otherwise healthy adults (Ng, et al., 2016). Symptoms include fevers, headache, muscle aches, lethargy, cough, sore throat, and rhinorrhea (Centers for Disease Control and Prevention, 2018-b). Complications of influenza include pneumonia, otitis media or ear infections, exacerbation of chronic conditions like asthma, bronchitis, musculoskeletal, and central nervous system complications. In children, otitis media accounts for 10-50% of complications due to influenza (Silvennoinen, Peltola, Lehtinen, Vainionpää, & Heikkinen, 2009). The number of outpatient visits for children under 18 due to influenza like illness ranges from 6 visits to 29 visits per 100 children dependent upon year (Poehling KA, 2013). While influenza can cause complications in children with underlying conditions, most children who were hospitalized due to influenza were previously healthy (Gill, et al., 2015). How quickly the virus spreads is dependent on how much a specific population is at risk (i.e. the number of unvaccinated individuals), and how often individuals are in close quarters for a prolonged period of time, like a school or daycare (World Health Organization, 2018).

### *Respiratory Viral Illnesses*

Viral respiratory infections are one of the most widespread easily transmissible infectious diseases in the United States. They represent extensive direct costs, indirect costs, and impaired quality of life. Respiratory infections can occur in the upper or lower respiratory tract, therefore named upper respiratory tract infections (URI) and lower respiratory tract infections (LRI). Lower respiratory tract infections may be more severe than upper respiratory tract infections and include symptoms such as high fever, cough, chest pain, headache, myalgia, nausea, vomiting and diarrhea (Dasaraju & Liu, 1996). LRIs can be viral or bacterial, causing bronchiolitis, acute bronchitis, or pneumonia. Viruses are most often responsible for cases of bronchitis and bronchiolitis and pneumonia cases can be caused by either viral or bacterial pathogens (Dasaraju & Liu, 1996). In the United States, community acquired pneumonia is identified as a leading causes of death from an infectious disease (Ramirez, et al., 2017).

URI caused by viruses are estimated to cause millions of infections each year and are the most diagnosed acute infection type in the U.S. (Galanti, et al., 2019). They are caused by a number of viral illnesses that affect the upper respiratory tract (Heikkinen T, 2003). These type of infections are most known as the common cold; a conventional term for a mild acute and typically self-limiting upper respiratory illness (Kirkpatrick, 1996). Most upper respiratory tract symptoms resolve in about 10 to 14 days however, symptoms can last for up to 3 weeks. Symptoms of upper respiratory infections include fever, sore throat, rhinorrhea or runny nose, lethargy, and muscle soreness. While rhinovirus makes up more than 50% of identified viral upper respiratory infections, there are other viruses that are responsible for causing upper respiratory infections for both children and adults (Heikkinen T, 2003). Other upper respiratory viruses that cause the common cold include respiratory syncytial virus (RSV), coronaviruses, parainfluenza, adenoviruses, and human metapneumovirus.

In an article published in Pediatrics in Review in 2011, Dianne Pappas and Owen Headly reviewed three modes of upper respiratory viral transmission; direct person to person contact with infected respiratory secretions, inhaling infectious particles and physical contact (Pappas DE, 2011). An example of direct contact with infected respiratory secretions is when a healthy person comes into contact with respiratory secretions. This mechanism requires the healthy person and the individual with the URI to be in close proximity since transmission occurs when the ill person coughs or sneezes and spreads respiratory droplets directly on the healthy person (Hendley J. , 1999). The second method of transmitting upper respiratory infections is when a healthy person “breathes in” infectious air particles (Winther, Gwaltney Jr., & Mygind, Viral induced rhinitis, 1998). An example of this type of transmission, also called droplet or aerosol transmission, is when a person infected with an upper respiratory infection coughs or sneezes and a healthy person is in the same environment. The healthy person is at risk of inhaling those droplets that are dispersed into the air and acquiring the infection (Hendley J. , 1999). An example of the third mechanism, known as indirect transmission, is if a healthy person’s hand comes

into contact with someone or an object contaminated with the virus and healthy individual subsequently touches their own mucous membranes (eyes, nose, and mouth), also defined as self-inoculation (Pica & Bouvier, 2012). Indirect transmission is considered to be the most common form of transmission (Arroll, 2011). Average peak viral shedding occurs approximately 3 days after introduction of the virus into the body (Hendley & Gwaltney, Jr., 2004).

Like influenza, the common cold can happen at any time of the year, but is there is a seasonality to many of the upper respiratory viruses (Monto, 2002). They are most prevalent during the fall and winter months when children are in schools and viruses are circulating throughout the community at large (Eccles R. , 2002). Children are often considered a reservoir for the common cold and influenza, considering that hand hygiene practices by school children are most times poor, and they are also in close contact with other students for long periods of time (Cotton, Innes, Jaspan, Maddie, & Rabie, 2008). Complications of URIs are a rare occurrence but include exacerbation of asthma, otitis media, sinusitis, and others (Winther, et al., 2002).

Common colds are considered one of the primary reasons children miss school and adults miss work (Fendrick, Monto, & Nightengale, 2003). On average, children acquire more viral upper respiratory infections than adults (Heikkinen T, 2003). Adults acquire 2-3 colds per year and children under 18 will average 8 to 12 colds per year (Arroll, 2011). Rates of upper respiratory viral infection are often times higher among children who attend school or daycare (Ball, Holberg, Aldous, Martinez, & Wright, 2002). Potential explanations include environmental and physiological differences between adults and children. Compared to children, adults possess better hygienic behavior and more mature immune systems (Gill, et al., 2015). As a result, children at a higher risk of being exposed to upper respiratory virals and also more prone to medical complications than adults (Nwachuku & Gerba, 2006).

For families with school aged children, there are both direct and indirect impacts of acquiring upper respiratory viral infections. In 1996, the CDC reported over 148 million days of restricted activity due to illness and nearly 20 million days of missed work, 22 million days of missed school and 45 million bedridden days (McClean, Peterson, King, Meece, & Belongia, 2017). An estimated 126 million days of work are missed by caregivers staying home with their sick child with a viral URTI (Fendrick, Monto, & Nightengale, 2003). A study performed by Kristin Smith and Andres Schaefer of the Carsey Institute identified that approximately 52 percent of employed parents "lack access to at least five days of sick days per year" and that employed parents take off an average of four days each year to care for their sick children (Smith & Schaefer, 2012) . Compounding the issue, an estimated 40 million working Americans lacked access to at least one day of leave-regardless of whether it was paid or unpaid (Parents., 2010). The financial impact of taking time off could also have play a role in making a decision as to how many days a parent or caregiver can take off to care for their child. The cost to parents or caregivers staying home was calculated to be 14.5 billion dollars per year (calculated by using an hourly wage of 14.35 per hour) (Fendrick, Monto, & Nightengale, 2003). An analysis of the estimated economic burden of seasonal influenza in the United States shows that total direct and indirect costs of influenza on the healthcare system and on society is on average 11.2 billion dollars annually (Putri, Muscatello, Stockwell, & Newall, 2018). Similarly, the estimated total cost of respiratory viral illness not related to influenza in the United States exceeds, on average, $40 billion dollars annually, with $22 billion in indirect costs and $17 billion a year in direct costs (Fendrick, Monto, & Nightengale, 2003). In both cases, direct and indirect costs refer to lost productivity, outpatient visits, emergency department visits, admissions, and sick patients who do not seek out clinical care, but will invest in over the counter medication to alleviate symptoms (Fendrick, Monto, & Nightengale, 2003).

### *2.2 Impact of gastrointestinal and upper respiratory viral infection on school aged children in the United States*

In September 2018, an elementary school in Conyers, Georgia closed completely for 1 day due to the severity of a norovirus outbreak in students and staff (The Associated Press, 2018). In addition, a gastrointestinal illness closed an entire school district in spring of 2019 (NBC Philadelphia, 2019). Students and staff tend to be in close quarters with shared spaces for extended periods of time. Being exposed to many high touch surfaces make it easy for a highly transmissible virus like norovirus to spread. Norovirus is one of the most communicable pathogens due to its low infectious dose, its ability to remain stable in the environment, and its resistance to commonly used disinfectants (Barclay L., 2014). In addition, lack of appropriate hand hygiene also makes schools vulnerable to enteric viral outbreaks.

Viral respiratory and gastroenteritis are associated with loss of productivity in school and work, loss of time at work or school, medical care costs, not to mention the impact on an individual's health (Bertino, 2002). Acute respiratory viral illness account for 30%-40% of illnesses in school children in the United States during the winter months (McClean, Peterson, King, Meece, & Belongia, 2017). While influenza comprises the majority of the respiratory viral infections, there are other viruses also. A study performed by McLean et al reviewed the burden on school absences due to respiratory viral illness, specifically laboratory confirmed influenza (McClean, Peterson, King, Meece, & Belongia, 2017). The objective of the study was to quantify school absences in order to determine appropriate prevention strategies. This study reviewed data collected from an influenza respiratory database and performed follow up surveys. It evaluated association between respiratory viral infections and school absenteeism. 75% of missed days were due to respiratory viruses like influenza, rhinovirus, and coronavirus. 40% of children who missed > 2 days were due to influenza. Households reporting one or more ILI episodes incurred $281.47 higher total annual medical expenditures than those without ILI (McClean, Peterson, King, Meece, & Belongia, 2017). ILI increased economic burden among households with school-aged

children and led to more school and workdays lost. This study also acknowledged that it likely underestimated school absenteeism due to other less severe viral respiratory illnesses.

