DEVELOPMENT AND VALIDATION OF TWO INFLUENZA ASSESSMENTS: EXPLORING THE IMPACT OF KNOWLEDGE AND SOCIAL ENVIRONMENT ON HEALTH BEHAVIORS

A Dissertation

Presented to

the Faculty of the Graduate School

University of Missouri

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

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December, 2011

The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

DEVELOPMENT AND VALIDATION OF TWO
INFLUENZA ASSESSMENTS: EXPLORING THE IMPACT OF KNOWLEDGE AND SOCIAL ENVIRONMENT ON HEALTH BEHAVIORS

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ACKNOWLEDGEMENTS

I would like to thank Dr. Lloyd Barrow for his dedicated support and sharing his knowledge of assessment as I completed this study. I would also like to thank my committee members, Dr. William Folk, Dr. Tom Freeman, Dr. Deborah Hanuscin, and Dr. Mark Volkmann for their guidance and support through my doctoral program.

I would like to thank Heather Worsham, Aaron Sickel, Dane Schaffer, Dr. Andrew West, Eddie Hedrick, Dr. William Folk, Katie Spears, Dr. Brian Thompson, Dr. Susan Even, Lori Osborne, and Dr. John Lednicky for reviewing the instruments. I would also like to thank Jamie Crist, Dan Miller, Roger Bergman, Tim Backes, Cay Miller, Elaine Mills, and Charles Cutelli for administering the instruments to students at their schools. I thank Dr. Stephen Osterlind and Ihui Su for giving helpful advice, guidance, and perspectives about Item Response Theory, and James Keller and Tanvi Banerjee for their advice and guidance with neural network modeling. I would additionally like to thank Tanvi for writing the code for running the neural network program in MATLAB. I would finally like to thank Doris Shoemaker for providing generous administrative assistance to support this project.

I thank my parents, Marc and Becky Romine, Keith and Cathy Schafer, and Suchi and Banani Banerjee, brothers, Jerod and Austin, and grandparents, Lee and Jeralee Westfall, for their encouragement, interest, and support through my program of study. I would finally like to thank my wife, Tanvi, for providing a great deal of patience and support on a daily basis.

DEVELOPMENT AND VALIDATION OF

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ABSTRACT

Assessments of knowledge and perceptions about influenza were developed for high school students, and used to determine how knowledge, perceptions, and demographic variables relate to students taking precautions and their odds of getting sick.

Assessments were piloted with 205 students and validated using the Rasch model. Data were then collected on 410 students from six high schools. Scores were calculated using the 2-parameter logistic model and clustered using the k-means algorithm. Kendall-tau correlations were evaluated at the $\alpha = 0.05$ level, multinomial logistic regression was used to identify the best predictors and to test for interactions, and neural networks were used to test how well precautions and illness can be predicted using the significant correlates.

Precautions and illness had more than one statistically significant correlate with small to moderate effect sizes. Knowledge was positively correlated to compliance with vaccination, hand washing frequency, and respiratory etiquette, and negatively correlated with hand sanitizer use. Perceived risk was positively correlated to compliance with flu vaccination; perceived complications to personal distancing and staying home when sick. Perceived risk and complications increased with reported illness severity. Perceived barriers decreased compliance with vaccination, hand washing, and respiratory etiquette. Factors such as gender, ethnicity, and school, had effects on more than one precaution. Hand washing quality and frequency could be predicted moderately well. Other predictions had small-to-negligible associations with actual values. Implications for future uses of the instruments and development of interventions regarding influenza in high schools are discussed.

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CHAPTER 1: INTRODUCTION

Introduction

Influenza has a key role in public health through both seasonal and pandemic infections. Seasonal flu is a constant threat through winter and early spring, causing high fever, severe body aches, and extreme fatigue in healthy individuals, and can lead to potentially fatal pneumonia, especially in children, the elderly, and smokers (American College of Chest Physicians, 1999). In the United States, seasonal influenza leads to 36,000 deaths and 114,000 hospitalizations annually (Dushoff et al., 2006; Harper et al., 2005; Thompson et al., 2004; Thompson et al., 2003). Globally, flu epidemics lead to three to five million cases and over 250,000 deaths each year (Rothman et al., 2006).

Given that influenza strikes 10-20% of people worldwide and about 10% of school children (Principi et al., 2003), seasonal influenza is an issue of personal health and also a social issue. Influenza results in statistically significant increases in medical visits and school absenteeism and negative consequences for the school children's family members including extra medical visits for parents and siblings, lost working days for parents, and lost school days for siblings as well as need for help in caring for ill children (Principi et al., 2003). Molinari et al., (2007), using 2003 population and epidemic data for the United States, estimate about 600,000 life years lost, 3 million hospital stays, and 30 million outpatient visits, all of which result in medical costs of around $10 billion and lost earnings of $16 billion annually. The total annual economic burden of seasonal influenza, they calculated, is around $87 billion.

In addition to seasonal influenza, the threat of pandemic infections resulting from mutation of influenza A strains is also prevalent from year to year. The most severe influenza pandemic in recent history was the 1918 Spanish Flu, which is thought to have been a direct adaptation from an avian subtype (Taubenberger et al., 2005). This pandemic claimed 50-100 million lives worldwide (Johnson & Mueller, 2002). Viral genome reassortment is thought to have been the cause of the 1957 Asian flu and 1968 Hong Kong flu pandemics (Webster, Sharp, & Claas, 1995; Bean et al., 1992), each of which claimed between 1 and 2 million lives (Ayob et al., 2006; Hampson & Mackenzie, 2006). Most recently, the Novel H1N1 Swine Flu pandemic of 2009, caused by a swine influenza A virus which went through three reassortments (Mossad, 2009), resulted in about 1.5 million cases and 25,000 deaths in 2010 (WHO, 2010). The social impact of pandemics depends largely on virulence of the strain involved (Schnitzler & Schnitzler, 2009). However, Pile and Gordon (2006) estimated the impact of a pandemic to be in the hundreds of billions of dollars, which includes the cost of quarantining and disruption in global trade.

The impact of pandemics on education is also severe, resulting in increased absences and school closings. Missed time on task and exclusion of students from benefits such as free or reduced lunch and adult supervision while parents are at work have the potential to create a multitude of social problems including hunger, delinquency, and missed income for parents who stay home to supervise children (Cauchemez et al., 2009).

These sobering problems prompt the important question of how to mitigate and minimize the spread and impact of influenza. Research shows that mitigation measures work best and cause least anxiety when the normal social functioning of society is not disrupted, hence putting into question the practical efficacy of intense screening, quarantine, and closure of schools and work places (Inglesby et al., 2006). Instead, effective strategies for encouraging residents to implement mitigation measures on their own through educational interventions is essential (Wensing, Van der Weijden, & Grol, 1998). Of these preventative measures, vaccination is by far the most important. Other potentially effective measures which cause minimal social impact include hygiene practices, such as respiratory etiquette, proper hand washing, and keeping hands away from the eyes, nose and mouth, self quarantine (staying home when sick), and keeping a distance of 3-6 feet from infected individuals (Inglesby et al., 2006, Center for Disease Control, 2009).

Wensing, Van der Weijden, and Grol (1998) studied interventions that were effective in changing health behavior in adults, and found that class-type interventions, reading materials, and reminders are relatively ineffective compared to establishment of rules, incentive structures, and individual instruction. Mulhauser and Berger (2009), in the context of insulin therapy, also note the ineffectiveness of lecture-style group "obedience training" in changing behavior.

The only effective school-based educational influenza intervention to be reported improved students' knowledge of topics such as virus structure, cellular tropism, and influenza epidemics (Dumais & Hasni, 2009). Through a longitudinal analysis (pretest, post test one week after, and post test six weeks after), they found that students learned and retained the material and overcame misconceptions through discussion, simulation, and modeling activities. However, whether or not this learning resulted in improved mitigation practice was beyond the scope of their study. Research on the effect of presentation styles on changing behavior is present both in the education and medical literature. However, links between students' understanding and behavior remains unexplored. A necessary next step involves identifying the effects of understandings and perceptions on mitigation practices against the flu.

Need for the Study

The importance of students becoming health literate has been documented in the National Health Education Standards (Joint Committee on National Health Education Standards, 2007). They argue that educational attainment alone is not sufficient to secure a competitive future since poor health presents such a major threat to one's ability to live a productive life.

People who have greater health knowledge will in turn have better health practices, and thus will have the following advantages towards their ability to contribute economically: working more effectively, missing fewer work days, using fewer medical services, and reducing use of health insurance benefits.

The state of Missouri has extended the National Health Education Standards by defining the Health Education Grade Level Expectations (GLE's, MoDESE, 2007) which are tied to the National Health Education Standards (JCNHES, 2007). Many of these state and national standards are aimed towards understanding various aspects of communicable infectious diseases such as influenza. While these standards exist with the intent of serving as a guide to Missouri's health education curricula, assessment of learning is not required or facilitated, and therefore no data exist to quantify the extent to which these standards have been met. These issues, accompanied by general agreement that seasonal influenza and the constant threat of an influenza pandemic provides a significant danger to our economy and national security (Webby & Webster, 2003), justifies the need for valid assessment tools to determine what students know about influenza. Such an assessment is a product of this study. This assessment is tied to Missouri's Health Education GLE's and will have established content and construct validity so to make it a useful tool for present and future use.

A large body of literature exists within the medical and education community on misconceptions and misunderstandings about influenza within student, lay, and health worker populations in a variety of cultural settings. However, these understandings were not measured using validated assessments, and the tying of knowledge to behavior is weak to nonexistent. Since a major goal of interventions is to impart knowledge in such a way that it will lead to behavioral change (Wensing, Van der Weijden, & Grol, 1998), an important question arises—does understanding of influenza relate to responsible behavior or are interventions aimed at imparting knowledge a waste of time and money? If increased understanding does lead to improved behavior, what aspects of influenza need to be understood to facilitate a particular desired behavior, and what is the relative importance of knowledge of the disease compared to other factors such as gender, previous negative experiences with the disease, and perceived susceptibility? Answers to these questions are essential to the development of efficient, effective, well-targeted interventions, but as of now, they remain unanswered.

If statistically significant relationships between preventative behaviors and elements of knowledge and experience can be established, an additional challenge is testing the efficacy of these variables as predictors for behavior. This study uses neural networks, one of the most robust predictive tools available. If strong predictive relationships between elements of students' knowledge and backgrounds and their ability and/or willingness to take steps to mitigate influenza can be established, the assessments developed could become important tools for diagnosing risk of influenza transmission in schools and defining how interventions should be developed and targeted. Findings from this study may prove useful to school state officials, administrators, teachers, and health professionals both in evaluating students' preparedness for seasonal epidemics and pandemics and for developing effective intervention strategies when influenza outbreaks occur.

Purposes for the Study

The purposes of this study are to:

1. Develop and validate two assessments, the Assessment of Understanding of Influenza (AUI) and the Survey of Background, Experience, and Risk (SOBER) to measure knowledge and perceptions of influenza.
2. Identify aspects of influenza for which students' understanding is high or low.

3. Determine statistically significant relationships between what students understand about influenza and ability and/or willingness to implement mitigation practices such as vaccination, proper hand washing, self quarantine, social distancing, refraining from touching the eyes, nose, and mouth, and practicing respiratory etiquette.
4. Identify statistically significant influenza knowledge and experiences which result in particular mitigation behaviors, and determine whether or not these can accurately predict a student's practice of a particular behavior.

Definitions

Ability score—A logit score calculated from the Rasch model based on questions answered correctly and their difficulties. Logit 0 indicates average ability. Negative logit values indicate below average abilities, and positive logit values indicate above average abilities. The higher a student's ability score, the higher the probability of a correct response on an item.

Activation function—A function designed to transform an input as it passes through a node of a neural network. These can be linear or sigmoidal.

Assessment of Understanding of Influenza (AUI)—An instrument that evaluates student knowledge of influenza related to flu transmission and management.

Behavior—An action which affects the efficacy of influenza transmission positively or negatively.

Construct Validity—The degree to which the instrument correctly measures the construct the instrument is designed to target (Hayes, Richard, & Kubany, 1995).

Content Validity—The degree to which elements of the instrument are relevant to the construct targeted by the instrument (Haynes, Richard, & Kubany, 1995).

Cross Validation—Testing of a model on a part of the data set other than that used to create the model.

Discrimination—The ability of an item to separate low and high ability, defined in item response theory as the maximum slope of the item characteristic curve.

Face Validity—Assurance that the assessment makes sense to the reader (i.e. high school students).

Hemagglutinin—The protein responsible for binding the flu virus to respiratory cells, abbreviated, “H” or “Ha.”

Hidden layers—Layers built within a neural network which are unobservable by the researcher.

Hidden nodes—Input nodes built into the hidden layers of a neural network.

Impact—The change in the dependent variable per unit increase in the independent variable, measured by the odds ratio in this study.

Influenza Mitigation Behavior Survey (IMBS)—A set of questions guided by CDC (2009) that measure students’ degree of compliance with efforts to mitigate influenza. Since each question measures degree of compliance with a different precaution, measures of validation and reliability are not available for the IMBS.

Item—A part of an instrument designed to collect a discrete piece of data.

Item Characteristic Curve (ICC)—In item response theory, the sigmoidal curve that relates probability of a student getting an item correct to his/her ability.

Item Difficulty—In the Rasch model, the logit ability level required to have a 50% chance of answering a question correctly.

Item Response Theory (IRT)—An extension of classical test theory which allows extraction of student abilities and item difficulties. It makes the assumption that student ability scores should be independent of items used on the assessment.

Latent Trait—A specific area of knowledge or experience measured by the AUI and SOBER instruments.

Layer—A set of nodes designed to transform one or more data inputs in a neural network.

Logit—In the Rasch model, the natural logarithm of the odds that a student of defined ability will answer a question correctly.

Mitigation—Suppression or prevention of the spread of influenza.

Mutation—A change in the gene encoding an amino acid sequence of a protein.

Neuraminidase—The protein responsible for allowing the flu virus to pass out of the cells in which it has replicated, abbreviated, "N" or "Na."

Overfitting—Oversensitivity of a regression or neural network model to the random errors in a data set, resulting in lack of generalizability.

Protective Measure—A behavior designed to protect oneself and others from contracting influenza. Protective measures explored in this study include getting vaccinated, washing hands frequently and properly with soap or hand sanitizers, staying away from people who are visibly sick, not touching the eyes, nose, or mouth, self quarantine, and respiratory etiquette.

Rasch Model—A subset of the two parameter IRT model, where the discrimination constant is fixed at 1. Often used as a framework for validating assessments.

Reassortment—The swapping of portions of genomes of two or more different flu viruses when they infect the same cell.

Respiratory Etiquette—Covering a cough or sneeze with the sleeve or a tissue (which is immediately thrown away) in order to prevent transmission through the air or touching of surfaces.

Survey of Background, Experience, and Risk (SOBER)—A validated instrument that measures student attitudes and social orientations towards influenza, including perceived risk, complications, and barriers.

Theme—A specific area of knowledge or experience measured by the AUI and SOBER instruments.

Training—Structuring a neural network to conform to a specific data set by iteratively adjusting weight factors at each node in order to minimize the error.

Weight—A quantity representing the magnitude by which the input into a node of a neural network will be transformed, analogous to the slope of a line.

Assumptions of the Study

1. Sampled students are representative of other high school students, to whom results can be generalized.
2. Sampled students have heard of and/or experienced influenza, and have developed both correct and incorrect conceptions about this disease through school, family, medical professionals, or the media.
3. Sampled students have developed behavior habits that either prevent or aid the transmission of influenza.