### *2.3 School nursing shortage*

In a recent study reviewing the effectiveness of school nurses on health education, Borawksi et. al referred to school nurses as an effective resource for promoting health protective behaviors. School nurses are influencers of the health and wellbeing of students, a resource for prevention of transmission of communicable diseases and are an essential connector for bridging health and education. (Children's National Health System, 2018). Having regular access to a school nurse can assist with disease prevention, health education, and healthy behaviors (National Association of School Nurses, 2015). However, the National Education Association published a national outlook of school nurses by state in 2017. Unfortunately, the nationwide school nursing shortage is growing (**figure 7**). For example, Pennsylvania, the geographic region that is the focus of my thesis, is one of the few states that require its school districts to employ school nurses. However, many argue that the nurse to student ratio is still too high (average of 882 students per school nurse). As a result, school nurses are typically not available full time on school premises every day for treatment.

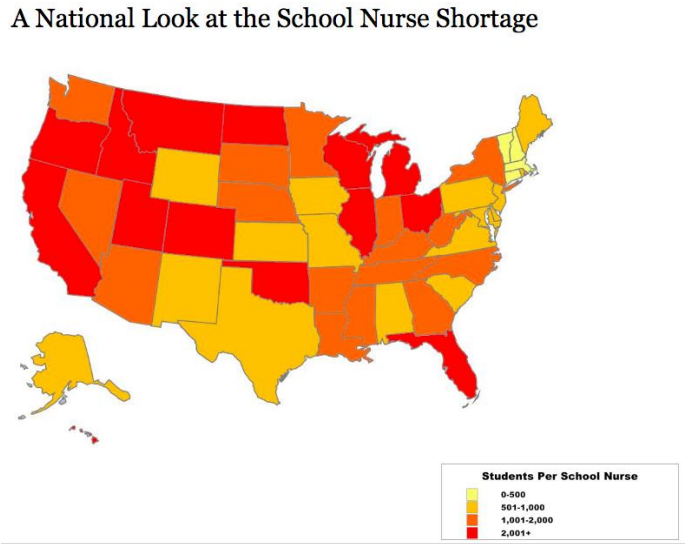


*Fig. 7 A National Look at the School Nurse Shortage* (National Education Association, 2019)

### *2.4 Prevention of upper respiratory and gastrointestinal infection transmission in the community and schools*

The Centers for Disease Control recommends that anyone who is sick with a respiratory viral illness should stay home from school or work to reduce the risk of transmission (Centers for Disease Control and Prevention, n.d.). People who are in close settings like a school are more likely to become sick. In order to prevent the spread of respiratory viral infections, it is important to avoid contact with others when sick, practice proper respiratory etiquette by coughing, and sneezing away from others, and disinfecting surfaces frequently touched like doorknobs or handles.

Most infection prevention efforts to reduce the spread of gastrointestinal and upper respiratory viral infections in healthcare facilities are multifactorial. Interventions include appropriate cleaning and disinfection agents, access to alcohol hand sanitizer and soap and water, and educating healthcare workers, patients, and visitors on the importance of staying home when sick, performing hand hygiene and cleaning (Association for Professionals in Infection Control and Epidemiology, 2019). The same interventions can be translated to schools and local communities. There are multiple peer-reviewed studies highlighting the effectiveness of alcohol-based sanitizer and cleaning and disinfection products with the aim of reducing upper respiratory and gastrointestinal viral illnesses.

The results from a study published by Sandora et.al showed that proper use of alcohol-based hand sanitizer, and appropriate disinfectant products significantly reduce absenteeism due to gastrointestinal illnesses in elementary school classrooms (Sandora, Shih, & Goldmann, 2008). The aim of the study was to identify whether or not implementing select infection prevention practices would impact student absenteeism due to gastrointestinal illness or respiratory viral illnesses in elementary schools. The participants enrolled in the study were students from elementary schools in grades 3-5 by school district. The students were stratified by grade and then randomized into intervention and non-intervention classrooms. The results showed that after adjustment, the rate of gastrointestinal illness

was significantly lower in the intervention group. While this study provides further evidence of the importance of these interventions in reducing absenteeism, there was no acknowledgement of educating students, parents, or school educators about transmission of gastrointestinal or respiratory viral illnesses.

Although many acknowledge the importance of hand hygiene in reducing the spread of germs, the rate of compliance of hand washing or use of alcohol based sanitizer has been consistently low, both in healthcare facilities and in schools (Lau, et al., 2012). A study focused on the effect of hand sanitizer use on student absenteeism asserts that while cleaning and disinfecting high touch surfaces is a key element of infection prevention, proper hand hygiene practices are considered a core practice of reducing preventable illness (Lau, et al., 2012). A systematic review performed by Wang et al. in 2017 challenges that there isn't enough published data to support that hand hygiene interventions reduce absenteeism associated with acute infectious diseases in elementary schools (Wang, Lapinski, Quilliam, Jaykus, & Fraser, 2017). The primary aim of the literature review was to identify publications that attempted to answer the question-is there a correlation between hand hygiene and acute infectious illness-related absenteeism in elementary schools. Between 1980 and 2015, there were over 1500 articles identified from the primary search-using relevant search terms including hand hygiene, handwashing, student, and education. The study concluded that based on the literature, the only findings that were considered significant were that hand hygiene does have an impact on reducing absenteeism for acute gastrointestinal illness. There was no significant change for acute respiratory illness and hand hygiene interventions. The hand hygiene education only interventions impact on absenteeism was inconclusive.

The American Public Health Association (APHA) is considered one of the more influential organizations of governmental policies dedicated to promotion of public health and the advancement of health equity. In 2006, the organization released a recommendation that stated legislatures should

create and implement mandatory hand hygiene standards, include funding for hand washing stations and supplies for daycares and schools, and provide support for childcare settings and schools (American Public Health Association, 2006). The APHA also put forth a statement that school districts including public and private schools and daycares should create partnerships, at the state and local levels with promoting hand hygiene and ensuring that all staff have adequate access to hand hygiene supplies and education (American Public Health Association, 2006).

### *2.5 Delaware County, PA and the Archdiocese of Philadelphia*

For my study, it was crucial to identify a geographic area that had recent challenges with transmission of upper respiratory and gastrointestinal illnesses. Delaware County Pennsylvania is a suburb, and adjacent to Philadelphia, Pennsylvania. It is considered one of the most populous counties in Pennsylvania (Delaware County Pennsylvania, 2017). Data from 2017 show there were 564,696 residents (United States Census Bureau, 2018). 5.9 percent of the residents were under 5 years old, 22 percent of residents were less than 18 years old, and 16.1 percent of residents were 65 years old or older. 51 percent are female and 66.8 percent of Delaware County residents are non-Hispanic white (Delaware County Pennsylvania, 2017). The median household income was $69,839 and is home to15 school districts and 20 Archdiocesan elementary schools (Deloitte , 2018).

According to the Robert Wood Johnson County Health Rankings and Roadmap, Delaware County is ranked 49$^{th}$ out of 67 in health outcomes (Robert Wood Johnson Foundation Program, 2018). In addition, Delaware County is the only county in the Philadelphia Suburbs and the largest county in Pennsylvania without a county health department for local public health guidance. A lack of a local health department and a school nursing shortage makes teacher knowledge of respiratory and gastrointestinal illness and prevention an essential part of the teaching curriculum.

The Archdiocese of Philadelphia covers territory in southeastern Pennsylvania, which is 2165 square miles including Philadelphia and surrounding counties. The surrounding counties include Bucks

County, Delaware County, Montgomery County, Chester County and Philadelphia County. Delaware County, while one of the smallest counties in southeastern Pennsylvania based on land mass, is one of the most populous, racially and economically diverse counties in Pennsylvania (Deloitte , 2018).

During the cold and flu season, the high burden of gastrointestinal and respiratory viruses circulating in Archdiocesan elementary schools in Delaware County may make it challenging to staff and students to remain healthy during the school year. Although the impact of good hand hygiene practices and other prevention interventions in healthcare and school settings is significant, little is known about teacher knowledge and perception of respiratory and gastrointestinal viral transmission. My study aims to address a current gap in the literature by examining teacher knowledge of how upper respiratory and gastrointestinal virals are transmitted.

# CHAPTER 3 METHODS

## *3.1 Study Design*

An observational cross-sectional design was ideal for this type of study because we were looking to administer a survey focusing on a certain population and location. Another advantage to using this type of study design was the ability to include multiple characteristics at once during survey analysis.

## *3.2 Protection of Human Subjects*

This study was conducted with approval from the Superintendent and the Assistant Superintendent of Philadelphia area Archdiocesan schools and the Emory Institutional Review Board. The research protocol was reviewed and approved by the Institutional Review Board at Emory University (IRB00103357, see appendix for approval) and the leadership of the Philadelphia Area Archdiocesan schools (approval in appendix).

## *3.3 Population and Sample*

The original intent of my study was to recruit Archdiocesan elementary school teachers and ancillary staff from all counties under the jurisdiction of the Philadelphia Archdiocese (Bucks County, Chester County, Philadelphia County, Delaware County, and Montgomery County) based on the total number of archdiocesan elementary teachers and ancillary staff currently employed during the study time. After the initial meeting with Archdiocesan leadership, it was decided to narrow the scope of the project to elementary schools located within Delaware County. The conclusion was based on the number of residents, number of parochial elementary schools, and economic and racial diversity in Delaware County. In addition, Delaware County had one of the highest rates of known ILI cases in Pennsylvania. Calculations for identifying an optimal sample size were based on the total population size of Philadelphia Archdiocesan Elementary School teachers in Delaware County and was determined by using a sample size calculator by Qualtrics$^{xm}$ (Qualtricsxm, 2019). In this study, population is defined as the number of Archdiocesan elementary school teachers and ancillary staff in Delaware County. Thus,

the designated sample size for this study was 163 participants based on the total population size of 281 with a 5% margin of error and 95% confidence interval.

In order to achieve the research aims of this study, a secured online survey was created and sent to all 281 Archdiocesan elementary school teachers and ancillary staff in Delaware County, Pennsylvania. The email requesting assistance in completing the survey was sent from the assistant superintendent of Philadelphia area Archdiocesan Schools to elementary school primary and ancillary educators of students in grades Pre-Kindergarten through 8$^{th}$ grade in Delaware County. The email included a link to the survey, noting that participation in the survey was voluntary and anonymous. Elementary school teachers were defined as educators of children in grades Pre-Kindergarten through 8$^{th}$ grade. Ancillary staff was defined as educators of activities like physical/health education, music, and language classes.