Scope and Delimitation of the Study

Participants were solicited for this study through a convenience sample under the following delimitations:

1. This study involves only Missouri high school science students in Grades 9-12.
2. This study only assesses mitigation behaviors that are common, deemed important, and easily accomplished. These include hand sanitation, respiratory etiquette, being vaccinated, and practicing social distancing. Mitigation practices such as wearing face masks (since this practice is uncommon) and taking antivirals (since a trip to the doctor and a prescription are required) were not assessed in this study.

Organization of the Chapters

Chapter 1 provides a general overview and introduction to the study. It includes a general introduction, a justification of need for the study, the purposes of the study, definitions, assumptions of the study, and scope and delimitations of the study.

Chapter 2 provides a review of the related literature. This review focuses on literature related to development, validation, and analysis of constructs, including state and national standards, misconceptions about influenza, and methodology for interpreting the assessments, including Item Response Theory (IRT) and neural networks.

Chapter 3 describes the methods and procedures used in the study. Research questions and hypotheses are outlined, and the students involved in the study are described. Third, a theoretical framework for health behavior is discussed. Fourth, development, validation, and use of the instruments are discussed, followed by the data gathering process using the final assessment. This chapter concludes with a description of analysis techniques and procedures for data on the final assessment, including the 2-parameter model from IRT, multinomial logistic regression, and neural network analysis.

Chapter 4 describes the results of the study. These include content and construct validity measures, description of findings regarding student understandings of influenza, Kendall-tau correlations between knowledge and experience to behavior, multivariate regression findings, and the results of neural network predictive models for behavior. Chapter 5 contains a summary of the study, conclusions, discussion of findings, and suggestions for further research.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

Introduction

This chapter provides a review of literature related to development and validation of an assessment on flu misconceptions, factors that contribute to students' health-related decisions, and techniques for analyzing and interpreting the data. According to the Cognition-Observation-Interpretation (COI) assessment triangle (Pellegrino et al., 2001), a logically consistent assessment first makes an assumption about how students think about material, governing the specific type of knowledge the assessment will measure (Cognition). The assessment is developed and administered with this in mind (Observation). Data collected from the assessment is then interpreted to inform the researcher of what students know based on the cognitive model (Interpretation) (Pellegrino et al., 2001). The first part of this chapter will include a review of Missouri's Health Education Grade Level Expectations (GLE's) (MoDESE, 2010) that pertain to communicable diseases such as influenza, previous assessments of influenza knowledge and perceptions, and their relation to preventative behaviors, and misconceptions about influenza.

Next, background on methodology for interpreting the results of the assessments using Item Response Theory (IRT), the Rasch model, and the 2-parameter model, will provide an approach that allows extraction of difficulty scores for individual items and ability scores for individual students on the assessments. A review of neural networks, a powerful technique for data classification and predictive modeling, will follow.

Cognition—What Students Know

Deciding what students should know about influenza and mitigation practice provided a logical basis for how items in the AUI and the IMBS were developed. To ensure that the assessments were meaningful to high school students and their curricula, it was necessary to understand what the students who participated in the study were expected to know about the flu and disease mitigation. A review was conducted of the National Health Education Standards (Joint Committee on Health Education Standards, 2007) and infectious disease-related objectives from Missouri's GLE's for Health Education (MoDESE, 2007) and Course Level Expectations (CLE's) for Biology (MoDESE, 2010). The assessments also assume that students have misconceptions about influenza, and that these lead to incorrect knowledge and irresponsible behaviors related to flu mitigation (i.e. improper hand washing, refusal to get vaccinated, coming to school sick, etc.). A review of the flu misconceptions and health behavior literature is summarized. Items for the AUI and IMBS were constructed based on Missouri's Health GLE's and recommendations by the Center of Disease Control (CDC, 2009), respectively, while the misconceptions and behavior literature were used to develop topics and distracters for the AUI.

A Guide to Assessment Items

The Health Education GLE's and the Biology CLE's for the state of Missouri identify concepts which should be mastered by Missouri students before they leave high school. The Health Education GLE's focus on recognizing influenza as a virus, understanding how it spreads and infects its hosts, mitigation methods, the impact of mitigation on self and society, and attaining information from public health specialists. In contrast, the Biology CLE's primarily address the genetic makeup of viruses such as influenza and their interaction with their hosts and environments (Strand 3), and invites students to develop understanding of influenza as an organism which interacts with other living organisms and adapts to survive (Strand 4). Items in the AUI are tied to one or more GLE and/or CLE.

Health Education Standards

The National Health Education Standards: Achieving Health Literacy (JCNHES, 2007) defines health literacy: "The capacity of individuals to obtain, interpret, and understand basic health information and services and the competence to use such information and services in ways which enhance health." (p. 5). This document puts forth seven outcomes students should attain by the end of high school: (1) Students will comprehend concepts related to health promotion and disease prevention; (2) demonstrate the ability to access valid health information and promotional products and services; (3) demonstrate the ability to practice health enhancing behaviors and reduce health risks; (4) analyze the influence of culture, media, technology, and other factors on health; (5) demonstrate the ability to use interpersonal communication skills to enhance health; (6) demonstrate the ability to use goal setting and decision making skills to enhance health, and (7) demonstrate the ability to advocate for personal, family, and community health. These seven standards are intended to provide a curricular framework for Health and Physical Education classes throughout the United States.

Missouri's Health Education GLE's (MoDESE, 2007) lists content that students are expected to know about health at each grade level. These are connected to the National Health Education Standards and are intended to guide Missouri's K-12 public school health curricula and provide outcomes that should be assessed at each grade level. Identifying GLE's which relate to prevention, treatment, and cause of communicable diseases such as influenza informed development of face valid assessment items for high school students. Influenza-related outcomes are found under nine topics: (1) the Lymphatic-Immune System; (2) Personal

Health, (3) Preventative Care, (4) Consumer Rights and Issues, (5) Community Services, (6) Decision Making and Problem Solving, (7) Communicable vs. Non-Communicable Diseases, (8) Body Defenses and Recovery, and (9) Types of Pathogens and Transmission. Expectations under each topic are summarized in Table 1.

Table 1.

A summary of Missouri's Health Education Grade Level Expectations (GLE's) (MoDESE, 2007)

	Elementary (Grades 1-5)	Middle (Grades 6-8)	Secondary (Grades 9-12)
Lymphatic-Immune System	Understand Vaccination and Immunization	Understand Lymphatic System Components and Functions	Understand Cause, Treatment, and Prevention of Immune Disorders
Personal Health	Create a Personal Health Plan		Examine System Functions and Disease Formation
Preventative Care	Identify Preventative Care Measures and How they Enhance Health	Identify Adolescent Needs; Foresee Consequences for Lack of Preventative Care; Develop Strategies	Understand Preventative Care and its Importance in Improving Health
Consumer Rights and Issues			Understand Health Care Information Services and Products
Community Services		Understand the Roles of CDC, DHSS, and other Public Health Agencies	Develop a List of Health Agencies and their Responsibilities
Decision Making and Problem Solving			Understand and Apply Responsible Health Practices
Communicable vs. Non-Communicable Diseases	Understand Communicable vs. Non-communicable Diseases; Causes, Symptoms, Treatment, and Management		Cite Epidemiological Studies in Describing how Positive Lifestyle Choices Prevent Disease Spread
Body Defenses and Recovery	Identify Body's Lines of Defense; Practices that Prevent Infection	Identify Stages of Disease Progression; Relate Progression to Body's Lines of Defense	Describe Primary and Secondary Defenses against Disease and their Maintenance
Types of Pathogens and Transmission	Identify Viruses, Bacteria, and Fungi as Pathogens; Function of Lifestyle in Spread	Hypothesize Optimal Growth and Transmission Conditions for Pathogens	Understand Formation and Reoccurrence of Resistant Pathogens

Lymphatic-Immune System

This set of standards address how the immune system works and how to keep it healthy. By Grade 4, students are expected to explain the role of vaccination and immunization in keeping the immune system healthy. By this age, students should understand that the flu vaccine can prevent contraction of the flu. By Grade 6, students are expected to be able to label the major components of the lymphatic system and understand its necessity in recognizing and destroying pathogens and providing immunity. This includes understanding that our body overcomes the flu by producing antibodies. By Grades 9-12, students should begin to investigate disorders, their treatment, and prevention techniques and their role in maintaining a healthy immune system. Students should begin to understand how the flu is transmitted and the role of vaccination, proper hygiene, and social distancing in mitigating transmission. Students should also begin to understand how the flu is treated, namely that the body builds immunity and gets better on its own in most cases, and the role of rest, proper diet, hydration, and antiviral medications in expediting recovery.

Personal Health

Ability to develop plans and strategies for staying healthy is assessed here. By Grade 5, students should create a personal health plan that includes balanced nutrition, physical activity, good hygiene, adequate sleep, no alcohol, and healthy snacking. Such a health plan could also include factors which minimize the risk of contracting and spreading diseases such as influenza. This includes understanding that proper diet, sleep, and physical activity helps give the immune system the support it needs to fight off infection as well as the benefit of proper hand washing and respiratory etiquette. By Grades 9-12, students are expected to examine system functions and disease formation encountered in daily living. This includes examination of how factors like poor hygiene and low immunity can increase risk of contracting respiratory infections such as influenza.

Preventative Care

What measures can we take to prevent disease? By Grade 1, students are expected to identify preventative health care measures, including immunizations and regular health checkups. By Grade 3, students extend this by explaining how preventative care serves to enhance health. This includes understanding the effectiveness of the flu vaccine in preventing influenza and the role of the doctor or nurse as a resource for developing understanding of ways to avoid contracting influenza. In Grade 6, students should begin to understand their health needs during adolescence, and by Grade 7, should develop the ability to foresee problems which may occur due to lack of preventative care. Students begin developing strategies for addressing health needs and problems by Grade 8. Discussions of risks associated with not getting the flu vaccine, not practicing social distancing, and exercising poor hygiene habits are encouraged here. Finally, by Grades 9-12, students are expected to have a strong general understanding of preventative care and its importance in maintaining and improving health. Students should understand how the flu vaccine works and why it is needed each year as well as reasons why proper hygiene measures such as regular and proper hand washing, use of hand sanitizers, respiratory etiquette, and social distancing can prevent spread of microbial infections like influenza.

Consumer Rights and Issues

Outcomes related to influenza under the topic of consumer rights and issues are listed under Grades 9-12. By this level, students are expected to analyze the reliability of health care information services and products that could affect consumer decision making. This includes locating information from specialists such as the Center for Disease Control (CDC), the National

Institute of Health (NIH), the World Health Organization (WHO), or the Department of Health and Senior Services (DHSS), county health departments, extension centers, insurance companies, clinics, hospitals, OB GYN's and emergency rooms. Understanding the role of these resources is important for high school students as they provide information on vaccine availability, guidelines for flu mitigation and pandemic preparedness, and flu outbreaks.

Community Centers/Careers

While consumer rights and issues deals with identification and proper utilization of potential information sources, community centers/careers addresses the responsibilities of these agencies in aiding public health in a variety of situations including influenza outbreaks. By Grade 8, students are expected to analyze how the DHSS, CDC and other public health agencies are responsible for disease reduction, control and prevention, research, education, and law enforcement. By Grades 9-12, students are expected to develop a list of such agencies and explain their responsibilities for providing assistance to individuals. Relating to influenza, this includes flu surveillance, dissemination of information on outbreaks and mitigation strategies and invoking ordinances regarding mandatory mitigation practices (e.g. vaccination and social distancing) and how vaccines will be distributed in event of an outbreak or pandemic.

Decision Making and Problem Solving

Students are asked to evaluate the broader impacts of their health decisions on others and identify strategies for making responsible decisions. By Grades 9-12, students analyze and apply practices designed to preserve and enhance the safety and health of others. While key points under this topic include conflict resolution, peer mediation, goal setting, and resisting peer pressure, understanding that individual actions to mitigate influenza can prevent others from getting infected should also be sought. For example, understanding of the self as a vector for influenza brings new light to the importance of getting vaccinated to build herd immunity, proper hygiene, and practice of social distancing to reduce transmission.

Communicable vs. Non-Communicable Diseases

Influenza-related objectives under this topic ask students to distinguish between diseases which are communicable and those which are not, how communicable diseases exist, and how they are spread. By Kindergarten, students should recognize that germs cause disease, and by Grade 1, should identify where germs are found, that they can harm the body, signs of illness, and methods for recovery. Students should begin to understand that influenza is a virus which can be transmitted through contact with contaminated surfaces or air. They should begin to understand the symptoms of influenza, including sudden onset, body aches, high fever, and cough, distinguishing them from other illnesses such as gastroenteritis and common cold. By Grade 2, students are asked to identify diseases which are communicable (such as common cold, flu, AIDS, and gastroenteritis) and those which are non-communicable (such as heart disease, diabetes, and cancer), and by Grade 3 are asked to properly categorize diseases. Additionally, second graders are asked to identify how germs are spread and to apply practices (such as hand washing and respiratory etiquette) which reduce the spread of germs. By Grade 4, students should be able to identify and describe the basic causes, symptoms, treatments, and management of common communicable diseases including influenza. By Grades 9-12, students are asked to describe how positive lifestyle choices prevent occurrence of disease through research citing epidemiological studies and evidence about the management and prevention of diseases, including influenza. By this time, students should be literate on the nature of influenza as a highly transmissible virus found on surfaces or in the air after an infected person coughs or sneezes, symptoms of influenza, and the role of active practice of mitigation strategies to prevent spread to oneself and others.

Body Defenses and Recovery

This topic relates to the body's role in preventing and recovering from diseases such as influenza as well as action we can take to minimize risk of infection. In Kindergarten, students are expected to model proper hand hygiene, and by Grade 1 to identify other behaviors that prevent or reduce chances of illness such as drinking water, eating healthy foods, getting adequate sleep, and getting immunizations. In Grade 3, students are expected to identify the body's basic lines of defense (skin, hair in nasal passages, and white blood cells), and by Grade 4, to explain how healthy behaviors can assist these lines of defense. By Grade 6, students are expected to identify the stages of disease progression, including transmission, infection, and incubation, and by Grade 8, students begin to relate the body's basic lines of defense to the stages of progression. By Grades 9-12, students describe the primary and secondary defenses against disease and strategies for maintaining or improving them.

Types of Pathogens and Transmission

Students learn to distinguish between the different types of pathogens, identifying similarities and differences between how they are transmitted and how to prevent and treat them. By Grade 3, students are expected to understand viruses, bacteria, and fungi as three major types of pathogens, to identify lifestyle behaviors that affect their growth and spread by Grade 4, and to analyze information about transmission and prevention of communicable diseases by Grade 6. This should include identification of influenza as a highly transmissible virus that can be spread though sneezing, coughing, and contact with surfaces. By Grade 8, students begin to hypothesize optimal conditions for growth and transmission of pathogens, which can include crowded populations with low immunity in the case of influenza. By Grades 9-12, students are expected to formulate and support an interpretation regarding the reoccurrence of resistant pathogen strains. As it relates to influenza, this includes the understanding that influenza is always changing and adapting to its environment, meaning that new vaccinations need to be taken each year, and that antiviral-resistant strains are emerging. In addition, this relates to students understanding that antibiotics do not work on viral infections, and that overuse can lead to antibiotic-resistant bacterial strains. In Grades 9-12, students are asked to use scientific laboratory investigations to test hypotheses related to pathogen transmission, including the effect of hand sanitizers and disinfectants. Similarly to other topics, this opens up discussion of the role of immunity and strategies for reducing transmission rate on mitigation of the flu.

Missouri's Influenza-Related Biology Course Level Expectations (CLE's)

While the Health Education GLE's focus on recognizing influenza as a virus, understanding how it spreads and infects its hosts, mitigation methods, the impact of mitigation on self and society, and attaining information from public health specialists, the Biology CLE's primarily address understanding the genetic makeup of viruses such as influenza and their interaction with their hosts and environments. Related concepts are found under Strand 3 (Characteristics and Interactions of Living Organisms) and Strand 4 (Changes in Ecosystems and Interactions of Organisms with their Environments). Students' progress towards mastery of the Biology CLE's is assessed via the Missouri Assessment Program (MAP) end-of-course examination.

Strand 3 contains concepts which invite students to develop understanding of influenza as an organism which interacts with other living organisms to survive. Students should recognize cells as the fundamental units of structure and function of all living things. Organisms progress through unique life cycles, and can reproduce sexually or asexually. An important factor is recognition that influenza is a virus, and is nonliving since it must reproduce using the machinery of cells. Students are expected to understand DNA/RNA, which is possessed by all organisms, codes for protein structure and function, carries hereditary information, and is responsible for heritable variation within all species. Students should understand that organisms are classified based on how they are related. Discussion on similarities and differences of influenza from other viruses such as HIV, ebola, or hepatitis, can be included here. Unique characteristics of the flu, such as its RNA composition, surface proteins, shape, and niche provide grounds for classification. Additionally, students are expected to be able to use concepts from Mendelian genetics to predict patterns of inheritance. These concepts can be used to understand reassortment of influenza strains within a host. Finally, students are expected to understand that life processes can be disrupted by disease, promoting discussion on how influenza affects human, swine, and bird populations. While this final objective is not assessed at the high school level, it is assumed that students have gained familiarity from previous grades in biology and health.

Strand 4 contains concepts which invite students to understand influenza as an organism which continually adapts to its environment. Students begin to understand that all populations living together in an environment interact with each other to survive and maintain a balanced ecosystem, and while living organisms have the capacity to produce populations of infinite size, resources are limited. Students can discuss how influenza interacts with its hosts, including environmental conditions which help or hinder its ability to reproduce and spread. All organisms cause changes in their environments which affect the ecosystem, and reproduction is essential to continuation of a species. Influenza's quest to reproduce within its host and spread to other hosts can create a wide variety of consequences based on the virulence and infectivity of the virus as well as population immunity. In this light, students can also discuss ways to change influenza's ecosystem, such as getting vaccinations, minimizing social contact, and practicing effective hygiene, which will hinder the virus's ability to spread. Students should understand natural selection as the process of sorting individuals based on their ability to survive and reproduce within a specific environment, and that diversity of species is affected by changes in the environment. Natural selection relates to influenza as students develop understanding of how and why it changes from season to season due to reassortment, mutation, or antigenic shift. Students should be able to relate the fast evolution of influenza to its short life cycle. In addition, the concept of natural selection should be used to understand why influenza strains are developing antiviral resistance as well as the potential negative impact of using antibiotics to treat viral infections.

Influenza Knowledge and Perceptions, and Connection with Prevention

Knowledge of influenza, perceptions of the disease, and preventative measures against influenza, have been addressed by previous studies with regard to the flu vaccination and hand washing, but studies on other preventative measures deemed important by the CDC (2009), including respiratory etiquette, social distancing, and keeping hands away from the eyes, nose, and mouth, are limited.

Assessments of Knowledge of Influenza

An assessment of influenza knowledge in high school students was undertaken by Dumais and Hasni (2009). To assess the impact of an intervention program focusing on increasing knowledge of the flu, they developed an assessment comprised of a mixture of open-ended and multiple choice questions focusing on virus and influenza biology, vaccination, and the emergence of epidemics and pandemics. This assessment showed that students' knowledge of influenza biology improved as a result of an 80-minute lecture-discussion style intervention.

The "Flu IQ" (CDC, 2011) is another influenza knowledge assessment. This is a 10-item online true-false assessment intended to measure knowledge of the flu related to influenza prevention and transmission. Flu IQ is a teaching tool for children and adults, and is not intended for research. No measures of validity and reliability were provided for these assessments, and no relationships between knowledge and preventative practice were explored by Dumais and Hasni. The only assessment of flu knowledge as a latent trait was undertaken by Falomir-Pichastor, Toscani, and Despointes (2009) on nurses in Switzerland. While their list of eight items measured knowledge with moderate reliability (α = 0.75), several items assessed opinions instead of facts (i.e. "The flu shot is painful," and "I do not trust scientific knowledge on the vaccine."), and their definition of knowledge was not focused or defined, making content validity questionable.

While there are no validated instruments to assess knowledge of influenza, such assessments for other diseases do exist. A 23-item diabetes knowledge test, which measures general knowledge of diabetes, and insulin use, was designed for adult patients with Type 1 and Type 2 diabetes and their healthcare providers (Fitzgerald et al., 1998). Reliabilities above 0.7 were reported. A 20-item two tiered test on knowledge of malaria, the "MalariaTT2," was developed to measure the knowledge and misconceptions of Bruneian nursing students (Cheong et al., 2010). The Malaria TT2 was validated using the Rasch model, and reliabilities above 0.6 were reported.

The Flu Vaccination

The relationship between knowledge and perceptions of the flu vaccine and peoples' decisions to vaccinate have been of particular interest in medical research; studies are comprise of adults, with health care providers on one side and patients on the other. Martinello, Jones, and Topal (2003) explored the link between misconceptions and likelihood of getting the flu vaccination through a cross-sectional study of doctors and nurses at a large urban teaching hospital. The knowledge instrument, "Survey Regarding General Knowledge of Influenza," asked health care workers five questions regarding knowledge of the risk of influenza to themselves and their patients, and the efficacy of the vaccine. They found a significant increase in vaccination rate in response to knowledge among nurses, but no significant difference among doctors. Reasons for declining the vaccination among nursing staff included concerns over catching the flu from the vaccine, pregnancy or breast feeding, aversion to needles, that the vaccine does not work, and influenza does not pose a significant health risk. Reasons reported by doctors were either informed, including ready availability of neuraminidase inhibitor medications, or not information-based, including inconvenience and forgetfulness.

Relationships between risk perception and vaccination were assessed by Weinstein et al. (2007) in a study of students, faculty, and staff at three universities. Variables studied included risk magnitude, beliefs about risk, and feelings about risk, as well as socio-demographic variables. Through logistic regression analysis, they found anticipated regret about not getting the flu shot, the female gender, and feeling at risk from the flu to be significant positive predictors, and the belief that the vaccine causes the flu to be a significant negative predictor. Instrument reliabilities between 0.8 and 0.9 were reported.

Relationships between ethnicity and decision to vaccinate have also been explored. Chen et al. (2007) conducted a telephone survey of adults in Los Angeles and Honolulu assessing effect of ethnicity on attitudes towards vaccination, perceived susceptibility to, and severity of influenza. High inter-rater reliability ($\kappa = 0.89$) was the only psychometric property reported for their survey. In this study, adult participants from 76 church parishes were asked questions regarding their race and socio-economic status, medical conditions, perceived susceptibility and severity of influenza, whether or not they got vaccinated in the past year, and if not, what barriers prevented them. Perceived risk of getting the flu was a strong predictor for vaccination among Whites and African Americans, and a moderate predictor for Hispanics. Vaccination rates of Whites and Japanese Americans were significantly higher than African Americans, Hispanics, and Filipino Americans. The negative impact of minority status on vaccination was also reported by Lindley et al. (2006) in a comparative study between African American and White Medicare beneficiaries in five US states. Economic barriers such as low income and lack of health insurance (Chen et al., 2007), and more persistent negative attitudes (Lindley et al., 2006) were shown to deter vaccination in minority populations.

More recently, Joshi et al. (2009) designed a vaccination instrument called the “Knowledge, Attitudes, and Practice” (KAP) questionnaire in order to assess the impact of a computer-based vaccination intervention called, the Patient Education Motivation Tool (PEMT) which targets parents of children aged six months to five years. In this instrument, six questions addressed knowledge of the vaccine, nine addressed perceptions related to the vaccine’s usefulness, safety, pain, and side effects. Practice was assessed with a single question asking parents whether or not they will get their child vaccinated this year. Significantly increased knowledge, attitude, and practice were documented outcomes of the PEMT. However, the KAP was not validated, and explorations of correlations between knowledge, attitude, and practice were not within the scope of the study. The positive impact of knowledge of the vaccination and perceived complications from the flu on intent to vaccinate was documented in a study of nurses in Switzerland (Falomir-Pichastor, Toscani, & Despointes, 2009). While reliabilities of 0.74 and 0.75 were reported for their assessments of knowledge and perceived complications, respectively, the lack of content validity of these assessments calls their conclusions into question.

Hand Hygiene

The relationship between knowledge and hand washing is similar to that documented for vaccination. In a knowledge-based intervention to improve hand washing, where posters describing nosocomial infection, cross transmission, hand carriage and hygiene, and disinfection with creams were posted in a hospital (Pittet et al., 2000), compliance improved among nursing staff, but not among doctors. Reported barriers against hand washing included skin irritation, the belief that hand washing supplies are inaccessible, wearing gloves, “being too busy,” and “not thinking about it” (Pittet et al., 2000, Kretzer & Larson, 1998). As with vaccination, doctor’s reasons for noncompliance with hand washing were not based on information deficit, and so knowledge-based intervention strategies were less likely to work. Increased compliance with hand washing in health care professionals working in higher stakes environments, such as intensive care and surgical units, where procedures carry a high risk of bacterial contamination, indicate a positive effect of perceived risk on compliance (Pittet et al., 2000; Harbarth et al., 2001).

Main ideas about disgust and the importance of hygiene are found to be relatively consistent across cultures (Curtis & Biran, 2001). However, religion has been established as a cause for cross-cultural differences in reasons for washing hands, and attitudes towards hand washing (Allegranzi et al., 2009). Specifically, Asian religions such as sects of Buddism, Sikhism, and Islam, strictly forbid proximity to alcohol, potentially reducing compliance with use of alcohol-based hand sanitizers. Additionally, some sects Jainism and Buddhism forbid the killing of any entity perceived as having life force, including bacteria and viruses, which may present a significant barrier to hand washing regimens of any form (Allegranzi et al., 2009).

Other Precautions

Studies exploring the impact of factors such as knowledge, perceptions, and socio-demographics on precautions outside of hand washing and vaccination are almost nil. A recent telephone survey study of adults in New York State gives a holistic look at what motivates precautions (Kiviniemi et al., 2011). Through logistic regression analysis, age was found as a positive predictor for social distancing and not touching the eyes, nose, and mouth, and working outside the home was a positive predictor for hand washing. Perceptions about influenza were also shown to impact precautions. Perceived efficacy of the precaution was a positive predictor for all precautions, and perceived severity of influenza was found to be a positive predictor for hand sanitizer use, social distancing, and vaccination. Assessments used did not have psychometric properties reported, and knowledge was not considered in this study.

The Need for Additional Study

While the role of knowledge, perceptions, and socio-demographic factors in the prevention of influenza has been a topic of study over the past decade, several gaps remain which need to be filled. First, there are currently no validated assessments to measure influenza-related knowledge and general perceptions about influenza for high school students. Second, there are no studies on how preventative practices relate to knowledge, perceptions, and socio-demographic variables in high school students. While studies addressing motivations for hand washing and vaccination exist, these are confined to adults and workers in the medical community. Attention to other important precautions, including social distancing, staying home when sick, respiratory etiquette, and keeping the hands away from the face, have received limited attention in all arenas. Finally, there are currently no studies comparing the effects of knowledge, perceptions, and socio-demographic variables on precautions, and none to assess which factors are most important in preventing student illness. This study will attempt to fill these gaps by: (1) validating assessments of influenza knowledge and perceptions for measurement of high school students; (2) exploring relationships between these variables and socio-demographics with preventative practices against influenza deemed important by the CDC (2009) and the likelihood of contracting illness; and (3) testing the efficacy of these factors in predicting preventative behavior and illness.

Misconceptions about Influenza

In addition to aligning with state and national standards, development of assessments included research on misconceptions about influenza. Through an extensive review of the education and medical literature, eight topic subthemes for misconceptions emerged: (1) history of influenza pandemics; (2) severity of influenza (3) the influenza vaccine; (4) cause/transmission; (5) nature of a virus; (6) immunity; (7) flu biochemistry; and (8) mitigation/treatment.

History of Influenza Pandemics

Influenza, due to high contagion and mortality rates, are a significant health concern. Over the past century, four pandemics have occurred: the Spanish influenza pandemic of 1918 and 1919, the Asian flu of 1957, the Hong Kong flu of 1968 and 1969, and the recent Novel H1N1 of 2009-2010. While the 1918-1919 and recent H1N1 pandemics are perhaps the best known, the Asian and Hong Kong flu pandemics, each of which resulted in over 1 million deaths (Ayob et al., 2006; Hampson & Mackenzie, 2006), are less studied. Furthermore, although awareness of the Spanish flu pandemic generally exists, proper understanding of its impact does not. For example, Romine, Siegel, and Roberts (2009) found that some teachers believe that the Spanish flu pandemic had the greatest negative effect on the very young and very old, whereas in actuality most deaths occurred among healthy middle aged adults. In addition, due to under-reporting and incomplete data, deaths due to this pandemic have been severely underestimated; Johnson and Mueller (2002) suggest the actual death toll rose well above 50 million, and possibly could have exceeded 100 million. History can serve as a lens into what is to come, and ignoring or underestimating the impact of past pandemics inhibits our ability to prepare for those to come.

Severity of Influenza

As the severity of past influenza events has been underestimated, so has the severity of the illness itself. Many people consider influenza to be a minor disease since a relatively low percentage of people who get illness suffer severe complications or death (Leggat, Speare, & Aitken, 2009; Gauthey et al., 1999; Hollmeyer et al., 2009; Virseda et al., 2010). In addition, it is a common conception that an individual's risk of influenza is not high enough to qualify for vaccination (Stinchfield, 2008). Finally, many people, especially those who consider themselves "healthy," hold the idea that the threat of influenza is serious for others, but not for oneself (Cornford & Morgan, 1999; Leggat, Speare, & Aitken, 2009; Hollmeyer et al., 2009; Virseda et al., 2010). Cornford and Morgan found patients making positive comparisons, that flu is less serious than other diseases and that they are healthier than less healthy people who get the flu. Patients' ideas of health or lack thereof were largely tied to independence and ability to keep up with their hobbies (Cornford & Morgan, 1999).