The inclusion criteria for survey participants were the following: 1) an educator of students in grades pre-kindergarten through 8$^{th}$ grade, 2) are employed in a parochial elementary school in Delaware County, PA, 3) were at least 18 years or older at the time of survey. After the participant received the link to the survey via email, the participant selected the link that brought them to the consent page of the survey. In order to proceed to the survey, the participant needed to acknowledge that they read information about the study, that they were at least 18 years of age or older, that they agreed to voluntarily participate in the survey and that they met the inclusion criteria (parochial elementary school educator in Delaware County, PA). The researcher's contact information was also available if the survey participant had any questions or concerns or wished to rescind their survey answers after completion. A participant's consent was recorded by clicking the "next" button before proceeding to the survey. At the end of the survey, the participant selected the "I agree" button to submit their data. If the participant chose not to participate they would select the "I do not agree"

button to have their data withdrawn. Identifiable data were encrypted. The only identifiable information from the survey included years of service, and grade taught by grouping (K-2), (3-5), (6-8).

### *3.3 Study Instrument (Survey)*

*Development*

The survey questions were developed after an extensive literature review and input from stakeholders at the Philadelphia Archdiocese, Thesis Chair, and field advisor, who works in the field of infection prevention. The descriptive 20 question survey included questions about current infection prevention practices within classrooms or teacher areas. The survey consisted of 18 close ended questions and 2 open ended questions. The only potentially identifiable information provided by the study participants were years of experience and grade taught. Specific school or school city were not included in the questionnaire. The questions were grouped by core infection prevention practices and modes of transmission of GI and upper respiratory viruses. The viral transmission, respiratory etiquette, and hand hygiene questions were created to help identify whether teachers were knowledgeable on how germs are transmitted. The transmission based questions focused on when an individual is considered infectious with a GI or upper respiratory viral illness, and fomite transmission (Table 2).

The cleaning questions were developed to gauge the importance the participant places on disinfecting surfaces. The respiratory and hand hygiene questions focused on proper hand hygiene practices according to guidance from CDC, and access to respiratory etiquette resources (ex. tissues).

This survey and consent form (described above) were uploaded to a secure cloud-based online survey application for development, distribution, data collection, and management (SurveyMonkey Premium, San Mateo, California/USA). In order to ensure anonymity, IP addresses were disabled so that the survey remained anonymous. In addition, SSL encryption was enabled to protect data.

### *Distribution and follow-up*

The survey was sent to 281 teachers and ancillary staff. Once the survey was distributed, the teachers had three weeks to complete and submit the survey online. There was one additional reminder email sent to the same participants requesting to complete the survey by the due date. 67 teachers completed the survey resulting in a response rate of 23%.

### *Data Analysis and Methodology*

After the survey form closed, the data was exported to Microsoft Excel 2016 (Microsoft, Redmond, WA) for basic statistical analysis. Sixty-seven survey responses were exported from the secured survey monkey site to an excel file for data cleaning and analysis and were subsequently saved on a secured server.

Data cleaning consisted of coding open-ended responses and performing summary statistics to identify any inconsistencies before moving on to more in depth data analysis.

Descriptive statistics were performed to review the primary characteristics of the data. Since most of the data exported were categorical, data were analyzed using frequency tables. A chi square test of independence was used to determine whether there was a significant association between years of experience and knowledge of infection prevention practices. Specifically, the aim was to identify whether there was a difference in knowledge of respiratory and gastrointestinal viral treansmission between teachers who have less than 11 years of experience and those who 11 years of teaching experience and longer.

# CHAPTER 4 Results

## *4.1 Introduction*

67 survey responses were collected and analyzed. No staff opted out of taking the survey and there were no discontinued or incomplete surveys. To understand the teaching characteristics of the survey sample, **the** first two questions on the survey asked about educator role and years of teaching experience (Table 1). Eighty percent of survey respondents identified as primary educators of students in grades Pre-Kindergarten through 8th grade, while the remaining twenty percent were ancillary staff. Over sixty five percent of respondents had at least 11 years of teaching experience. In summary, over half of the survey participants were primary teachers with at least 11 years of experience.

**Table 1.**
**Characteristics of Archdiocesan Elementary School Educators in Delaware County PA-study participants**

| **Variable** | Responses (%) |
|---|---|
| **Grades taught** | |
| **K-2** | 22 (32.8%) |
| **3-5** | 13 (19.4%) |
| **6-8** | 20 (30%) |
| **Ancillary** | 12 (18%) |
| **Years of teaching experience** | |
| **>21** | 22 (33%) |
| **11-20** | 22 (33%) |
| **6-10** | 13 (19%) |
| **2-5** | 7 (10%) |
| **<1** | 3 (4%) |

## *4.2 Key Findings*

To answer the research question of whether teachers are knowledgeable about upper respiratory and GI viral transmission, the survey questionnaire and results were categorized into themes based on survey content (Table 2). The survey themes include: viral transmission, respiratory etiquette, hand hygiene, cleaning, and influenza vaccinations. The majority of survey respondents correctly identified that fomite transmission is possible with upper respiratory and GI viruses. In addition, almost

all participants correctly identified that individuals can be considered infectious prior to showing respiratory or GI symptoms. In contrast, a majority of responses were inaccurate about the length of time influenza can live on surfaces. Although most respondents correctly identified that gloves and hand hygiene are not interchangeable, the percentage of accurate responses was less than eighty percent for the remaining hand hygiene questions. Just more than half of respondents were able to select the important components of hand hygiene, and how long should a person wash their hand. Participants had a slightly higher correct response rate for the question about hand sanitizers vs. soap and water. In conclusion, respondents were able to correctly answer questions related to fomite transmission and appropriate use of gloves, however, participants are not as knowledgeable about when and how to perform hand hygiene.

**TABLE 2. TRANSMISSION BASEDAND HAND HYGIENE QUESTIONS**

| **Survey Questions** | ANSWERED CORRECTLY N (%) |
|---|---|
| **Transmission based Questions** | |
| GERMS CAN BE SPREAD THROUGH THE PHYSICAL ENVIRONMENT | 66 (98%) |
| FLU VIRUS CAN "LIVE" ON SOME SURFACES LIKE DOORKNOBS OR TABLE FOR UP TO 2 WEEKS | 11 (16%) |
| WHEN IS A PERSON WITH A RESPIRATORY OR GI VIRAL ILLNESS FIRST CONTAGIOUS | 48 (72%) |
| **Hand Hygiene** | |
| **IT IS OK TO USE GLOVES TO REPLACE WASHING YOUR HANDS** | **61(90%)** |
| **WHAT IS IMPORTANT TO REMEMBER WHEN WASHING HANDS** | 41(60%) |
| **HOW LONG SHOULD YOU WASH YOUR HANDS** | 35 (51%) |
| **ALCOHOL BASED HAND SANITIZERS ARE JUST AS EFFECTIVE AS SOAP AND WATER WHEN HANDS ARE VISIBLY DIRTY OR GREASY** | 52(76%) |

To determine if the respondents have access to respiratory etiquette supplies (tissues, access to sink with soap and water, and hand sanitizer), and disinfection products on a daily basis **(figure 8),** questions about availability of tissues, hand sanitizer, and disinfectant were included in the survey. All respondents have access to tissues and a majority of respondents have access to hand sanitizer or soap/water with sink **(figure 8).** All respondents disclosed that they had access to disinfectant to clean surfaces in the classroom and eighty eight percent of respondents identified they clean surfaces like student desktops and other commonly touched surfaces once/week or more **(figure 9).** Therefore, a majority of respondents have access to respiratory etiquette supplies and disinfectant to aid in performing basic infection prevention practices.