The Influenza Vaccine

Epidemiology studies have shown that being vaccinated can be one of the most effective measures for reducing impact of influenza (Nuno, Chowell, & Gumel, 2007). An individual's perceived risk of influenza plays a large part in their decision to be vaccinated since this decision lies upon evaluating the perceived risk of catching influenza versus the perceived risk/benefit of the vaccination. Indeed, many believe that the flu vaccination is not necessary if they are in good health (Tapiainen, Schaad, & Heininger, 2005; McEwen & Farren, 2005; Canning, Phillips, & Allsup, 2005; Gauthey et al., 1999; Begue, 1998; Lester et al., 2003; Nichol & Hauge, 1997; Steiner et al., 2002; Harbarth et al., 1998; Sartor et al., 2004; Esposito, Tremolati, & Bellasio, 2007; O'Reilly, Cran, & Stevens, 2005; Nowalk et al., 2007; Kroneman, Essen, & Paget, 2006; Stinchfield, 2008) and practice good hygiene techniques such as frequent hand washing (Johnson, 2008). In conjunction with the belief of non-necessity, the negative effects of the vaccine on health are highly overestimated. This is exemplified by beliefs that the vaccine causes influenza or colds (Nicholson, 1993; May, 2005; O'Rorke et al., 2003; Steiner et al., 2002; Stephenson, Roper, & Nicholson, 2002; Takayanagi et al., 2007; Wodi, Samy, & Ezeanolue, 2005; Abramson & Levi, 2008; O'Reilly, Cran, & Stevens, 2005; Nowalk et al., 2007; Johnson, 2008; Virseda et al., 2010; Stinchfield, 2008; Patriarca & Cox, 1997), that it has harmful side effects (Nicholson, 1993; May, 2005; McEwen & Farren, 2005; Canning, Phillips, & Allsup, 2005; Gauthey et al., 1999; Hollmeyer et al., 2009; Qureshi et al., 2004; O'Reilly, Cran, & Stevens, 2005; Virseda et al., 2010) including seizures (Wodi et al., 2005), that it will complicate an existing cold or underlying illness (Nicholson, 1993), that it has possible drug interactions (Nicholson, 1993; Fernandez et al., 2009; Hollmeyer et al., 2009), that it is unsafe for women and infants (Johnson, 2008), and that too many vaccines can weaken a child's immune system (Gellin, Maibach, & Marcuse, 2000). These result from hearing about adverse reactions experienced by others or perceiving adverse reactions from past vaccination experiences. The former factor is more powerful however; a large majority of people who get vaccinated one year will get vaccinated the next (Fernandez et al., 2009). Other negative beliefs about the vaccine also abound, including that the vaccine does not work to prevent influenza (Nicholson, 1993; May, 2005; Fernandez et al., 2009; Tapiainen, Schaad, & Heininger, 2005; McEwen & Farren, 2005; Gauthey et al., 1999; Hollmeyer et al., 2009; Lester et al., 2003; Begue, 1998; O'Rorke et al., 2003; O'Reilly, Cran, & Stevens, 2005; Stinchfield, 2008; Patriarca & Cox, 1997), and that it is not worth the time and inconvenience (Hollmeyer et al., 2009; Qureshi et al., 2004; Virseda et al., 2010). Others feel that vaccines and medications are bad (Hollmeyer et al., 2009) and are against vaccination on principle (Kroneman, Essen, & Paget, 2006), preferring homeopathic treatments instead (Gauthey et al., 1999). Some people are largely unaware of the vaccine's existence and availability. A commonly held belief is that the vaccine is only for at-risk patients of certain age groups (Johnson, 2008), and that healthy people do not qualify (Kroneman, Essen, & Paget, 2006). Complimenting this is a general belief that the current year's vaccine is does not exist or is not available (Nicholson, 1993; Canning, Phillips, & Allsup, 2005; Hollmeyer et al., 2009). Stinchfield (2008) recommends combating unawareness and increasing availability by offering the vaccine year round. Finally, while people generally understand that the goal of getting vaccinated is to protect oneself, they often do not realize that getting vaccinated also protects others (Stinchfield, 2008).

Cause and Transmission

People generally do not see themselves as vectors for influenza (Heininger, Bachler, & Schaad, 2003; Takayanagi et al., 2007; Yang et al., 2007; Virseda et al., 2010), illustrating misunderstanding of how influenza is transmitted from host to host and how it infects cells. A group of high school science teachers believed that swine and humans, not birds, were the primary carriers of Influenza A strains (Romine, Siegel, & Roberts, 2009). Another common belief is that H1N1 swine flu can be contracted from eating pork (Lau, Griffiths, Choi & Tsui, 2009; Mathew, Daniel, & Campbell, 2009; WHO, 2009). In an effort to combat misconceptions such as this, the WHO (2009) encouraged the media and health professionals to avoid the "swine flu" label. Lau, Griffiths, Choi, and Tsui (2009) found a number of other misconceptions about how H1N1 is transmitted; people implicate insect bites, infected waterways, and believe that it can be spread from building to building via aerosols from a cough or sneeze. In a study of a Hispanic population in Northern Manhattan, Larson et al. (2009) found misconceptions that influenza is caused by cold weather, changes in weather, being stressed, bacteria, and not wearing enough clothes, and mythical beliefs from rural areas that influenza is caused by "the evil eye" and sudden fright. Misunderstandings about how influenza infects cells exist within high school students (Dumais & Hasni, 2009), including that viruses proliferate more easily in cells that are damaged and that influenza's surface proteins act like spikes, which open the cell membrane and allow the virus to pass though. These misconceptions result from lack of understanding of viruses.

Nature of a Virus

Misconceptions about how influenza exists and is transmitted as a virus come from an intervention study of high school students (Dumais & Hasni, 2009). Students often confuse viruses with bacteria. They consider viruses to attack the immune system, to be a cell that contains bacteria, and to divide like cells or bacteria to proliferate. Underdeveloped conceptions exist, including that viruses are transmitted by "airlike influenza," that they are something the body is not accustomed to have, that they are something that attacks cells, and that they are something that is harmful to our bodies and health. Other viral transmission misconceptions include that they tend to attack damaged cells and that they attack cells with fewer antibodies. This latter misconception indicates that students possess misunderstandings about how our immune systems work.

Immunity

A study of secondary science teachers by Romine, Siegel, and Roberts (2009) identified several misunderstandings about antibodies and immunity. Misunderstandings about how antibodies work include: antibodies physically break apart the virus, kill virus infected cells, prevent viruses from exiting cells, and the body must be exposed to a virus over and over in order to stay immune. This latter misunderstanding possibly resulted from hearing about the requirement of a flu shot every year without understanding that the influenza virus changes each year via reassortment, mutation, and antigenic shift. A full understanding of these phenomena requires understanding the molecular aspects of this virus.

Flu Biochemistry

Romine, Siegel, and Roberts (2009) identified six misconceptions about the biochemical aspects of influenza among high school biology teachers, three dealing with protein chemistry and three with assays for testing for influenza. One idea was that the "H" in H1N1 stands for "highly pathogenic," indicating unawareness of the hemagglutinin and neuraminidase surface proteins. Another was that the hemagglutinin protein changes shape in response to passage across the cell membrane when the virus enters a host cell. A third was that protein folding is dictated by pH levels within cells. In addition, three misconceptions regarding the Enzyme Linked Immunosorbent Assay (ELISA) were revealed. One was that it works by combining viral strains to create a new vaccine, indicating unawareness of ELISA's purpose. More developed understandings included that ELISA works by estimating the individual's load of viral nucleic acid, and that it works by distinguishing the strain's DNA strands from other strains, showing a confusion with the Polymerase Chain Reaction (PCR) as well as misidentification of influenza as a DNA (as opposed to RNA) virus. While one could argue that development of correct conceptions regarding the molecular details of the virus is beyond the scope of secondary level health and biology classes, a basic understanding of such concepts is important in understanding how influenza develops and mutates, the implications this has for the need for a new vaccine every year, and prevention and treatment options for the infection, including vaccination and neuraminidase inhibitors.

Prevention, Mitigation, and Treatment

As indicated by previous discussion of misconceptions about the flu vaccine, misconceptions regarding logistics and consequences for prevention and treatment options are prevalent. Other misconceptions regarding prevention and mitigation address pandemic planning and quarantine. One is that the goal of pandemic planning is to eliminate the virulence of the next influenza strain, indicating a misunderstanding of the term, "virulence;" another is that the goal of pandemic planning is to quarantine the largest number of susceptible people, indicating lack of understanding of the multidimensional nature of pandemic planning (Romine, Siegel, & Roberts, 2009). Another misconception is that quarantine is more effective than the influenza vaccine in mitigating pandemic infections (Seale et al., 2009), indicating underestimation of the effectiveness of the flu shot, how quickly influenza typically spreads through a population, and the difficulty of finding, transporting, and quarantining infected individuals without spreading the infection.

Along with strategies for preventing flu transmission, those for treating influenza are also misunderstood and misplaced. A severe misunderstanding is that influenza will not get better without medical intervention (Larson et al., 2009). While such advice is given in regards to babies, the elderly, and immunocompromised individuals, many healthy individuals consider this to include them. Negative consequences include infected individuals needlessly going into public to get medication, thereby spreading infection, and erroneously turning to antibiotics as a treatment option. In fact, antibiotics are often used to treat influenza despite its viral nature, and in many cases, are even prescribed by doctors to treat these infections (Larson et al., 2009; Dumais & Hasni, 2009; Trepka et al., 2001; Larson et al., 2006; Kuzujanakis et al., 2003; Huang et al., 2007; Belongia et al., 2002; Seale et al., 2009). Overuse of antibiotics to treat viral infections such as influenza compromises patient health, and has lead to dangerous antibiotic resistant bacteria strains (Chung et al., 2007; Levy & Marshall, 2004) such as Methicillin-resistant Staphylococcus aureus (MRSA).

Item Response Theory

Item Response Modeling

Classical Test Theory (Spearman, 1904), the most commonly used model for interpreting assessments, treats the entirety of an examination as a single continuous variable. Due to the singularity of a test score, it is impossible to extract examination difficulty and examinee ability independently. Does a high test score mean that the test was easy? Or does it mean that the examinee had high ability? Item Response Theory (IRT) was designed to address this concern, and enables separation of examinee and test characteristics (Lord & Novick, 1968). Specifically, it allows the researcher to simultaneously evaluate test item difficulty and the ability of participants along a latent trait. The model constraints give assurance that scores vary with respect to the defined latent trait as opposed to other undefined traits, which is essential for establishing validity (Thurstone, 1928).

Most IRT models make three assumptions (Junker & Sijtsma, 2001). First, they assume independence of items, meaning that a student's score on one item is independent of another. Second, they assume monotonicity, meaning the value of the item response function $P(\theta)$ increases with ability θ. Third, the dimension of θ (the number of latent traits measured by θ) is small relative to the number of items. These conditions are satisfied in this study.

The item-characteristic logistic curve is the mathematical basis for IRT. The two-parameter dichotomous model takes the form:

$$P(\theta) = \frac{1}{1+ e^{-a(\theta-b)}} \qquad (1)$$

where *b*, *a*, and θ are parameters corresponding to item difficulty, item discrimination, and examinee ability along the latent trait, respectively. Hence, $P(\theta)$ relates student ability level to the probability of answering the corresponding item correctly. The difficulty parameter *b* is defined as the point on the ability scale where the probability of answering the item correctly is 0.5, and the item discrimination parameter *a* is the maximum slope of the item characteristic logistic curve.

Both item difficulty and discrimination ability are expressed in the logistic curves. In an easy item, the probability of a student of average ability (logit 0) answering the question correctly will be above 50%. The probability of this student answering a difficult item correctly, however, will be much lower. A logistic function with $a = 0$ has no ability to discriminate, and so $P(\theta)$ becomes constant. When *a* approaches infinity, the question discriminates perfectly as shown by a step function. Adding the constraint $a = 1$ for all items ensures that curves do not cross, allowing calibration of students and items along a metric. This defines the Rasch model.

Rasch (1960, 1961) made the case that comparison between any two test takers should be independent of the items used in the assessment. The Rasch model makes no assumptions about the ability distribution of the persons tested. Instead, the model focuses upon the outcome of an assessment governed solely by two parameters: ability of the person and difficulty of the item (Wright, 1967). The probability that a person will answer a given item correctly is a function of these (Loevinger, 1965). With *a* equal to 1, the 2-parameter dichotomous model (*Eq. 1*) becomes:

$$P(\theta) = \frac{1}{1+ e^{-(\theta-b)}} \qquad (2)$$

Polytomous models, such as the Graded Response (Samejima, 1969, Andrich, 1978) and Partial Credit (Masters, 1982), are used when data are scored polytomously.

The Rasch Paradigm

IRT theorists have historically taken two views towards interpreting assessments. The traditional, positivistic view is that theories should be discovered from data (Lord & Novick, 1968; Birnbaum, 1968). These proponents advocate using the more advanced two and three-parameter IRT models which allow variation of the discrimination parameter since these provide the closest fit to data. An alternative, more constructivist view is that the function of a strong model is to disclose anomalies in data (Kuhn, 1961; Rasch, 1960, 1977), making Rasch a strong model for validating assessments. Identifying anomalies in data from statistical misfit relative to a model that has transcended reasonable doubt is one of the roles of measurement in the physical sciences (Kuhn, 1961). Measuring goodness of fit relative to the Rasch model allows identification of anomalous questions within the assessment (Andrich, 2004; Rasch, 1977).

IRT and the Rasch model have been given limited attention in science education as a tool for interpreting assessments. Validity of most science education assessments is established under the paradigm of Classical Test Theory, where parametric tests such as t-tests or ANOVA's are calculated using raw scores (Boone & Scantlebury, 2005). Scantlebury et al. (2001) used the

Rasch model to establish validity for instruments measuring qualities of science learning environments and attitudes towards science, Schoon and Boone (1998) used this model to validate a multiple choice test on science alternative conceptions and a Likert survey of science teaching efficacy (adapted from Enochs & Riggs, 1990) to find the relationship between the two qualities. Siegel and Ranney (2003) used the Rasch Partial Credit Model (Masters, 1982) to validate the Changes in Attitude about the Relevance of Science (CARS) survey. Further, Panizzon and Bond (2006) used Rasch to interpret data on conceptual understandings of diffusion and osmosis, and Kauertz and Fischer (2006) used Rasch in assessing students' knowledge levels of physics. Most recently, Cheong et al. (2010) used the model to validate a two-tiered test evaluating students' conceptions of Malaria. Despite the relatively limited use of Rasch, it is becoming recognized as a valuable tool (Liu & Boone, 2006). Scantlebury et al. (2001) recommend that science assessments move towards use of IRT modeling due to its ability to provide independent student abilities, item difficulties and a valid metric.

Neural Networks

The idea of using neural networks as computing machines was introduced by McCulloch and Pitts (1943). Development of neural networks has been motivated by the processes and the neural responses in the brain and interprets information very differently from other statistical or computational techniques.

A neural network (Figure 1) is an adaptive learning machine, which Haykin (1999) defined:

> …a parallel distributed processor made up of simple processing units, which has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects:
>
> 1. Knowledge is acquired by the network (inputs X1 through X7) from its environment through a learning process.
> 2. Interneuron connection strengths, known as synaptic weights (W1 through W7), are used to store the acquired knowledge. (p. 24)

Synaptic inputs are entered into a function *f* to give an output *y*. A neural network's learning algorithm functions to modify the synaptic weights of the network in order to match the data set it is describing as closely as possible.

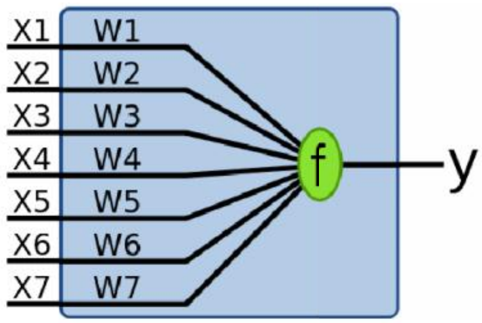


Figure 1. A diagram of a single-layer neural network (Rosenblatt, 1958; Foster, 2009). X1 through X7 serve as inputs, which are modified by weights W1 through W7, and are input into a function *f* to generate an output *y*.

In the context of this study, neural networks have the following advantages over conventional regression methods for predictive modeling (Haykin, 1999):

1. They don't assume linearity of data. Flexibility with nonlinear data is important in light of the fact that most data sets have at least a small nonlinear component, which has the potential to increase error in multivariate regression models.
2. They can be trained. During the learning process, the network is presented with an example picked at random from the data set, and the synaptic weights are adjusted to minimize the difference between the desired response and the actual response observed in the data set. Since the data set trains or teaches the neural network, there is no need to make probabilistic assumptions such as normality. This is an advantage considering perfect normality does not exist in most empirical data.

3. Neural networks, like the brain, are adaptable and can be retrained in the presence of new data. This extends the invitation for future studies to gather data and add them to the neural network, which will continually improve its ability to make correct predictions.

While neural networks, due to their flexibility, are known to be excellent at prediction with large data sets, they lack the capacity for explanation due to the fact that importance of inputs cannot be evaluated. Multivariate regression provides a helpful compliment to the neural network design by yielding straightforward weight factors and null hypothesis tests attributable to individual predictors.

Some computation software packages, including MATLAB (Demuth & Beale, 1998) and SPSS, contain neural networks of the multilayer feedforward design, also called multilayer perceptrons (Dawson et al., 2000). These contain a set of input nodes, into which data on influenza knowledge, demographics, and experience can be entered. The signal is then altered by a logistic activation function of output versus the weighted sum of all inputs plus the bias and transferred to one or more layers of hidden nodes, which perform similar, increasingly sensitive alterations to the signal,

$$f = \frac{1}{1+e^{\varphi}} \; where \; \varphi = \sum_{i=0}^{n} w_i * x_i \qquad (3)$$

where *f*, the activation function, is the output of the node, and φ is the sum of inputs *x* with fixed weight factors *w* into the node from *n* previous nodes. After passing through the hidden layer(s), the signal arrives at the output layer, which expresses a prediction and an error relative to the observed behavior. This error is then fed back into the neural network in the reverse direction, during which weights at each node are adjusted to minimize the difference between the calculated output and the observed outcome. This is done using the error back propagation algorithm (Haykin, 1999; Rumelhart & McClelland, 1986). This process is repeated through the entire training data set until the mean squared error converges to a stable minimum value.

Over the last 20 years, neural networks have been used widely to predict outcomes in the fields of accounting, engineering, and bioinformatics. They have been used to predict bankruptcy (Atiya, 2001), in computer decision and control systems (Lin & Lee, 1991), and to predict how genes will express themselves (Herrero, Valencia, & Dopazo, 2001). In addition, neural networks have been used in epidemiology for predicting disease contraction. Lucek and Ott (1997) used neural networks to predict passing of non-Mendelian genetic disease traits, and Batchelor, Yang and Tschanz (1997) used them to predict the severity of soybean rust epidemics based on climate inputs. While neural networks have been used in applications related to disease, there is no record of their use to predict behavior in the education setting.

Summary

The purpose of this chapter is to provide a review of literature. This chapter begins with a review of state standards, misconceptions, and models for health behavior, including a review of Missouri's GLE's and CLE's (MoDESE, 2010) that pertain to communicable diseases such as influenza and a review of misconceptions about influenza. This review provides information on what students are expected to know about influenza by high school, misunderstandings they have on the topic, and how these misunderstandings translate to behavioral decisions.

The role of Item Response Theory (IRT) and neural networks as interpretation tools are described. IRT provides student ability and item difficulty parameters independently, and the Rasch model is well suited for test validation and calibration. Background on neural networks is provided, including how they work and how they have been used in research to date. Accounting and engineering employ them most extensively. However, they are beginning to be used in other areas as well. Due to increased focus on cognitive and behavior outcomes in education, neural networks may prove to be a useful predictive tool.

CHAPTER THREE: DESIGN, METHODOLOGY, AND PROCEDURES

Introduction

This chapter describes the research procedures used in this study. It is divided into seven sections: (1) research questions and hypotheses, (2) the theoretical framework, (3) instrumentation and instrument development, (4) the sampled population, (5) data gathering process, (6) data analysis, and (7) summary.

Research Questions and Hypotheses

This cross-sectional, exploratory study investigates the relationships between high school students' knowledge of influenza, demographics, experience with influenza, and risk of complications from influenza, to preventative behavior such as getting vaccinated, proper hand washing, and social distancing. It addresses four questions.

1. What do students know about influenza transmission and management?
2. What is the relationship of student knowledge, social background, and demographic variables with ability and/or willingness to take measures to protect oneself and others from influenza? Null hypotheses include:

   Ho1: Receiving the influenza vaccine will have no statistically significant correlation with other precautions, knowledge (understanding of flu spread and management) and background (age, gender, race, perceived risk of becoming sick, perceived complications, perceived barriers to prevention, and/or perceived social responsibility)

   Ho2: Washing hands frequently and correctly according to the CDC's recommendations will have no statistically significant correlation with other precautions, knowledge (understanding of flu spread and management) and background (age, gender, race, perceived risk of becoming sick, perceived complications, perceived barriers to prevention, and/or perceived social responsibility)

Ho3: Willingness to distance oneself from others who have influenza or stay home when sick with influenza will have no statistically significant correlation with other precautions, knowledge (understanding of flu spread and management) and background (age, gender, race, perceived risk of becoming sick, perceived complications, perceived barriers to prevention, and/or perceived social responsibility)

Ho4: Refraining from touching eyes, nose, and mouth (per CDC's recommendations) will have no statistically significant correlation with other precautions, knowledge (understanding of flu spread and management) and background (age, gender, race, perceived risk of becoming sick, perceived complications, perceived barriers to prevention, and/or perceived social responsibility)

Ho5: Respiratory etiquette (making effort to properly minimize disease transmission when coughing or sneezing) will have no statistically significant correlation with other precautions, knowledge (understanding of flu spread and management) and background (age, gender, race, perceived risk of becoming sick, perceived complications, perceived barriers to prevention, and/or perceived social responsibility)

3. What is the relationship of student knowledge, social background, and demographic variables with the probability of getting sick with influenza? The null hypothesis is:

   Ho6: Contraction of influenza will have no statistically significant correlation with precautions, knowledge (understanding of flu spread and management) and background (age, gender, race, perceived risk of becoming sick, perceived complications, perceived barriers to prevention, and/or perceived social responsibility)

4. What are the best predictors of each preventative behavior or getting ill?

    Ho7: Predictors will have no impact on precautions or illness.

5. Can reported precautionary behavior, student knowledge, social background, and demographic variables be used effectively to predict behavior and illness?

Theoretical Framework

Understanding Compliance

The range and number of misconceptions about influenza is numerous, spanning a variety of topic categories and walks of life from students to teachers to health professionals. Understanding misconceptions about influenza may give us personal insight into prevention and treatment decisions. In high schools, where there is interplay between expectations of the government, school administrators, teachers, students and parents, expectations which often conflict with each other. For example, in deciding whether a student with influenza should stay home from school, a variety of factors come into play. The student may be ill and need to stay home, but the parent must work, the student may have a test or assignments to turn in, and government funding/assistance to the school is based on enrollment for a particular day. Alternatively, fellow students, and in some cases, the teacher, may prefer the sick student stay home to avoid spreading the infection. The mutual decision of all parties that the student should stay home depends on understanding of how influenza is transmitted, understanding that it is highly contagious and life threatening to certain people, and thus perceiving it as a serious disease. The problem of noncompliance with health advice is an age old problem, and thus behavior theories such as the Health Belief Model and Protection Motivation Theory have been developed to explain these decisions.

The Health Belief Model and Protection Motivation Theory

The Health Belief Model was developed to explain compliance or noncompliance with medical advice, while Protection Motivation Theory provides an explanation of how people react in high stress or emergency situations where genuine fear exists. The Health Belief Model (Rosenstock, 1966, 1974; Janz & Becker, 1984) contains six independent factors influencing a person's likelihood of being proactive about their health and complying with medical advice (Becker & Maiman, 1975): (1) perceived susceptibility to a disease; (2) perceived seriousness of the disease; (3) perceived benefits of taking preventative action; (4) perceived barriers to preventative action; (5) strength of external forces promoting the behavior (e.g. family, peer, and media pressure); and (6) self efficacy of the individual. While it is difficult to quantify the inter-relations between these variables (Rosenstock, 1966), the Health Belief Model has been one of the most widely used models (Janz & Becker, 1984), providing a useful framework for exploring prevention practices and what motivates people to undertake them. This study uses the Health Belief Model as a guide for development of items for the SOBER assessment.

Protection Motivation Theory (Rogers, 1975) describes how people respond to fear, simplifying the Health Belief Model by eliminating the variables of social pressure and perceived benefits, leaving three perception components: (1) perceived severity of the disease; (2) perceived probability of the disease's occurrence, and (3) the perceived effectiveness of the person's response. The fact that this model was designed under the assumption of fear limits it to analysis of responses to emergency situations such as pandemics where genuine fear exists. Almost 70% of Americans noted that flu doesn't worry them (Reinberg, 2010), increasing the importance of social pressure and perceived benefits, making the Health Belief Model a better candidate for understanding preventative behavior against influenza. This can be used to understand why students choose to either take or forego the preventative behaviors to mitigate influenza transmission measured by the IMBS such as hand washing, staying home when sick, and getting vaccinated. The Health Belief Model served as a guide for what to include on the SOBER.

Instrumentation and Instrument Development

Two instruments were developed and used in this study. The pilot AUI (Appendix A) was composed of questions about influenza that measure understanding of different facets of the disease: history of influenza, influenza severity, the vaccine, cause and transmission, nature of a virus, immunity, flu chemistry, preventative measures, and treatment. The pilot SOBER (Appendix A), guided by the Health Belief Model, asked questions regarding prior experience with influenza, perceptions of risk, whether or not one has had influenza previously, and perceived risk of complications from influenza in oneself or one's family members, perceived barriers, and social and self efficacy. The SOBER also included demographic questions.

Development of Items

AUI and SOBER items were developed with the goal of representing key factors in the domains of mitigation, flu knowledge, and perspectives towards influenza and its prevention, respectively. AUI items were developed using the themes discovered in the flu misconceptions literature: flu transmission, flu vaccine, mechanism of the flu, flu chemistry, symptoms, hygiene, and treatment. Items for the SOBER were developed using the six-theme framework of the Health Belief Model: (1) perceived susceptibility to a disease; (2) perceived seriousness of the disease; (3) perceived benefits of taking preventative action; (4) perceived barriers to preventative action; (5) strength of external forces promoting the behavior (e.g. family, peer, and media pressure); and (6) self efficacy.

Establishing Content Validity

After development, items were subjected to a panel of five content reviewers who had extensive background in the field of infectious disease as physicians or researchers. Content reviewers rated each item based on accuracy and relevance to the flu (Lynn, 1986), and gave advice on how items should be revised to increase content validity. Items were revised or eliminated based on the advice of the content reviewers. Items rated as content valid by at least four out of five reviewers were used in pilot testing (Waltz & Bausell, 1981).

Establishing Face Validity

Face validity, or the assurance that the assessments make sense to high school students (Lacity & Jansen, 1994), was established two ways. First, the assessments were given to a panel of former secondary science teachers, who reviewed them and suggested changes regarding item structure and wording to increase understandability for high school students. Second, face validity was further established for the AUI and IMBS through linking items to Missouri's Health Education GLE's and Biology CLE's (Appendix A).

Exploratory Factor Analysis

Exploratory factor analysis (EFA) was used to identify latent traits within the SOBER and AUI assessments. The intent of EFA is to identify items that share common variance, and thus measure a single latent trait. The promax rotation (Hendrickson & White, 1964) was used, which allows latent trait vectors to be correlated. This contrasts with the varimax method (Kaiser, 1958), which transforms the data into a new set of uncorrelated latent traits (Jolliffe, 1986). While varimax rotation makes for a simpler model, the promax was more appropriate since it is reasonable to expect that latent traits related to flu knowledge, and to aspects of the Health Belief Model, are correlated (Rosenstock, 1966, 1974).

The SAS statistical software was used to develop a set of component scores and scree plots for each latent trait through maximum likelihood estimation (MLE). NOHARM (Fraser & McDonald, 1988) and LISREL (Jöreskog & Sörbom, 2006) were used to generate factor loadings for the dichotomously scored AUI and polytomously scored SOBER, respectively. These programs calculated polychoric correlations, and used the normal ogive response function to estimate factor loadings. For ordinal data, this is preferred over the traditional method of treating the data as continuous and metric (Muthen, 1984, Jöreskog & Moustaki, 2001). Scree plots of factor loadings are shown in Figure 2. The decision on how many factors to keep is subjective. Guidelines used in this study (Hatcher, 1994) were:

a. Scree plot should begin to level off (Cattell, 1966; Zhu & Ghodsi, 2006).
b. Item loadings onto factors should exhibit simple structure (items correlate largely on one factor while correlating lowly on the rest), meaning they measure only one latent trait.
c. Items loading on similar factors should share a conceptual framework, which allows identification of the latent trait the factor measures.

A three factor model for the AUI, and a four factor model for the SOBER, fit these guidelines well.

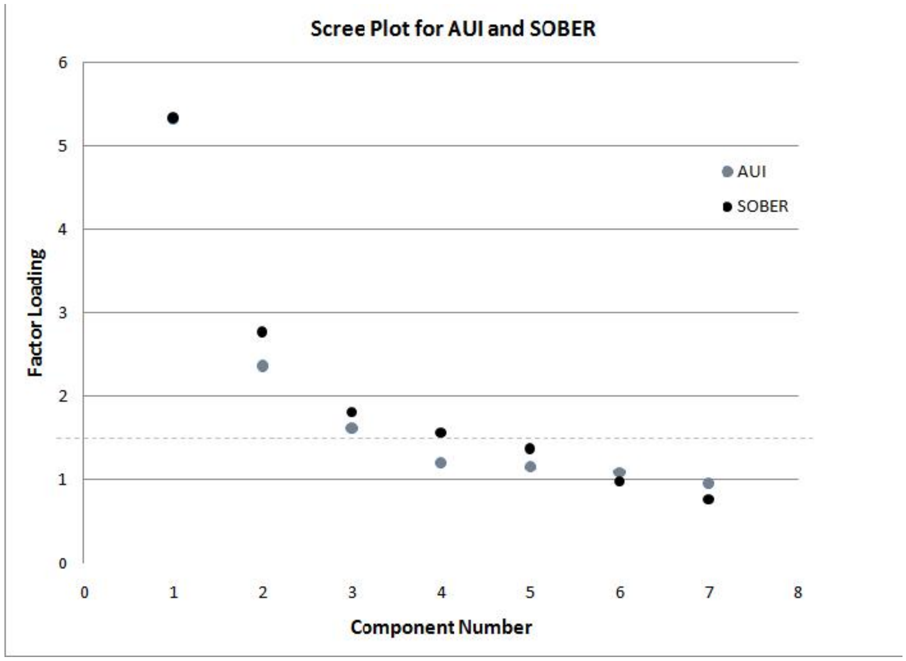


Figure 2. Scree plot of factor loadings for first seven components of the AUI and SOBER assessments

Item-factor loading outputs for the AUI

Items 39-76 in the AUI assessment were coded V39-V76 during analysis. Item loadings on the three factors are represented in Table 1. Items with positive loadings above 0.300 onto one factor were considered for retention.