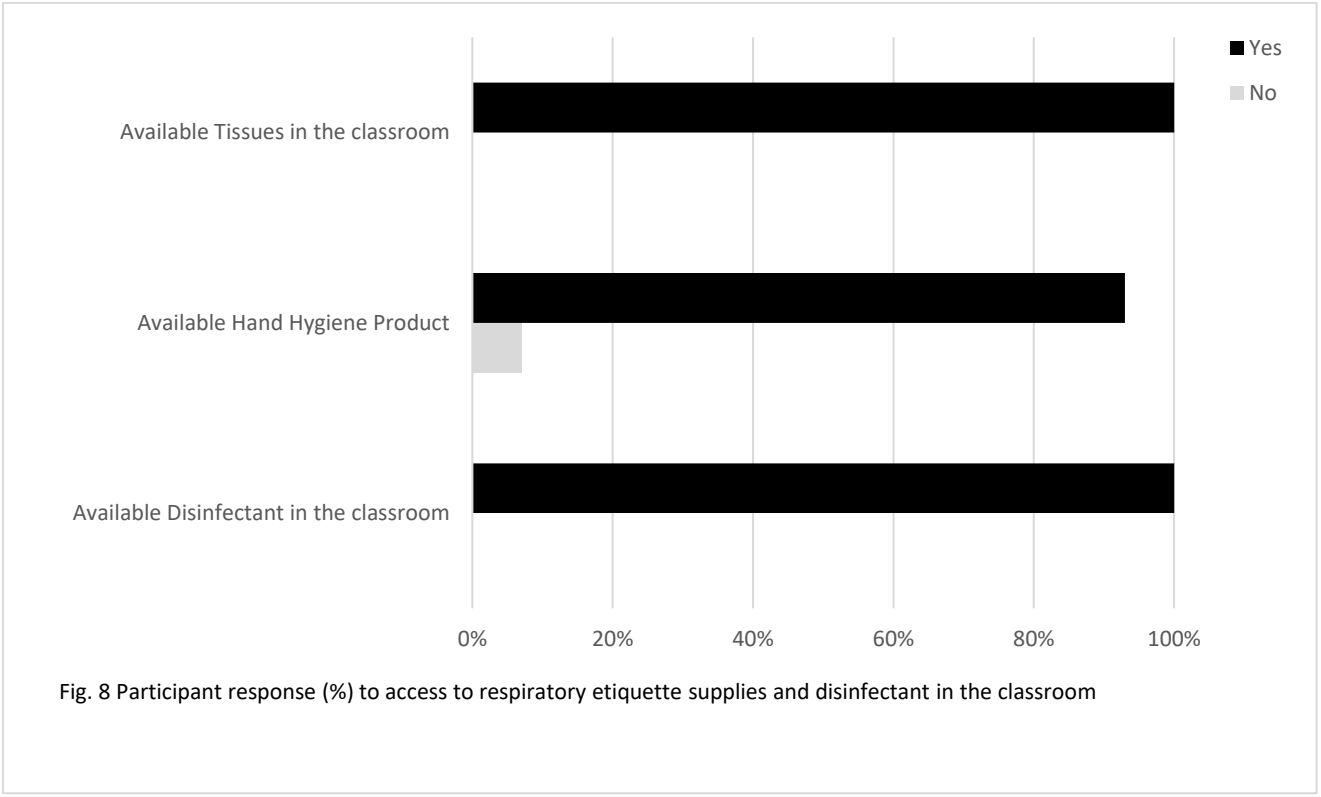


Fig. 8 Participant response (%) to access to respiratory etiquette supplies and disinfectant in the classroom

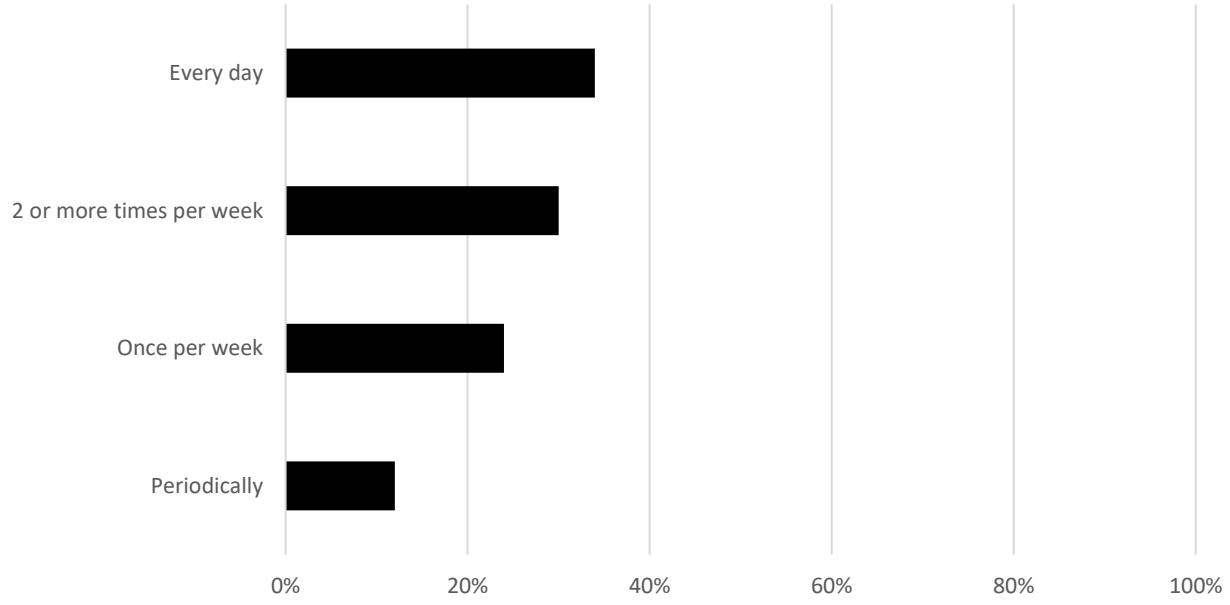


Fig. 9 Participant response (%) how often high touch surfaces are cleaned in the classroom

### *4.3 Other Findings*

To examine elementary school educators' beliefs about influenza vaccination, survey questions about the influenza vaccination status and beliefs about flu vaccines were included. In addition, participants who did not receive the flu vaccine were asked to identify the top reason why the they did not receive the influenza vaccine. The list of predefined answers included common misconceptions about the influenza vaccine. An 'other' answer option was also included to provide the participant an opportunity to include a reason using free text and no responses were provided. More than half of respondents received flu shots within the past year of taking the survey **(figure 10)**. However, of the 27 respondents who did not, 26 provided follow up responses based on multiple choice options as to why they did not receive their flu shots **(figure 11).** 15 out of 26, or fifty eight percent, of respondents perceived the influenza vaccine as not being effective, or that the chances of becoming sick with ILI symptoms is higher in recipients of the flu vaccine. In summary, more than half of survey participants

received the flu shot. The majority of respondents who did not receive the influenza vaccine chose a commonly held misconception about influenza vaccine effectiveness from the answer choices provided.

Fig. 10 participants (%) who received the flu shot in the past twelve months

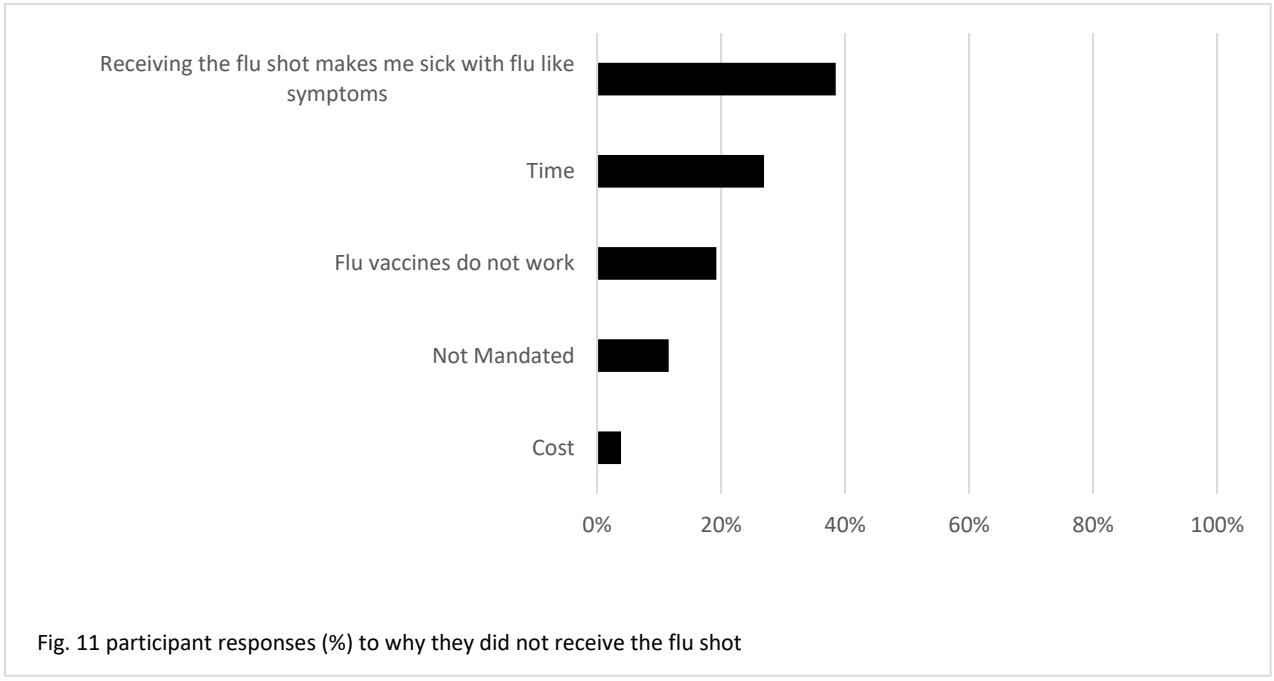

Fig. 11 participant responses (%) to why they did not receive the flu shot

To evaluate whether there was a significant association between years of teaching experience and hand hygiene practices, a chi square test of independence was utilized. Chi square analysis showed there was no significant association between years of experience and correctly identifying proper hand hygiene technique. There was also no significant association between years of experience and receiving

the flu shot. While a majority of the survey respondents had at least 11 years of experience, there was no relationship between years of experience and whether or not participants received the flu shot or between years of experience and being able to identify proper hand hygiene technique.

To assess what infection prevention measures teachers are currently using to reduce spread of viral transmission in the classroom, open ended questions about current infection prevention practices were provided at the end of the survey. The main themes included daily disinfection of high touch surfaces or surfaces touched by ill students. Respondents also identified utilizing either hand sanitizer or accessing sinks often to wash hands. There was also the opportunity for survey participants to propose resources or education topics that they believe would be beneficial to best protect their classrooms from the spread of illnesses. Educators also spoke to the need to quickly isolate a symptomatic student by sending them home. However, a frequently identified challenge is how to reduce the likelihood of a student coming to school while symptomatic or coming back to school within 24 hours of being sent home due to a upper respiratory or GI viral infection. Participants also identified additional needed resources regarding hand hygiene education. This included education to parents and students on how viruses are transmitted, the importance of staying home when sick, and understanding what are the most effective cleaning products and how often to use them. In conclusion, while many survey participants utilize infection prevention best practices, the responses also mention the need to educate both caregivers and students on viral transmission and the importance of remaining home while ill.