Items under Factor 1 (V39, V40, V41, V43, V44, V46, V49, V51, and V67) addressed the theme, "Understanding Spread." Those under Factor 2 (V53, V57, V60, V61, V62, and V70) addressed, "Understanding Flu Symptoms." Items under Factor 3 (V42, V45, V50, V55, V66, V69, V73, V74, and V75) addressed, "Understanding Flu Management."

Table 2.

Promax rotated item loadings to the AUI three factor model

Item	1	2	3
V39	0.571	0.084	0.009
V40	0.448	-0.212	0.126
V41	0.563	-0.085	0.147
V42	0.104	-0.061	0.315
V43	0.610	0.108	0.066
V44	0.436	0.022	-0.102
V45	0.103	-0.085	0.564
V46	0.506	0.026	-0.030
V47	0.253	-0.094	0.272
V48	-0.018	0.091	0.292
V49	0.373	-0.108	-0.167
V50	-0.026	-0.011	0.306
V51	0.585	0.280	0.174
V52	0.221	0.067	0.154
V53	-0.045	0.483	-0.275
V54	-0.064	-0.155	0.125
V55	-0.055	0.069	0.422
V56	0.295	0.364	0.300
V57	-0.068	0.681	0.050
V58	-0.776	-0.526	0.179
V59	-0.354	-0.468	0.023
V60	0.112	0.321	0.156
V61	0.159	0.546	0.212
V62	0.192	0.431	0.102
V63	-0.514	-0.336	0.310
V64	0.163	0.132	-0.146
V65	0.090	-0.046	0.275
V66	0.053	0.028	0.741
V67	0.316	-0.019	0.102
V68	0.301	-0.263	0.352
V69	0.107	-0.092	0.776
V70	-0.196	0.386	-0.313
V71	0.111	-0.012	0.086
V72	0.035	-0.338	-0.026
V73	-0.193	0.264	0.692
V74	0.164	0.091	0.385
V75	-0.212	0.101	0.508
V76	-0.005	0.056	0.009

Item-factor loading outputs for the SOBER

Items 9-34 in the SOBER assessment were coded V9-V34 during analysis. Item loadings on the four factors are represented in Table 3. Items with loadings above 0.300 onto one factor were considered for retention.

Table 3.

Promax rotated item loadings to the SOBER four factor model

Item	1	2	3	4
V9	0.502	0.027	-0.012	-0.007
V10	1.001	0.064	-0.013	0.011
V11	0.013	0.815	0.104	0.058
V12	0.144	0.682	0.067	-0.006
V13	0.449	0.385	0.353	-0.082
V14	-0.101	-0.042	-0.150	-0.230
V15	-0.034	0.120	0.073	0.311
V16	-0.099	0.271	0.433	-0.054
V17	-0.057	0.496	0.006	0.336
V18	-0.044	0.112	0.455	-0.171
V19	-0.079	0.291	-0.472	0.045
V20	0.038	-0.076	0.451	-0.025
V21	0.043	0.206	-0.448	-0.105
V22	-0.064	0.011	0.359	0.203
V23	0.044	0.306	-0.239	-0.248
V24	0.080	0.094	0.238	-0.078
V25	-0.150	0.237	-0.238	-0.225
V26	0.123	-0.006	0.379	-0.081
V27	-0.108	0.187	0.223	-0.432
V28	0.074	0.114	0.084	0.216
V29	-0.095	0.060	0.329	0.333
V30	-0.112	0.121	0.294	0.016
V31	-0.102	0.109	0.478	-0.097
V32	-0.021	-0.056	0.041	-0.426
V33	0.091	-0.164	0.176	-0.579
V34	-0.077	0.157	0.241	-0.505

Negative loadings (designated by an “r”) showed that items V19, V21, V27, V32, V33, and V34 needed to be coded in reverse to fit the latent trait they were to measure. Data coding was transformed accordingly in subsequent analyses.

Items under Factor 1 (V9, V10, and V13) addressed the theme, "Perceived Risk of Becoming Sick." Factor 2 (V11, V12, V17, and V23) measured, "Perceived Complications." Factor 3 (V16, V18, V19r, V20, V21r, V22, V26, and V31) measured, "Perceived Barriers to Prevention," and Factor 4 (V15, V27r, V32r, V33r, and V34r) measured, "Perceived Lack of Efficacy." These four latent traits correspond well to the six elements of the Health Belief Model, reducing the six-factor Health Belief Model to four latent traits. The latent trait defined by Factor 1 combines perceived susceptibility and perceived seriousness, and the latent trait defined by Factor 4 combines self efficacy and perceived external forces promoting preventative behavior.

Reliability Analysis

Reliability is a function of correlations between items and number of items on a test, and is a measure of the lack of precision of observed scores in comparison to true scores (Schmitt, 1996). It documents the extent to which measures are repeatable, and is most valuable as an indicator of loss of precision due to test design (Nunnally, 1967, Chronbach, 1947). Chronbach's alpha coefficient (Chronbach, 1951), calculated using SPSS 16.0, was used to evaluate reliability of items within each factor and for the entire assessments. Items were eliminated as necessary down to a minimum of three per factor to improve reliability. Correlations of factors, Chronbach's alpha (in parentheses), and items remaining in each factor after reliability analysis, are shown in Tables 4 and 5. Due to the low reliability value for Factor 2, and the necessity that the final assessment be as short as possible, Factor 2 was eliminated from the AUI assessment. This also improved the reliability of the entire AUI assessment from 0.656 to 0.709. Alpha for the entire SOBER assessment was 0.519. This moderate alpha value makes sense in that the latent traits measured are much more distinct than those measured on the AUI. Hence, there is no underlying latent trait. This implies that individual factor scores, not a total assessment score for the SOBER, should be used in modeling.

Table 4.

Factor correlations, alpha reliability values (in parentheses), and items retained for the AUI.

	Factor 1	Factor 2	Factor 3	Items
Factor 1	(0.628)			V39,V40,V41,V43,V44,V46,V51
Factor 2	-0.129	(0.449)		V53,V57,V61,V62,V70[a]
Factor 3	0.432	-0.107	(0.643)	V42,V45,V55,V66,V69,V73,V74,V75

[a]Factor 2 eliminated for final assessment

Table 5.

Factor correlations, alpha reliability values (in parentheses), and items retained for the SOBER

	Factor 1	Factor 2	Factor 3	Factor 4	Items
Factor 1	(0.709)				V9,V10,V13
Factor 2	0.148	(0.615)			V11,V12,V17
Factor 3	0.191	0.107	(0.535)		V16,V19r,V20,V21r,V22,V26,V31
Factor 4	0.027	-0.229	0.175	(0.535)	V27r,V32r,V33r,V34r

Most of the reliability measures in these assessments were below 0.7, the standard for use in social science research. Schmitt (1996) describes this cutoff as shortsighted. Modest reliability does not significantly hinder validity, and when an assessment has other meaningful properties such as coverage of a specific content domain and established dimensionality, low reliability may not impede its usefulness (Schmitt, 1996). The level of reliability that is adequate depends on how the scale is going to be used—the finer the distinction that needs to be made, the higher the reliability that is required (Cortina, 1993). This implies that attempts to model fine distinctions using data from these instruments may have limited meaning. To take this into account, ability scores were clustered into five category levels with SPSS 16.0 using the k-means clustering algorithm (Theodoridis & Koutroumbas, 2006) before input into logistic regression and neural network models.

The k-means algorithm begins by specifying five equidistant centers along the range of numerical values. Data points are then assigned to the cluster with the nearest center, and a sum of squares error value is calculated for the data with respect to the nearest center. The mean of points in each cluster becomes the new cluster center, data points are reassigned, and the sum of squares is recalculated. This continues until the sum of squares function is minimized.

Construct Validity with Respect to the Rasch Model

Construct validity for the AUI and SOBER was established using the Rasch model (Scantlebury et al., 2001). There are four major advantages to using the Rasch model for establishing construct validity. First, to calibrate the test relative to a reference, it is necessary to have non-crossing curves like Rasch curves (Wright, 1997). Consequently, the Rasch model is useful in identifying questions that provide misleading measurement information. For example, items that do not discriminate well, or those that miscategorize high and low ability students become evident though lack of fit with the model (Lincare, 2010). Second, logit ability scores calculated from the Rasch model provide equal interval values that do not assume linearity. While the relationship between score and ability are approximately linear at middle ability levels, they become nonlinear at the high and low ends due to the ceiling and floor effects, which the logistic function represents via asymptotes at 0 and 1. The logistic function’s allowance for nonlinearity at the extremes allows for adequate representation of students at the high and low ability levels (Boone & Scantlebury, 2005). Third, Rasch modeling yields equal interval, invariant scales which measure the latent trait in the same way over multiple trials across subjects (Boone & Scantlebury, 2005; Scantlebury et al., 2001). Having all participants on the same metric is essential for predictive modeling (Byrk et al., 1998), and if multiple items in the assessment lie at the same place along the metric, or are at the extremes, a case could be made for removing one or more of the items to allow for a shorter instrument. Finally, items can be anchored at a fixed difficulty metric to compare test takers over multiple time points. With items measured and anchored, these assessments will be of use to future researchers who wish measure high school students' knowledge of and dispositions towards influenza.

Rasch modeling with BIGSTEPS (Linacre & Wright, 2006) used Joint Maximum Likelihood Estimation (JMLE) to calculate person abilities, item difficulties, and goodness of fit of each item with the Rasch model. Outfit is calculated from a sum of squares of standardized residuals modeled to approximate a unit normal distribution. Dividing this sum by degrees of freedom yields a mean square outfit value with an expectation of 1 and a range from zero to infinity (Wright & Masters, 1982). Infit is an information-weighted form of outfit, which reduces the influence of less informative responses that have little variance or are off target (Wright & Masters, 1982). Fit values larger than 1 indicate noise in the data that is not modeled; lower values indicate a Guttman pattern (lack of stochasticity), where a test taker succeeds on items up to a certain difficulty, but fails on all of those above. Items with fit values between 0.5 and 1.5 are generally productive for measurement and should be retained (Wright & Linacre, 1996). Point biserial correlations are used as a diagnostic indicator—negative correlations often indicate reverse coding of items (Linacre, 2010). Person-item maps (Figures 3-8) show the distribution of examinee ability and item difficulty scores. Considerable overlap in these distributions shows that items in a factor are written at an appropriate difficulty level to extract valid information from responses (Linacre, 2010).

AUI Factor 1 item difficulties range from -1.21 to 1.38, which fall within the distribution of examinee abilities (Figure 3). Infit values range from 0.85 to 1.15; outfit values range from 0.80 to 1.28 (Table 6). These values fall within the range of 0.5 to 1.5 suggesting the items provide appropriate information.

Table 6.

Rasch modeling results for AUI Factor 1

AUI Factor 1 Item	Difficulty	Error	Infit (MNSQ)	Outfit (MNSQ)	PTBIS CORR
V39	0.31	0.15	0.91	0.96	0.29
V40	-0.72	0.15	1.05	1.16	0.11
V41	-1.21	0.16	0.93	0.85	0.21
V43	-0.27	0.15	0.85	0.80	0.35
V44	0.55	0.15	1.15	1.22	0.09
V46	1.38	0.18	1.03	1.28	0.11
V51	-0.04	0.15	0.99	1.00	0.21
Mean	0.00	0.16	0.99	1.04	0.20
Stdev	0.85	0.01	0.10	0.19	0.10

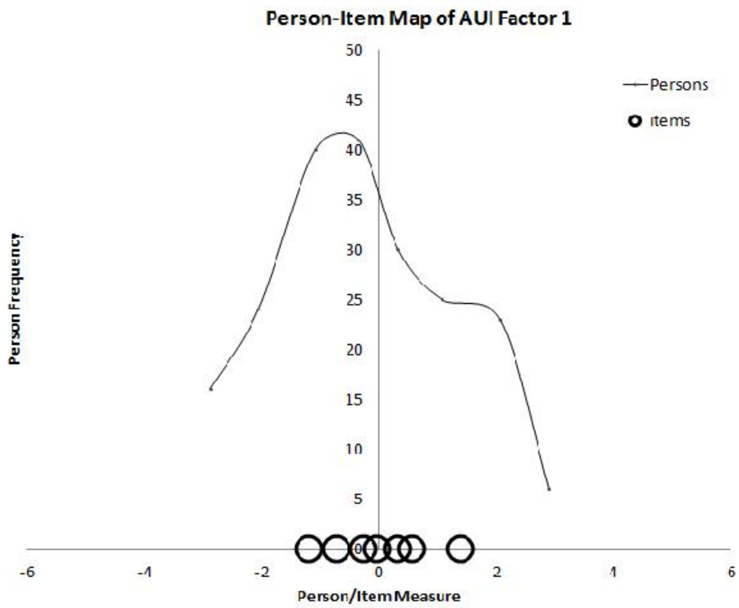


Figure 3. Person ability and item difficulty distributions for AUI Factor 1.

AUI Factor 3 item difficulties range from -0.89 to 1.59, which fall within the distribution of examinee abilities (Figure 4). Infit values range from 0.79 to 1.09; outfit values range from 0.72 to 1.26 (Table 7), suggesting the items fit well with the Rasch model and are informative.

Table 7.

Rasch modeling results for AUI Factor 3

AUI Factor 3 Item	Difficulty	Error	Infit (MNSQ)	Outfit (MNSQ)	PTBIS CORR
V42	1.59	0.17	1.08	1.00	0.09
V45	-0.72	0.16	0.96	0.96	0.26
V55	0.10	0.15	1.09	1.26	0.13
V66	-0.89	0.16	0.89	0.75	0.36
V69	-0.83	0.16	0.79	0.72	0.43
V73	-0.02	0.15	1.01	1.03	0.21
V74	-0.05	0.15	1.10	1.09	0.14
V75	0.81	0.15	1.03	1.10	0.14
Mean	0.00	0.16	0.99	0.99	0.22
Stdev	0.86	0.01	0.11	0.18	0.12

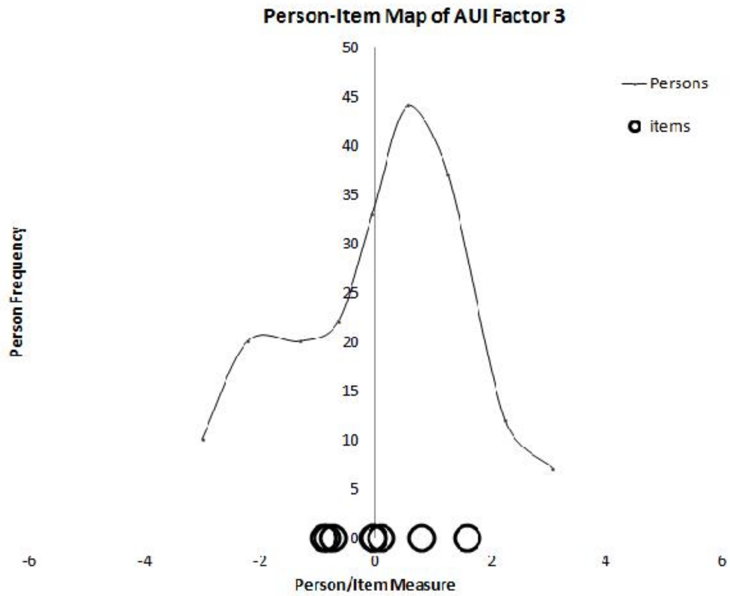


Figure 4. Person ability and item difficulty distributions for AUI Factor 3.

SOBER Factor 1 item difficulties range from -0.71 to 0.40, which falls within the distribution of examinee abilities (Figure 5). Infit values range from 0.67 to 1.16; outfit values range from 0.65 to 1.17 (Table 8), suggesting the items fit well with the Rasch model and are informative.

Table 8.

Rasch modeling results for SOBER Factor 1

SOBER Factor 1 Item	Difficulty	Error	Infit (MNSQ)	Outfit (MNSQ)	PTBIS CORR
V9	-0.71	0.10	1.16	1.17	0.42
V10	0.31	0.10	0.67	0.65	0.64
V13	0.40	0.11	1.09	1.09	0.45
Mean	0.00	0.10	0.97	0.97	0.50
Stdev	0.62	0.01	0.27	0.28	0.12

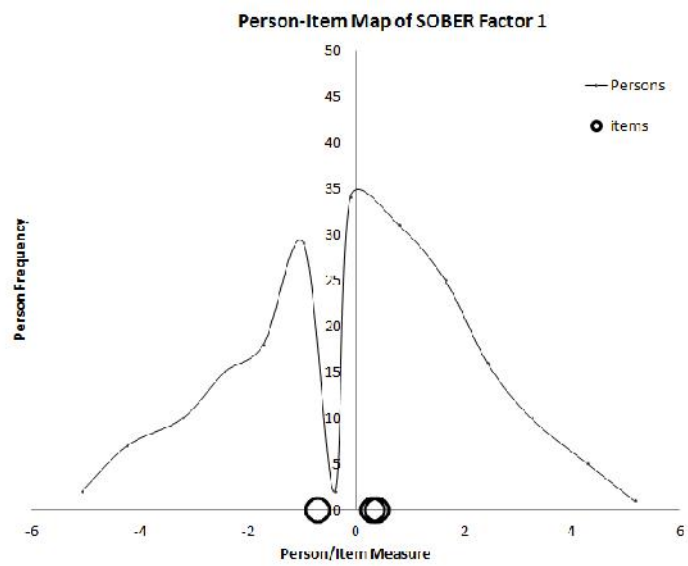


Figure 5. Person ability and item difficulty distributions for SOBER Factor 1.

SOBER Factor 2 item difficulties range from -0.72 to 0.55, which falls within the upper range of the distribution of examinee abilities (Figure 6). This may indicate that the items in this factor were somewhat difficult for participants to score highly. Infit values range from 0.83 to 1.09; outfit values range from 0.81 to 1.81 (Table 9).

Table 9.

Rasch modeling results for SOBER factor 2

SOBER Factor 2 Item	Difficulty	Error	Infit (MNSQ)	Outfit (MNSQ)	PTBIS CORR
V11	-0.72	0.11	0.83	0.81	0.50
V12	0.17	0.10	1.01	1.02	0.37
V17	0.55	0.08	1.09	1.81	0.22
Mean	0.00	0.10	0.98	1.21	0.36
Stdev	0.65	0.02	0.13	0.53	0.14

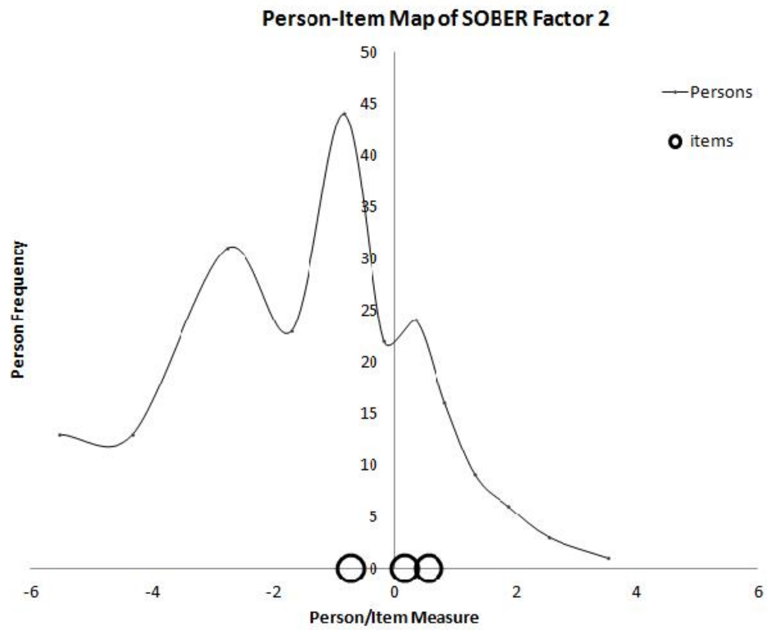


Figure 6. Person ability and item difficulty distributions for SOBER Factor 2.

SOBER Factor 3 item difficulties range from -0.65 to 0.86, which falls within the upper range of the distribution of examinee abilities (Figure 7). This may indicate that the items in this factor were somewhat difficult for participants to score highly. Infit values range from 0.96 to 1.08; outfit values range from 0.92 to 1.38 (Table 10). These indicate consistency of items with the Rasch model.

Table 10.

Rasch modeling results for SOBER factor 3

SOBER Factor 3					
Item	Difficulty	Error	Infit (MNSQ)	Outfit (MNSQ)	PTBIS CORR
V16	0.23	0.07	1.01	0.96	0.24
V19r	-0.58	0.09	0.96	0.92	0.29
V20	0.86	0.10	1.00	1.38	0.26
V21r	-0.65	0.08	0.99	0.96	0.29
V22	0.64	0.09	0.94	1.07	0.32
V26	-0.28	0.07	1.08	1.09	0.22
V31	-0.20	0.06	1.03	1.06	0.25
Mean	0.00	0.08	1.00	1.06	0.27
Stdev	0.59	0.01	0.05	0.15	0.03

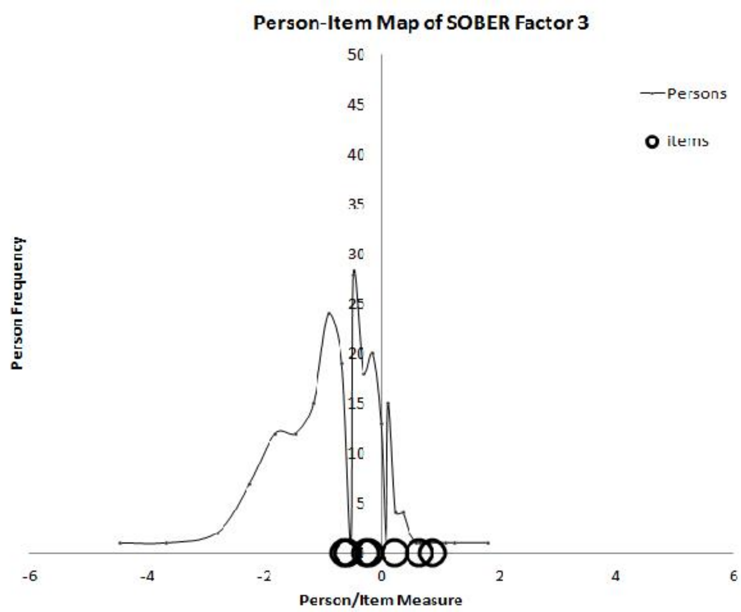


Figure 7. Person ability and item difficulty distributions for SOBER Factor 3.

SOBER Factor 4 item difficulties range from -0.62 to 0.48, which falls within the range of the distribution of examinee abilities (Figure 8). Infit values range from 0.89 to 1.16; outfit values range from 0.92 to 1.14 (Table 11). These indicate consistency with the Rasch model.

Table 11.

Rasch modeling results for SOBER Factor 4

SOBER Factor 4 Item	Difficulty	Error	Infit (MNSQ)	Outfit (MNSQ)	PTBIS CORR
V27r	0.09	0.07	0.93	0.92	0.33
V32r	0.48	0.07	1.16	1.14	0.18
V33r	-0.62	0.07	1.07	1.07	0.23
V34r	0.05	0.06	0.89	0.83	0.34
Mean	0.00	0.07	1.01	0.99	0.27
Stdev	0.46	0.01	0.13	0.14	0.08

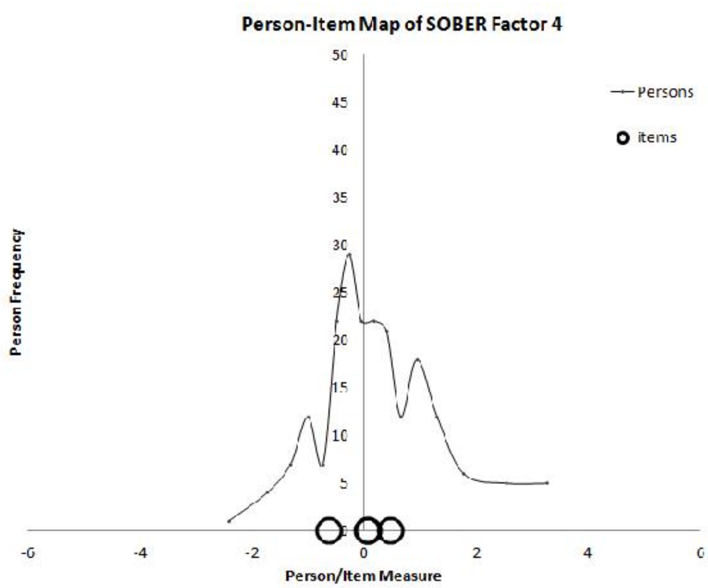


Figure 8. Person ability and item difficulty distributions for SOBER Factor 4.

Through the Rasch model, construct validity was established for all tested items on the AUI and SOBER. Item difficulties were moderate (within +/- 2). Person-item maps show that item difficulty and person ability measures were comparable. Fit statistics indicate that all items fit with the Rasch model, demonstrating that they discriminate appropriately across the ability range of the student population, and that they provide useful estimations of item difficulty and student ability. Comparing distributions of item difficulty and student ability for each factor shows that items are appropriately written for high school students. The final version of the AUI and SOBER is shown in Appendix B.

Sample

This study targeted students from a six school districts. A total of 410 students from five school districts were sampled in final data collection. Three large, urban schools in Mid-Missouri were sampled, with 29, 186, and 25 participants, respectively. One small, rural school in Mid-Missouri was sampled for a total of 16 participants. One hundred students from a medium-sized school in Northwest Missouri, and 54 students from a large, suburban St. Louis school participated. A total of 205 students in grades 9-12 at a rural school in South Missouri participated in piloting the assessment. Outside of grade, no other exclusion criteria were imposed. Teachers administered the assessments at theirs and their schools' convenience during the spring semester of 2011.

Data Gathering

Data were gathered according to the standards of University of Missouri's Institutional Review Board (IRB). A copy of the permission letter can be found in Appendix C. Items from the three instruments were coded onto a Scantron program, with ordering of items and responses selected based on outputs from a random integer generator (Haahr, 2010). A Scantron bubble sheet and booklet of items were administered April through May, 2011.

The booklet, along with the assessment items (pilot—Appendix A; final—Appendix B), contained detailed instructions for students, including that they would be provided number 2 lead pencils, bubbles need to be filled in completely, a best answer should be chosen for each item, and students should not put their names on the booklets or bubble sheets. It was emphasized that this assessment was not being graded, and that responses were to be kept completely confidential.

After the students entered their responses, teachers were asked to collect the booklets and bubble sheets and take them to the main office, where they were picked up by the researcher. The bubble sheets were then taken to the testing center for scanning. Scantron output data were exported into Microsoft Excel for analysis.

Data Analysis

Item Scoring and Correlation Tests of Null Hypotheses

The 2-parameter logistic model (2PL) was used to calculate scores for factors on the dichotomous AUI; the 2PL graded response model (Samejima, 1969) to calculate scores on the polytomous SOBER. Both were implemented using MULTILOG 7, using Marginal Maximum Likelihood Estimation (MMLE) to calculate student ability scores on each factor of the final assessment. After reliability and validity of the instrument have been established, the 2PL has increased accuracy over Rasch in calculating student ability scores because it takes item discrimination into account. Ability scores were then clustered into five ability levels using the k-means clustering algorithm, and the Kendall-tau correlation test was used to test the null hypothesis that no relationship exists between the factors. The Kendall-tau correlation is defined as the probability of observing concordant pairs in the data minus the probability of observing discordant pairs. A value of +1 indicates perfect concordance; -1 indicates perfect discordance. The expected value is 0, indicating no correlation. An alpha level of 0.05 was chosen as the standard for a test of significant deviation from the expected value. As a measure of practical significance, Cohen's D effect sizes were calculated from Kendall's tau coefficients using the formulas of Kendall (1970) and Rosenthal (1994). Effect sizes under 0.2 indicate negligible effect; 0.2-0.49 small effect; 0.5-0.79 moderate effect; and 0.8 and above indicate large effect (Cohen, 1988).

Finding Significant Regression Models

Logistic regression aims to predict a correct categorical outcome using the most parsimonious model possible, and so was useful for finding the best predictors for each behavior. As a non-parametric form of regression, it makes no assumptions about the distributions of predictor variables. However, to make inferences on the relative effects of individual predictor variables, correlations between these variables should be low (Bewick, Cheek, & Ball, 2005).

Ability scores calculated on each latent trait were used in predictive models for mitigation behavior and contraction of influenza. Significant data were modeled using a multinomial logistic regression model taking the form:

$$\ln(\pi_{ij}/\ \pi_{ik}) = x_i^T b_j,\ j \neq k \quad (4)$$

where j is the category being tested and k is the baseline category, and b_j is the coefficient for the predictor variable x_i. π_{ij} is the probability of variable x_i being in category j, and π_{ik} is the probability of variable x_i being in the baseline category k. Similar to IRT, the logit transform serves to change the s-shaped cumulative likelihood distribution to a linear log likelihood function.

Factors discovered to be significant at the $\alpha = 0.05$ level using the Kendall-tau test were introduced into a forward stepwise model. Significance of each predictor was tested using the likelihood ratio method, which compares the fit of the model with the predictor to the fit of the simpler model without the predictor. The likelihood ratio method is desirable in that it is more powerful than the Wald chi square statistic of smaller sample sizes (Agresti, 2007). Significant change to the model at the α = 0.05 level was required for entry. After significant main effects were entered, 2-way interactions were tested in a similar forward stepwise format.

Relative importance of each variable was tested using odds ratios, or the ratio between the odds of being in category j when the predictor is included in the model to that when the predictor is not included. An odds ratio of 1 signifies no effect of the predictor, greater than 1 indicates a positive, and less than 1 indicates a negative effect. Wald's chi square test was used to test for statistical significance of odds ratios.

Neural Network Analysis

Artificial neural networks can be used in a wide variety of classification problems since they have the capability to learn patterns in data. Once trained, the network can provide reasonable solutions for similar inputs, making them able to generalize and tolerate slight deviations from the training data (Kriesel, 2007). MATLAB's Neural Networks Toolbox (Demuth & Beale, 1998) was used to construct the neural networks. The input data were normalized before submitting the neural network (i.e. the mean of data points for a given feature was computed and subtracted from all the data points and the overall standard deviation was divided from the difference). Various permutations and combinations of the number of hidden layers, the number of nodes in each hidden layer, the learning rate, as well as the type of activation function, were tried.

A neural network with gradient descent method coded in MATLAB was used for this application. The input layer consisted of number of nodes equivalent to the number of significant variables that were input into the model. Two hidden layers, with 15 nodes in each, were used. Through experimentation, this was found to work better than single and three-layer networks. A regular neural network sends the difference in the calculated and expected output back through its layers, and the weights in each hidden layer update themselves to minimize the error between them. In the gradient descent method, the weights were updated after being multiplied by a learning rate of 0.5, which prevented the system from settling into a local minimum (Bishop, 2006). This was done for 10,000 iterations, which allowed the network to learn, but not memorize, the training set. The activation function used for the two hidden layers was the hyperbolic tangent function normalized to a range of -1 and 1, which is preferred since it is differentiable at all values.