# CHAPTER 5 DISCUSSION

## *5.1 Introductory Paragraph*

We performed a cross sectional study to assess teacher knowledge of infection prevention principles and best practices in reducing upper respiratory and gastrointestinal viral infections in Archdiocesan elementary school classrooms in Delaware County, Pennsylvania. While we found that over ninety percent of participants have access to respiratory etiquette and cleaning products in their classrooms/labs, there was variability in answer selection of the transmission based questions (sixteen percent of respondents correctly answered a question related to the length of time influenza virus remains active on surfaces). Hand hygiene survey results showed that approximately half of respondents correctly identified the appropriate amount of time needed to perform hand hygiene and more than half or respondents were able to correctly identify the important techniques of hand hygiene. In addition, eighty percent of survey participants who did not receive the flu shot identified 1 of 3 common misconceptions about receiving the flu shot as the primary reason for not receiving the influenza vaccine. In conclusion, our findings suggest that teachers are knowledgeable on most upper respiratory and GI viral transmission, have access to respiratory etiquette and cleaning products, and understand importance of hand hygiene. There are opportunities for education around influenza transmission, influenza vaccination, and how to perform proper hand hygiene technique.

## *5.2 Main discussion points*

### *Access to respiratory etiquette supplies and hand hygiene challenges*

While survey participants have access to respiratory etiquette and disinfectant products, only 50-60 % of participants correctly answered survey questions about performing proper hand hygiene. Hand hygiene education is consistently listed as a top strategy in increasing hand hygiene compliance and compliance with proper hand hygiene technique. Globally, both overall compliance with hand washing and adhering to proper technique is consistently poor. One explanation about why following hand hygiene compliance remains low is the lack of education about utilizing appropriate hand hygiene/hand washing

techniques. This explanation is consistent with evidence from study published in the American Journal of Infection Control about hand hygiene practices in college students identified that while over 70% of college students were observed washing their hands, only 26% of students used appropriate hand hygiene technique (Anderson, et al., 2008). How much education a person has is not an indicator of whether they understand how to perform hand hygiene, but rather, on how much education they have specific to hand hygiene that will most likely determine compliance with performing appropriate hand hygiene (Bakalar, 2005). Therefore, the survey participants may have understood the importance of hand hygiene, but need additional education on performing hand hygiene correctly each time. Having access to hand hygiene supplies like alcohol hand rub, and/or soap and water with sink access significantly reduce student absenteeism due toand GI viral infections in the classroom when used in conjunction with hand hygiene education (Randle, et al., 2013). Students who are in schools with access to hand sanitizer are significantly less likely to be absent from school due GI viral illness compared to schools without access to hand sanitizer in the classroom (Hammond, Ali, Fendler, Dolan, & Donovan, 2000). Hand hygiene compliance and its association with infection transmission in healthcare has been studied extensively. Recent publications suggest that there is an increasing focus on improving hand hygiene compliance in non-healthcare settings as well (Curtis, et al., 2011). The CDC provides specific recommendations for washing hands and when and how to use hand sanitzer (Centers for Disease Control and Prevention, 2020). Hand hygiene compliance and education remain a consistent challenge across community settings-whether healthcare, workplace, schools, or at home. Studies piloting school based interventions focused on reducing student and staff absenteeism have documented poor hand hygiene compliance and education in schools as a persistent issue (Sun, et al., 2019). Multiple studies also show that with the relevant han appropriate hand hygiene with appropriate education can significantly reduce the number of GI and URI in elementary schools based on multiple interventions implemented in classrooms (Willmott, et al., 2016). Misconceptions about elements crucial to washing

hands were also highlighted in the survey as well. Survey respondents identified warm water and focusing on part of the hand as important parts to performing appropriate hand hygiene. Water temperature and what part of the hand to focus on when washing is not relevant and in fact, warmer water can cause skin irritation (Centers for Disease Control, 2019-c).

### *Results from transmission based questions*

Survey responses suggest that Archdiocesan elementary school educators' understanding of upper respiratory and GI viral transmission was varied. This conconclusion based on the percentage of correct answers specifically about upper respiratory and GI viral transmission. One reason for the variability could be overall understanding of how viral and bacterial organisms are transmitted. The chain of infection is a widely utilized educational tool to understand how virus and bacteria are transmitted. It is commonly used in healthcare, but also can be modified to use in daycare settings and elementary schools. Literature about public knowledge of transmission of upper respiratory and GI viral illnesses is limited. A qualitative research study published in 2018 concluded that misconceptions about the difference between the common cold and influenza still exist including the self-limiting nature of both illnesses and the notion that influenza is an illness of the elderly (Mayrhuber, et al., 2018). In another qualitative study, participants acknowledged they felt more empowered to stay home from work based on perception of severity of symptoms rather than communicability (Jutel & Banister, 2013).

### *Perception and Misconceptions about influenza vaccine*

Survey results also indicated that a number of misconceptions about receiving the influenza vaccine still exist among Archdiocesan elementary school educators in Delaware County. Over half of the respondents who did not receive the influenza vaccine identified that receiving the influenza vaccine makes vaccine recipients sick with influenza or that the influenza vaccine does not work. Further discussion is needed on teacher and ancillary staff perception of influenza vaccinations. Misinformation about the influenza vaccine continues. In support of this finding, data published by the American Academy of Family Physicians identified that 80% of participants were unable to correctly point out all

the true statements about the influenza vaccine during a survey (American Academy of Family Physicians, 2020).

### *5.4 Strengths and limitations*

The decision to distribute surveys electronically was a cost effective and efficient method to gathering a potentially large number of responses. In addition, including both open and close ended questions also helped to identify additional challenges for teachers. Providing participants the opportunity to detail their specific challenges in reducing viral transmission in their classrooms in free text form identified additional themes that were not included in the close-ended questions. For example, one issue identified from an open ended question are children arriving to school noticeably sick which would highlight the need for parental education on importance on keeping children home when sick.

Limitations included the time of year the survey was sent and the resulting sample size. The survey was sent out during the summer, there may have been an increased response rate if the survey was disseminated during the school year. A potential factor contributing to the low response rate was the time of year the survey was distributed. While teachers were responsible for checking email on a regular basis during the summer, per school HR policy, being on summer break may have led to a decreased number of participants. In addition, because of the ethical implications of receiving identifiable information, we were unable to ascertain the representativeness from the elementary schools within Delaware County. While this could be listed as a potential strength that allowed for candid responses from survey participants, knowing if most of the responses came from one elementary school or if the responses were more representative of all elementary archdiocesan schools in Delaware County, PA would help with data analysis and tailor next steps. Finally, we did not achieve power to state that our results could be generalizable to all elementary school teachers and ancillary staff in Delaware County, PA.

## *5.5 Implications*

Our key results highlight the need to address common myths and misconceptions about influenza vaccination, perceived severity of viral illness and transmissibility, and the importance of having access to and performing proper hand hygiene in Archdiocesan Elementary Schools in Delaware County PA.

Our goal is to disseminate these findings and use as further evidence to justify why infection prevention education is not only essential in healthcare settings, but in the community settings like schools as well. The Centers for Disease Control and Prevention provides multiple tool kits focused on the audience (families, healthcare providers etc.) on prevention education. In addition, we would like to further validate the results of our studies by increasing statistical power and expanding the survey to other Archdiocesan elementary school teachers in Philadelphia and surrounding counties within the jurisdiction of the Archdiocese of Philadelphia.

Based on our findings, future studies focused on Archdiocesan Elementary Schools in Delaware County PA should include:

- How to implement tailored education to teachers and school staff
- Evaluate what caregivers of school-aged children understand understand about viral transmission, hand hygiene, and staying home when sick and,
- How to reduce inaccurate beliefs about Influenza vaccination
- How to increase Influenza vaccination compliance among Archdiocesan Elementary School teachers in Delaware County.

A retrospective cohort study published in Infection Control and Hospital Epidemiology showed a significant decrease in staff opposed to receiving the influenza vaccine in a healthcare setting after implementing successive educational campaigns and other strategies focused on improving healthcare worker influenza vaccination compliance (Quan, Tehran, Dickey, & Spiritus, 2012)

***5.6 Conclusion***

This study demonstrates a need for focused infection prevention education for teachers. In addition, teacher responses to the open ended questions created another opportunity for future studies to learn more about caregiver knowledge of viral transmission and hand hygiene.

# Appendix

## Survey

### Objective: To assess infection prevention practices in the classroom

---

1. **Grade taught:**
   - ○ K-2
   - ○ 3-5
   - ○ 6-8
   - ○ Other (Please specify)_____

2. **Teaching experience (in years):**
   - ○ <1
   - ○ 2-5
   - ○ 6-10
   - ○ 11-20
   - ○ >21
   - ○ Other (Please specify)_____
   - ○

3. **Do you have access to hand hygiene products (i.e. purrell, hand sanitizer, sink/soap/water with paper towels) in your classroom (or science lab)?**
   - ○ Yes
   - ○ No

4. **Do you have access to tissues in your classroom (or science lab) on a daily basis?**
   - ○ Yes
   - ○ No

5. **Do you have disinfectant available to clean surfaces in the classroom?**
   - ○ Yes

- ○ No

6. **If yes to #3, how often are the surfaces (desk tops, commonly touched surfaces) in the classroom cleaned?**
   - ○ Every day
   - ○ 2 or more times a week
   - ○ 1 time a week
   - ○ Periodically

7. **When is a person with a cold or stomach illness first contagious?**
   - ○ A day or two before symptoms start
   - ○ When symptoms first appear
   - ○ When symptoms are at their worst
   - ○ 1 week **before** symptoms begin
   - ○ 1 week **after** symptoms begin

8. **Germs are spread through? (select all that apply)**
   - ○ Nose, mouth, eyes to hands to others
   - ○ Food to hands to food
   - ○ Person who is sick to hands of another
   - ○ Unclean hands to food

9. **Germs can be spread through the physical environment (commonly touched surfaces)**
   - ○ True
   - ○ False

10. **When washing hands, which of the following is important to remember? (Select all that apply)**
    - ○ Wash with the hottest water possible
    - ○ Focus on palms when washing hands
    - ○ Lather and rub hands together for 20 seconds

11. **Which of the following can expose an individual to germs that cause the 'common cold'? (Select all that apply)**

    - ○ Touching doorknobs and then touching your face
    - ○ Shaking hands with someone who is sick and then touching your face
    - ○ Being in a classroom with someone who is coughing or sneezing
    - ○ Cold weather

12. **How long should you wash your hands?**

    - ○ At least 20 seconds
    - ○ At least 30 seconds
    - ○ At least 1 minute
    - ○ At least 2 minutes
    - ○ Time doesn't matter

13. **It is ok to use gloves to replace washing your hands or using hand sanitizers (True/False)**

    - ○ True
    - ○ False

14. **Alcohol based hand sanitizers are just as effective as soap and water when hands are visibly dirty or greasy (True/False)**

    - ○ True
    - ○ False

15. **Flu Virus can "live" on some surfaces like doorknobs and tables for up to 2 weeks.**

    - ○ True
    - ○ False

16. **Did you receive the flu shot this year?**

    - ○ Yes
    - ○ No

17. **If no, what was the primary reason?**

- ○ Time
- ○ Not mandated
- ○ Insurance coverage
- ○ Receiving the flu shot makes me sick with flu like symptoms
- ○ Cost
- ○ Flu vaccines do not work

**18. Do you currently have a full time nurse employed at your school?**

- ○ Yes
- ○ No
- ○ Not sure

What are some prevention practices that can be used in your classroom if a student comes to school sick?

What are some resources you feel would be helpful to keep everyone in your classroom germ free?

# References


Allegranzi, B., & Pittet, D. (2009, December). Role of hand hygiene in healthcare-associated infection prevention. *Journal of Hospital Infection, 73*(4), 305-315.

American Academy of Family Physicians. (2020, January 22). *Survey Reveals Common Misconceptions about Flu, Vaccination*. Retrieved from American Academy of Family Physicians (AAFP): https://www.aafp.org/news/health-of-the-public/20200122flusurvey.html

American Public Health Association. (2006, November 8). *Hand Hygiene in Pre-K-12 Schools and Child Care Settings*. Retrieved from American Public Health Association: https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2014/07/07/11/15/hand-hygiene-in-prek-to-12-schools-and-child-care-settings

Anderson, J. L., Warren, C. A., Perez, E., Louis, R. I., Phillips, S., Wheeler, J., . . . Misra, R. (2008, June). Gender and ethnic differences in hand hygiene practices among college students. *American Journal of Infection Control, 36*(5), 361-368.

Archdiocese of Philadelphia. (n.d.). *A Sharper mind. A brighter spirit. A kinder heart.* Retrieved 2018, from Archdiocese of Philadelphia: http://www.aopcatholicschools.org/

Arroll, B. (2011, March 16). Common cold. *BMJ Clinical Evidence, 1510*(3).

Association for Professionals in Infection Control and Epidemiology. (2018). *School.* Retrieved from Infection Prevention and You: http://professionals.site.apic.org/settings-of-care/non-healthcare-setting/school/

Association for Professionals in Infection Control and Epidemiology. (2019). *Break the Chain of Infection*. Retrieved from Infection Prevention and You: https://professionals.site.apic.org/protect-your-patients/break-the-chain-of-infection/

Bakalar, N. (2005, September 27). *Many Don't Wash Hands After Using the Bathroom.* Retrieved from The New York Times: https://www.nytimes.com/2005/09/27/health/many-dont-wash-hands-after-using-the-bathroom.html

Ball, T. M., Holberg, C. J., Aldous, M. B., Martinez, F. D., & Wright, A. L. (2002, February). Influence of attendance at day care on the common cold from birth through 13 years of age. *JAMA Pediatrics, 156*(2), 121-126.

Barclay L., P. G. (2014, August). Infection control for norovirus. *Clinical Microbiology and Infection, 20*(8), 731-740.

Bertino, J. S. (2002, April 22). Cost burden of viral respiratory infections: issues for formulatory decision makers. *The American Journal of Medicine, 112*(6-Supplement 1), 42-49.

Borrows, C., & Turner, P. (2014, June). Seasonal screening for viral gastroenteritis in young children and elderly hospitalized patients: is it worthwhile? *Journal of Hospital Infection, 87*(2), 98-102.

Boyce, T. G. (2019, June). Merck Manual: Gastroenteritis. Kenilworth, NJ, USA. Retrieved from https://www.merckmanuals.com/professional/gastrointestinal-disorders/gastroenteritis/gastroenteritis

Brankston, G., Gitterman, L., Hirji, Z., Lemieux, C., & Gardam, M. (2007, April). Transmission of influenza A in human beings. *The Lancet Infectious Disease, 7*(4), 257-265.

Camera, L. (2016, March 23). *Many School Districts Don't Have Enough School Nurses*. Retrieved August 2017, from U.S News: https://www.usnews.com/news/articles/2016-03-23/the-school-nurse-scourge

Cedars Sinai. (2019). *Bacterial Gastroenteritis*. Retrieved from Health Library: https://www.cedars-sinai.org/health-library/diseases-and-conditions/b/bacterial-gastroenteritis.html

Centers for Disease Control. (2018-a, June 1). *Burden of Norovirus in the U.S*. Retrieved from Norovirus: https://www.cdc.gov/norovirus/trends-outbreaks/burden-US.html

Centers for Disease Control. (2018-c, December 1). *Percentages of Visits for Influenza-like Illness (ILI) Reported by the U.S. Outpatient Influenza-like Illness Surveillance Network.* Retrieved from FluView: https://gis.cdc.gov/GRASP/Fluview/FluHospRates.html

Centers for Disease Control. (2019-a, April 1). *Norovirus*. Retrieved from Norovirus: https://www.cdc.gov/norovirus/index.html

Centers for Disease Control. (2019-c, July 12). *Show Me the Science-How to Wash Your Hands*. Retrieved from Handwashing: Clean Hands Saves Lives: https://www.cdc.gov/handwashing/show-me-the-science-handwashing.html

Centers for Disease Control and Prevention. (2018-b, 27 2018). *Key Facts About Influenza (Flu)*. Retrieved from Influenza (Flu): https://www.cdc.gov/flu/about/keyfacts.htm

Centers for Disease Control and Prevention. (2018-d, June 1). *Norovirus*. Retrieved from Common Settings of Norovirus Outbreaks: https://www.cdc.gov/norovirus/trends-outbreaks/outbreaks.html

Centers for Disease Control and Prevention. (2019-b, September 5). *Summary of the 2017-2018 Influenza Season*. Retrieved from Centers for Disease Control and Prevention: https://www.cdc.gov/flu/about/season/flu-season-2017-2018.htm

Centers for Disease Control and Prevention. (2020, March 4). *Show Me the science-How to Wash Your Hands*. Retrieved from Handwashing: Clean Hands Saves Lives: https://www.cdc.gov/handwashing/show-me-the-science-handwashing.html

Centers for Disease Control and Prevention. (n.d.). *Statistics*. Retrieved from Healthy Schools, Healthy People: http://www.itsasnap.org/Resources/Statistics

Children's National Health System. (2018). *Why School Nurses Are Important.* Retrieved from Children's National Health System: https://childrensnational.org/advocacy-and-outreach/in-the-community/community-partnerships/childrens-school-services/why-school-nurses-are-important

Chow, C. M., Leung, A. K., & Hon, K. L. (2010, July 14). Acute gastroenteritis: from guidelines to real life. *Clinical and Experimental Gastroenterology, 3*, 97-112.

Chunara, R., Goldstein, E., Patterson-Lomba, O., & Brownstein, J. (2015, April). Estimating influenza attack rates in the United States using a participatory cohort. *Nature: Scientific Reports, 5*(9540). doi:10.1038/srep09540

Churgay, C. M. (2012, June 1). Gastroenteritis in children: part I diagnosis. *American Academy of Family Physicians, 85*(11), pp. 1059-1062.

Cochran, W. J. (2017, July). Gastroenteritis in Children. *Merck Manual*.

Cohen, M. (1991, April). Etiology and mechanisms of acute infectious diarrhea in infants in the United States. *Journal of Pediatrics, 118*(4, Part 2), 834-839.

Cope RC, R. J. (2018, August 16). Characterising seasonal influenza epidemiology using primary care surveillance data. *PLoS Computational Biology, 14*(8), 1-21.

Cotton, M., Innes, S., Jaspan, H., Maddie, A., & Rabie, H. (2008, March-April). Management of upper respiratory tract infections in children. *South African Family Practice/Primary Care, 50*(2), 6-12.

Curtis, V., Schmidt, W., Luby, S., Florez, R., Toure, O., & Biran, A. (2011, April). Hygiene: new hopes, new horizons. *Lancet Infectious Disease, 11*(4), 312-321. doi:10.1016/S1473-3099(10)70224-3.

Dasaraju , P. V., & Liu, C. (1996). Chapter 93: Infections of the Respiratory System. In *Medical Microbiology 4th edition.* Galveston , Texas: University of Texas Medical Branch at Galveston. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK8142/

Delaware County Pennsylvania. (2017). *Welcome to Delaware County, PA!* Retrieved from Delaware County Pennsylvania: http://www.delawarecountypa.com/index.html

Deloitte . (2018). *Delaware County, Pennsylvania*. Retrieved from Data USA: https://datausa.io/profile/geo/delaware-county-pa

Dolin, R. (2018, December 25). *Clinical Manifestations of seasonal influenza in adults*. Retrieved from UpToDate: https://www.uptodate.com/contents/clinical-manifestations-of-seasonal-influenza-in-adults?search=influenza&source=search_result&selectedTitle=3~150&usage_type=default&display_rank=3

Dryden MS, G. R. (1996, June 22). Empirical treatment of severe acute community-acquired gastroenteritis with ciproflaxin. *Clinical Infectious Disease, 22*(6), 1019-1025.

Eccles, R. (2002). An explanation for the seasonality of acute upper respiratory tract viral infections. *Acta Oto-Laryngologica, 122*(2), 183-191. doi:10.1080/00016480252814207

Eccles, R. (2005, November). Understanding the symptoms of the common cold and influenza. *Lancet Infectious Disease, 5*(11), 718-725.

Elliott, E. (2007, January 6). Acute gastroenteritis in children. *BMJ, 334*(35), 35-40.

Fendrick, A., Monto, A. S., & Nightengale, B. (2003, February 24). The economic burden of non-influenza-related viral respiratory tract infection in the United States. *JAMA Internal Medicine, 163*(4), 487-494.

Ferrer, R., & Klein, W. M. (2015, October 1). Risk perceptions and health behavior. *Current Opinion Psychology, 5*, 85-89. doi:10.1016/j.copsyc.2015.03.012

Galanti, M., Birger, R., Ud-Dean, M., Filip, I., Morita, H., Comito, D., . . . Shaman, J. (2019, May). Longitudinal active sampling for respiratory viral infections across age groups. *Influenza Other Respiratory Viruses, 13*(3), 226-232. doi:10.1111/irv.12629

Gill, P. J., Ashdown, H., Wang, K., Heneghan, C., Roberts, N., & Hamden, A. (2015, February). Identification of children at risk of influenza-related complications in primary and ambulatory care: a systematic review and meta-analysis. *Lancet Respiratory Medicine, 3*(2), 139-149.

Glanz, K., Rimer, B. T., Viswanath, K., & Orleans, C. (2008). *Health Behavior and Health Education: Theory, Research, and Practice.* San Francisco, California: Jossey-Bass.

Golden, S. D., McLeroy, K. R., Green, L. W., Earp, J. L., & Lieberman, L. D. (2015, April). Upending the Social Ecological Model to guide health promotion efforts toward policy and environmental change. *Health Education and Behavior, 42*(1 Supplement), 8S-14S.

Grohskopf LA, S. L. (2018, August 24). Prevention and control of seasonal influenza with vaccines: recommendations of the advisory committee on immunization practices-United States, 2018-19 influenza season. *MMWR Recommendations and Reports*, 1-20.

Guinan ME, M.-G. M. (1997, October). Who washes hands after using the bathroom? *American Journal of Infection Control., 25*(5), 424-425.

Hall, A. J., Lopman, B. A., Payne, D. C., Patel, M. M., Gastanaduy, P. A., & Parashar, U. D. (2013, August). Norovirus disease in the United States. *Emerging Infectious Diseases, 19*(8), 1198-1205.

Hammond, B., Ali, Y., Fendler, E., Dolan, M., & Donovan, S. (2000, October). Effect of hand sanitizer on elementary school absenteeism. *American Journal of Infection Control, 28*(5), 340-346. doi: 10.1067/mic.2000.107276

Heikkinen T, J. A. (2003, January 4). The common cold. *Lancet, 361*(9351), 51-59.

Hendley, J. (1999, March 4). Clinical virology of rhinoviruses. *Advances in Viruses Research, 54*, 453-466.

Hendley, J., & Gwaltney, Jr., J. M. (2004, August). Viral titers in nasal lining fluid compared to viral titers in nasal washes during experimental rhinovirus infection. *Journal of Clinical Virology, 30*(4), 326-328.

Ip, D. K., Lau, L. L., Chan, K.-H., Fang, V. J., Leung, G. M., Peiris, M. J., & Cowling, B. J. (2016, February 15). The dynamic relationship between clinical symptomatology and viral shedding in naturally acquired seasonal and pandemic influenza virus infections. *Clinical Infectious Diseases, 62*(4), 431-437.

Jacobs, S. E., Lamson, D. M., St. George, K., & Walsh, T. J. (2013, 1 1). Human rhinoviruses. *Clinical Microbiology Reviews, 26*(1), 135-162. doi:10.1128/CMR.00077-12

Jones, C. L., Jensen, J. D., Scherr, C. L., Brown, N. R., Christy, K., & Weaver, J. (2015, June 3). The Health Belief Model as an explanatory framework in communication research: exploring parallel, serial,

and moderated mediation. *Health Communication, 30*(6), 566-576. doi:10.1080/10410236.2013.873363

Jutel, A., & Banister, E. (2013). “I was pretty sure I had the 'flu”: Qualitative description of confirmed-influenza symptoms. *Social Science Medicine, 99*, 49-55. doi:doi: 10.1016/j.socscimed.2013.10.011

King, C. K., Glass, R., Breese, J. S., & Duggan, C. (2003, November 21). Managing acute gastroenteritis among children, oral rehydration, maintenance and nutritional therapy. *MMWR Recommendation Rep, 52*(RR16), 1-16.

Kirkpatrick, G. L. (1996, December). The common cold. *Primary Care, 23*(4), 657-675.

Klein, R. (2014, January 25). *Philadelphia School Nurse Shortage Causing 'Crisis', Says Documentarian*. Retrieved from HuffPost: https://www.huffpost.com/entry/philadelphia-nurse-shortage-photos_n_4612507

Kretzer, E. K., & Larson, E. L. (1998, June 26). Behavioral interventions to improve infection control practices. *American Journal of Infection Control, 26*(3), 245-253.

Lau, C. H., Springston, E. E., Sohn, M.-W., Mason, I., Gadola, E., Damitz, M., & Gupta, R. S. (2012, May 15). Hand Hygiene instruction decreases illness-related absenteeism in elementary schools: a prospective cohort study. *BMC Pediatrics, 12*. doi:10.1186/1471-2431-12-52

Lau, L. L., Cowling, B. J., Fang, V. J., Chan, K.-H., Lau, E. H., Houck, P. M., . . . Leung, G. (2010, 5 15). Viral shedding and clinical illness in naturally acquired influenza virus infections. *Journal of Infectious Disease, 201*(10), 1509-1516. doi:10.1086/652241

Lee RM, L. J. (2013, September 25). Incubation periods of viral gastroenteritis: a systematic review. *BMC Infectious Diseases, 13*(446), 1471-2334.

Lee, K., Burnett, E., Morrison, K., & Ricketts, I. (2014, February). Use of hand-held computers to determine the relative contribution of different cognitive, attitudinal, social, and organizational factors on health care workers' decision to decontaminate hands. *American Journal of Infection Control, 42*(2), 133-138. doi:10.1016/j.ajic.2013.08.010

Lee, W.-M., Lemanske, R. F., Evans, M. D., Vang, F., Pappas, T., Gangnon, R., . . . Gern, J. E. (2012, 11 1). Human rhinovirus species and season of infection determine illness severity. *American Journal of Respiratory and Critical Care Medicine, 186*(9), 886-891. doi:10.1164/rccm.201202-0330OC

Lewis, K. L., & Thompson, J. M. (2009, July-September). Health care professionals' perceptions and knowledge of infection control practices in a community hospital. *The Health Care Manager, 28*(3), 230-239.

Lucero-Obusan C, S. P. (2018, March 18). Epidemiology and burden of influenza in the U.S. Department of Veterans Affairs. *Influenza and other respiratory virus, 12*(2), 293-298.

Mandl, K. M. (2004, March-April). Implementing syndromic surveillance: a practical guide informed by the early experience. *Journal of the American Medical Informatics Association, 11*(2), 141-150.

Mayrhuber, E. A., Peersman, W., van de Kraats, N., Petricek, G., Divak, A. C., Wojczewski, S., & Hoffmann, K. (2018, December 12). “With fever it’s the real flu I would say”: laypersons’ perception of common cold and influenza and their differences - a qualitative study in Austria, Belgium and. *BMC Infectious Diseases, 18*(647). Retrieved from https://doi.org/10.1186/s12879-018-3568-9

McClean, H. Q., Peterson, S. H., King, J. P., Meece, J. K., & Belongia, E. A. (2017, November 25). School absenteeism among school-aged children with medically attended acute viral respiratory illness during three influenza seasons 2012-2013 through 2014-2015. *Influenza Other Respiratory Viruses, 11*(3), 220-229.

Minnesota Department of Health. (2019, Janueary 29). *Norovirus Fact Sheet*. Retrieved from Minnesota Department of Health: https://www.health.state.mn.us/diseases/norovirus/noro.html

Monto, A. S. (2002). Epidemiology of viral respiratory infections. *The American Journal of Medicine, 112*(6A), 4S-12S.

Musher, D. M., & Musher, B. L. (2004, December 2). Contagious acute gastrointestinal infections. *New England Journal of Medicine, 351*(23), 2417-2427.

National Association of School Nurses. (2015). *School Nurse Workload: Staffing for Safe Care (Position Statement).* Retrieved from National Association of School Nurses: https://www.nasn.org/advocacy/professional-practice-documents/position-statements/ps-workload

National Education Association. (2019, February 21). *A National Look at the School Nurse Shortage*. Retrieved from National Educational Association: 2020

NBC Philadelphia. (2019, April 5). *Stomach Bug Outbreak Closes an Entire New Jersey School District*. Retrieved from NBC Philadelphia: https://www.nbcphiladelphia.com/news/local/Ocean-Township-Stomach-Bug-Schools-Close-508157591.html

Ng, S., Lopez, R., Kuen, G., Gresh, L., Balmaseda, A., Harris, E., & Gordon, A. (2016, May 3). The timeline of influenza virus shedding in children and adults in a household transmission study of influenza in Managua, Nicaragua. *Pediatric Infectious Diseases, 35*(5), 583-586.

Nwachuku, N., & Gerba, C. P. (2006). Health Risks of Enteric Viral Infections in Children. In L. A. Albert, P. de Voogt, C. P. Gerba, O. Hutzinger, J. B. Knaak, F. L. Mayer, . . . F. A. Gunther (Eds.), *Reviews of Environmental Contamination and Toxicology* (Vol. 186, pp. 1-56). New York, New York: Springer.

Office of Behavioral and Social Sciences Research. (2014). Important theories and key constructs. *e-Source Behavioral & Social Sciences Research*. Bethesda, Maryland. Retrieved from http://www.esourceresearch.org/tabid/724/default.aspx

Pappas DE, H. J. (2011, February). The common cold and decongestant therapy. *Pediatrics in Review, 32*(2), 47-55.

Parents. (2010, September). *A Working Mom's Guide to Sick Kids*. Retrieved from Parents.com: https://www.parents.com/parenting/work/life-balance/a-working-moms-guide-to-sick-kids/

Payne, D. C., Vinjé, J., Szilagyi, P. G., Edwards, K. M., Staat, M., Weinberg, G. A., . . . Shirley, H. (2013, March 21). Norovirus and medically attended gastroenteritis in U.S. children. *New England Journal of Medicine, 368*(12), 1121-1130.

Pennsylvania Department of Health. (2018, October 2). *Influenza Surveillance Data Archive.* Retrieved from Pennsylvania Influenza Report: Season-To-Date Influenza Case Counts By County and Influenza Type: https://www.health.pa.gov/topics/disease/Flu/Pages/Archive.aspx

Philadelphia Department of Public Health. (2019, January 4). *Influenza Surveillance*. Retrieved from Health Information Portal: https://hip.phila.gov/DataReports/Influenza

Pica, N., & Bouvier, N. M. (2012, February). Environmental factors affecting the transmission of respiratory viruses. *Current Opinion in Virology, 2*(1), 90-95.

Poehling KA, E. K. (2013, February). The burden of influenza in young children, 2004-2009. *Pediatrics, 131*(2), 207-216.

Purushothama, D. V., & Liu, C. (1996). Introduction to Infectious Diseases. In S. (. Barron, & S. Baron (Ed.), *Medical Microbiology 4th Edition* (4th ed.). Galveston, Texas: University of Texas Medical Branch at Galveston. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK8142/

Putri, W. C., Muscatello, D. J., Stockwell, M. S., & Newall, A. T. (2018). Economic burden of seasonal influenza in the United States. *Vaccine*, 3960-3966.

Qualtricsxm. (2019, July). *Sample Size Calculator*. Retrieved from Qualtricsxm: https://www.qualtrics.com/blog/calculating-sample-size/

Quan, K., Tehran, D. M., Dickey, L., & Spiritus, E. (2012, January). Voluntary to mandatory: evolution of strategies and attitudes toward influenza vaccination of healthcare personnel. *Infection Control and Hospital Epidemiology, 33*(1), 63-70. doi:10.1086/663210

Ramirez, J. A., Wiemken, T. L., Peyrani, P., Arnold, F. W., Kelley, R., Mattingly, W. A., . . . Carrico, R. M. (2017). Adults hospitalized with pneumonia in the United States: incidence, epidemiology, and mortality. *Clinical Infectious Diseases*, 1806-1812.

Randle, J., Metcalfe, J., Webb, H., Luckett, J., Nerlich, B., Vaughan, N., . . . Hardie, K. (2013, November). Impact of an educational intervention upon the hand hygiene compliance of children. *Journal of Hospital Infection, 85*(3), 220-225.

Revai, K., Dobbs, L. A., Nair, S., Patel, J., Grady, J. J., & Chonmaitree, T. (2007, June). Incidence of acute otitis media and sinusitis complicating upper respiratory tract infection: the effect of age. *Pediatrics, 119*(6), 1408-1412. doi:10.1542/peds.2006-2881

Robert E Black, S. C. (2010, June 5). Global, regional, and national causes of child mortality in 2008; a systematic analysis. *The Lancet, 375*(9730), 1969-1987. doi:10.1016/S0140

Robert Wood Johnson Foundation Program. (2018). *County Health Rankings and Roadmaps*. Retrieved from Pennsylvania: http://www.countyhealthrankings.org/app/pennsylvania/2018/rankings/delaware/county/outcomes/overall/snapshot

Sandora, T., Shih, M., & Goldmann, D. (2008, 6). Reducing absenteeism from gastrointestinal and respiratory illness in elementary school students: A randomized, controlled trial of an infection-control intervention. *Pediatrics, 121*(6).

Sattar, S. B. (2019, March 8). *Bacterial Gastroenteritis*. Retrieved from StatPearls: https://www.ncbi.nlm.nih.gov/books/NBK513295/

Schensul, J. J. (2009, June). Community, culture, and sustainability in multilevel dynamic systems intervention science. *American Journal Community Psychology, 43*(3-4), 241-256. doi:https://doi.org/10.1007/s10464-009-9228-x

Schreiber M.D, D. S., Blacklow, MD, N. R., & Trier, J. S. (1973, June 21). The mucosal lesion of the proximal small Intestine in acute infectious nonbacterial gastroenteritis. *New England Journal of Medicine, 288*(25), 1318-1323.

Silvennoinen, H. M., Peltola, V., Lehtinen, P., Vainionpää, R., & Heikkinen, T. (2009, May). Clinical presentation of influenza in unselected children treated as outpatients. *Pediatric Infectious Diseases Journal, 28*(5), 372-375. doi:10.1097/INF.0b013e318191eef7

Smith, K., & Schaefer, A. (2012). *Who Cares for the Sick Kids (Parents' Access to Paid Time to Care for a Sick Child).* University of New Hampshire, The Carsey School of Public Policy at the Scholars' Repository . Durham: University of New Hampshire. Retrieved from https://scholars.unh.edu/carsey/171

St. Louis Children's Hospital. (2019). *Common Cold and Respiratory Infections*. Retrieved from St. Louis Children's Hospital: https://www.stlouischildrens.org/conditions-treatments/common-cold-and-upper-respiratory-infections

Stanford Children's Health. (2019). *Upper Respiratory Infection (URI or Common Cold)*. Retrieved from Standford Children's Health: https://www.stanfordchildrens.org/en/topic/default?id=upper-respiratory-infection-uri-or-common-cold-90-P02966

Stempel, H. E., Martin, E. T., Kuypers, J., Englund , J. A., & Zerr, D. M. (2009, January). Multiple viral respiratory pathogens in children with bronchiolitis. *Acta Paediatrica, 98*(1), 123-126. doi:10.1111/j.1651-2227.2008.01023.x

Stuempfig, N. D., & Seroy, J. (2019, June 17). Viral Gastroenteritis. *StatPearls*. Treasure Island, Florida, United States. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK518995/

Sun, C., Wang, Q., Adhikari, S. P., Ye, R., Meng, S., Wu, Y., . . . Zhou, H. (2019, September 3). Correlates of school children: a study of Tibetan primary schools. *International Journal of Environmental Research and Public Health, 16*(3217), 2-12.

Teunis, P. F., Moe, C. L., Liu, P., Miller, S. E., Lindesmith, L., Baric, R. S., . . . Calderon, R. L. (2008, August). Norwalk virus: how infectious is It? *Journal of Medical Virology, 80*(8), 1468-1476.

The Associated Press. (2018, September 24). *Georgia Elementary School Closed for Norovirus Outbreak*. Retrieved from U.S. News: https://www.usnews.com/news/best-states/georgia/articles/2018-09-24/georgia-elementary-school-closed-for-norovirus-outbreak

United States Census Bureau. (2018, July 1). *Quick Facts, Delaware County, Pennsylvania*. Retrieved from Delaware County Pennsylvania: https://www.census.gov/quickfacts/delawarecountypennsylvania

Velazquez, F., Matson, D. O., Calva, J. J., Guerrero, M., Morrow, A. L., Carter-Campbell, S., . . . Ruiz-Palacios , G. M. (1996, October 3). Rotavirus infection in infants as a protection against subsequent infections. *New England Journal of Medicine, 335*(14), 1022-1028. doi:10.1056/NEJM199610033351404

Walker, J. M., & Slifka, M. K. (2010). Longevitity of T-Cell Memory following Acute Viral Infection. In M. Zanetti, & S. P. Schoenberger (Eds.), *Memory T Cells. Advances in Experimental Medicine and Biology* (Vol. 684, pp. 96-107). New York, NewYork: Springer. doi:https://doi.org/10.1007/978-1-4419-6451-9_8

Wang, Z., Lapinski, M., Quilliam, E., Jaykus, L.-A., & Fraser, A. (2017, June). The effect of hand hygiene interventions on infectious disease associated absenteeism in elementary schools: A systematic review. *American Journal of Infection Control, 45*, 682-689.

Willmott, M., Nicholson, A., Busse, H., MacArthur, G., Brookes, S., & Campbell, R. (2016, January). Effectiveness of hand hygiene interventions in reducing illness absence among children in educational settings: a systematic review and meta-analysis. *Archives of Disease in Childhood, 101*(1), 42-50.

Winther, B., Gwaltney Jr., J. M., & Mygind, N. (1998, January-February). Viral induced rhinitis. *American Journal of Rhinology, 12*(1), 17-20.

Winther, B., Hayden, F. G., Arruda, E., Dutkowski, R., Ward, P., & Hendley, J. (2002, May). Viral respiratory infection in schoolchildren: effects on middle ear pressure. *Pediatrics, 109*(5), 826-832.

World Health Organization. (2018, November 6). *Influenza (Seasonal)*. Retrieved from World Health Organization: https://www.who.int/en/news-room/fact-sheets/detail/influenza-(seasonal)

Wu, Q.-s., Xuan, Z.-l., Liu, J.-y., Zhao, X.-t., Chen, Y.-f., Wang, C.-x., . . . Hu, Y. (2019, July 8). Norovirus Shedding among asymptomatic employees in outbreak settings in Shanghai, China. *BMC Infection Disease, 592*(19). Retrieved from https://doi.org/10.1186/s12879-019-4205-y

Zeigheimat, F., Ebadi, A., Rahmati-Najarkolaei, F., & Ghadamgahi, F. (2016, June 23). An Investigation into the effect of health belief model-based education on healthcare behaviors of nursing staff in controlling nosocomial infections. *Journal of Education and Health Promotion, 5*(23). doi:10.4103/2277-9531.184549