After the neural network models were developed, tests were conducted to determine how well predictions matched the data. In order to obtain a realistic prediction scenario, the 10-fold cross-validation technique was used. In this technique, data were divided into ten portions. Nine portions were used to train the neural network, which was tested on the tenth portion. Next, another model was built with a different portion of the data and is tested on another portion. After 10 cycles, all of the data were tested outside of the models that produced them, thereby ensuring that overfitting had not occurred (that the neural network had not memorized the noise in the data set), and that the models are generalizable outside of the test data.

Degree of association between predictions versus actual data was tested using the Kendall-tau test. An alpha of 0.05 was used to test the null hypothesis that there is no association between predictions and actual data. The usefulness of these models lies in their ability to make class predictions (low, medium, high). Classification plots give information on the percentage of data that the model puts into the correct class and whether the model tends to over- or under-predict at a value for a given behavior. Percentage of correct predictions at each level was calculated.

Summary

This chapter described the tools and processes used to collect and interpret data relating high school students' knowledge of influenza, demographics, experience with the disease, and risk of complications to preventative behavior such as getting vaccinated, proper hand washing, and social distancing. AUI development was guided by the misconceptions literature and the SOBER was guided by the Health Belief Model. A panel of 5 infectious disease experts established content validity for the instruments. Face validity was established through review by 5 experts in secondary pedagogy, and through linking the AUI to Missouri's Health Education GLE's and Biology CLE's. Pilot testing, including the sample population, exploratory factor analysis (EFA), reliability analysis, and construct validity analysis, were described. EFA indicates 3 dimensions were appropriate for the AUI, and 4 dimensions for the SOBER. Dimension 2 on the AUI had low reliability (alpha less than 0.5), and was thus excluded, leaving two dimensions (1 and 3) for the final assessment. Reliability measures for other dimensions were moderate (0.535-0.709). Construct validity of remaining items were established through fit with the Rasch model. Data collected from the final version of the AUI and SOBER were used to formulate ordinal logistic regression models to test the null hypotheses using ability scores calculated from the two-parameter model. Neural network predictive models were formulated to assess knowledge, demographics, past experience, and other behaviors as predictors for a certain behavior. The goodness of fit of neural network models with the data was assessed using the root mean square deviation of residuals as well as how well the data fall within the behavior classification categories.

CHAPTER 4: PRESENTATION AND ANALYSIS OF DATA

Descriptive data, structure and reliability of the AUI and SOBER instruments, correlations and logistic regression results for tests of null hypotheses, and neural network predictions are described in Chapter 4.

Descriptive Statistics

Description of the Sample

A school location was identified for each participating student (Table 11). Six schools were represented. Twenty-nine (7.1%) and 25 (6.1%) students participated from Schools 1 and 5, respectively. Each had over 1500 students located in a medium-sized Midwestern city supporting a public research university with very high research activity. One hundred (24.4%) students were sampled from School 2, a high school of over 1500 students in a medium-sized Midwestern city supporting a public baccalaureate university with diverse colleges. One hundred eighty-six (45.4%) students were sampled from School 4, a high school of over 1500 students in a medium-sized Midwestern city supporting a primarily baccalaureate public university with multiple master's colleges. Fifty-four (13.2%) students were sampled from School 6, a high school of over 1500 students in a medium-sized suburb of a Midwestern metropolis, near where a private not-for-profit research university with very high research activity is located. Sixteen students (3.9%) were sampled from School 3, a high school of below 250 students in a small Midwestern town.

Descriptive statistics for the sample of high school students participating in this study are shown in Table 12. Four hundred ten students participated; 342 provided fully completed assessments. Of 405 students reporting age, 94 (23.2%) were 15 or under, 169 (41.7%) were 16, 76 (18.8%) were 17, 53 (13.1%) were 18, and 13 (3.2%) were over 18. Three hundred ninety-six students reported their grade in school; 62 (15.7%) freshmen, 201 (50.8%) sophomores, 75 (18.9%) juniors, and 58 (14.7%) seniors. Three hundred seventy-five students reported their gender; 169 (45.1%) males and 206 (54.9%) females. While 266 out of 389 (68.4%) reporting students were white, 50 black (12.9%), 27 Asian (6.9%), and 22 Hispanic (5.7%) students were also represented. Twenty-four (6.2%) students marked "other" for their ethnicity.

Students were asked two questions about their experiences: whether or not they contracted illness during the year, and how many health professionals they have in their family (Table 11). Of 374 students reporting, 83 (22.2%) reported that they had not been sick during the year, 213 (57.0%) reported that they had contracted an illness with symptoms of a cold, and 78 (20.9%) reported contracting an illness with symptoms of the flu. Regarding the number of health professionals in their families, 392 reported; 199 (50.8%) reported none, 101 (25.8%) one, 53 (13.5%) two, 20 (5.1%) three, and 19 (4.9%) reported more than three health professionals.

Description of Assessment Scores

Scores for the IMBS questionnaire and the AUI, and SOBER instruments are described in Table 13. On the IMBS, 408 (99.5%) students reported on their favorability towards getting vaccinated (M = 3.3, SD = 1.3). Four hundred nine students (99.8%) reported on touching the eyes, nose, and mouth (M = 2.4, SD = 1.2), respiratory etiquette (M = 4.1, SD = 1.2), and staying home when sick (M = 3.4, SD = 1.1). Four hundred ten (100%) reported on hand washing quality (M = 3.9, SD = 1.0) and frequency (M = 3.2, SD = 1.2), personal distancing (M = 2.9, SD = 1.2), and hand sanitizer use (M = 2.8, SD = 1.6).

Table 12.

Measurements of sample size, mean, and standard deviation for demographic variables

Variable	Category	N	M	SD
School	School 1	29		
	School 2	100		
	School 3	16		
	School 4	186		
	School 5	25		
	School 6	54		
	Total	410	NA	NA
Age	15	94		
	16	169		
	17	76		
	18	53		
	19	13		
	Total	405	16.3	1.1
Grade	Freshman	62		
	Sophomore	201		
	Junior	75		
	Senior	58		
	Total	396	2.3	0.9
Gender	Male	169		
	Female	206		
	Total	375	NA	NA
Ethnicity	Black	50		
	White	266		
	Asian	27		
	Hispanic	22		
	Other	24		
	Total	389	NA	NA
Sickness Severity	None	83		
	Cold	213		
	Flu	78		
	Total	374	1.0	0.7
Health Professionals	0	199		
	1	101		
	2	53		
	3	20		
	4	19		
	Total	392	0.9	1.1

Table 13.

Means and standard deviations of scores, and number of respondents, for variables measured by the IMBS, AUI, and SOBER assessments

Assessment	Variable	N	M	SD
Influenza Mitigation Behavior Survey				
	Q1 Vaccination	408	3.3	1.3
	Q2 Hand Washing Quality	410	3.9	1.0
	Q3 Hand Washing Frequency	410	3.2	1.2
	Q4 Personal Distancing	410	2.9	1.2
	Q5 Touching Eyes, Nose, and Mouth	409	2.4	1.2
	Q6 Respiratory Etiquette	409	4.1	1.2
	Q7 Staying Home When Sick	409	3.4	1.1
	Q8 Hand Sanitizer Use	410	2.8	1.6
Assessment of Understanding of Influenza				
	AUI f1 Flu Spread	410	2.8	1.1
	AUI f2 Flu Management	410	3.4	1.1
Survey of Background, Experience, and Risk				
	SOBER f1 Perceived Risk	410	2.9	0.9
	SOBER f2 Perceived Complications	410	2.7	0.9
	SOBER f3 Perceived Barriers	410	2.3	0.9

On the AUI and SOBER assessments, scores were calculated for all students. These were logit ability scores calculated from the 2-parameter logistic model for the AUI and Samejima's two-parameter logistic graded response model for the SOBER. Scores were then clustered into 5 hierarchical ability domains (1 = lowest; 5 = highest) using the k-means algorithm (Table 14). On the AUI, the mean knowledge level for flu transmission was 2.8, with a standard deviation of 1.1. For flu management, the average level was 3.4, with a standard deviation of 1.1. On the SOBER, the mean rank for perceived risk was 2.9, with a standard deviation of 0.9. Perceived complications and barriers had means of 2.7 and 2.3, with standard deviations of 0.9, respectively.

Table 14.

K-means cluster centers of 2PL scores for AUI and SOBER assessments.

Assessment	Variable	Cluster Center 1	Cluster Center 2	Cluster Center 3	Cluster Center 4	Cluster Center 5
Assessment of Understanding of Influenza						
	AUI f1 Flu Spread	-1.29	-0.64	0.19	0.83	1.29
	AUI f2 Flu Management	-1.39	-0.72	0.28	0.95	1.39
Survey of Background, Experience, and Risk						
	SOBER f1 Perceived Risk	-1.13	-0.57	-0.08	0.37	1.13
	SOBER f2 Perceived Complications	-1.12	-0.45	0.00	0.52	1.28
	SOBER f3 Perceived Barriers	-1.89	-1.01	-0.12	0.77	1.89

Confirmatory Factor Analysis and Reliability

Structural models were generated for the AUI and SOBER assessments under the initial hypothesis that final assessment structures were similar to those derived from the pilot. Structural models and implications for assessment interpretation are described along with reliabilities of measurements. The final assessment is found in Appendix B.

AUI Assessment Structure and Reliability

Preliminary reliability analyses showed that Q33 (When is a person infected with the flu contagious?) and Q40 (What effect does taking zinc supplements have on the flu?) reduced the reliability of the entire AUI assessment, reducing alpha from 0.819 to 0.809. These two items were eliminated, and confirmatory factor analysis (CFA) was conducted on the remaining 13 items. The structural model (Table 15) was not significantly different from the data at the α = 0.1 level (χ^2 = 72.26, df = 63, p = 0.20). The Root Mean Square Error of Approximation (RMSEA) and Comparative Fit Index (CFI) (Bentler, 1990) provided further evidence of good fit, at 0.019

and 0.99, respectively. RMSEA's of 0.06 or less (Hu & Bentler, 1995), and CFI's above 0.93 (Byrne, 1994) indicate good fit to the data.

Table 15.

Factor estimates and reliabilities for the AUI

Assessment of Understanding of Influenza (α = 0.819)		
Item	Transmission[a] (α = 0.701)	Management[a] (α = 0.755)
Q26	1.00	N
Q27	1.13	N
Q28	0.12	0.83
Q29	1.05	N
Q30	0.65	N
Q31	1.08	N
Q32	1.06	N
Q34	N	1.00
Q35	N	0.86
Q36	N	0.69
Q37	N	0.97
Q38	N	0.60
Q39	N	0.59

[a]N = Not needed in the model

LISREL suggests additions to the model which will improve the fit. Structural estimates suggest high similarity with the hypothesized factor structure with the exception of Q28 (What effect does population density have on the spread of the influenza virus?), which measures knowledge of flu management better than knowledge of flu transmission in this sample. Item Q28 was thus eliminated from the flu transmission item pool, and assigned to the flu management item pool for scoring. Reliability of the total 13-item AUI assessment was 0.819. Six items (Q26, Q27, Q29, Q30, Q31, Q32) measured knowledge of flu transmission with a reliability of 0.701. The other seven items (Q28, Q34, Q35, Q36, Q37, Q38, Q39) measured knowledge of flu management with a reliability of 0.755.

SOBER Assessment Structure and Reliability

Preliminary reliability analysis showed that Q18 (how effective are hand sanitizers?), Q20 (difficulty of staying away from people who are coughing or sneezing), and Q21 (my parents put pressure on me to stay healthy) reduced the reliability of the perceived barriers theme to 0.357. These items were eliminated. Further, in order to improve fit for the model for the SOBER, the latent trait of Lack of Social Efficacy needed to be eliminated from the assessment. The best fitting structural model for the remaining traits and items (Table 16) was significantly different from the data at the $\alpha = 0.01$ level ($\chi^2 = 86.95$, df = 45, p = 0.00018). The less conservative Root Mean Square Error of Approximation (RMSEA) and Comparative Fit Index (CFI) provided evidence of good fit, at 0.048 and 0.95, respectively.

Table 16.

Factor estimates and reliabilities for the SOBER

Survey of Background, Experience, and Risk ($\alpha = 0.687$)			
Item	Perceived Risk[a] ($\alpha = 0.640$)	Perceived Complications[a] ($\alpha = 0.677$)	Perceived Barriers[a] ($\alpha = 0.629$)
Q9	1.00	N	N
Q10	1.13	0.09	N
Q11	0.44	0.74	0.21
Q12	N	1.00	-0.02
Q13	N	1.59	N
Q14	N	-0.14	3.01
Q15	N	N	2.41
Q16	N	N	1.00
Q17	N	N	2.01
Q19	N	N	1.51
Q22*	N	0.30	N
Q23*	N	-0.49	1.01

*Not included in final reliability and 2PL scores
[a]N = Not needed in the model

In addition to eliminating the social efficacy factor, the final structural model for the SOBER deviated from the hypothesized model. Item Q11 (I feel my risk of becoming sick with the flu is [very low to very high]) was found to measure perceived complications better than perceived risk, leaving two items (Q9 and Q10) to measure the former trait. Item Q14 (The money it costs to get the flu vaccination prevents me from wanting to get it) was found to measure perceived barriers better than perceived complications. Items Q22 (I have no control over whether or not I get the flu) and Q23 (I am worried that getting sick will negatively affect my school work), which were stranded by eliminating the social efficacy theme, fit within the traits of perceived complications and barriers, respectively. These were eliminated because they reduced the reliability of the theme.

Factor estimates and reliability measures for the SOBER are reported in Table 15. Two items, Q9 and Q10, measured perceived risk with a reliability of 0.640, and three items, Q11, Q12, and Q13, measured perceived complications with a reliability of 0.677. Item Q22 (I have no control over whether or not I get the flu) was eliminated from this theme since it reduced the reliability to 0.578. Five items, Q14, Q15, Q16, Q17, and Q19, measured perceived barriers with a reliability of 0.629. Item Q23 (I am worried that getting sick will negatively affect my school work) was eliminated from this theme since it reduced the reliability to 0.573. Total reliability of the 10 items retained in the SOBER was 0.687.

What Do Students Know About the Flu?

Responses on the AUI provided insight into what students knew about flu transmission and management. Knowledge levels represent one of five clusters, calculated through the k-means algorithm, to which a student's logit ability score was assigned, where cluster 1 comprises the lowest scores, and cluster 5 the highest scores. Knowledge level distributions for each trait are presented in Table 17.

Table 17.

Distributions of knowledge level for flu transmission and management (n = 410)

Level	Flu Transmission	Flu Management
1	45	18
2	134	62
3	126	146
4	64	95
5	41	89

Forty-five students scored at the lowest knowledge level for flu transmission, 18 for flu management. There were 134 and 62 students scoring at the second knowledge level for flu transmission and management, respectively. On knowledge of flu transmission, 126 students scored at the third level; 146 for flu management. Sixty-four and 41 students scored at the fourth and fifth level, respectively, for flu transmission; 95 and 89 students for flu management. Distribution of scores on knowledge of flu transmission was approximately normal, slightly right skewed, whereas a majority of the scores on knowledge of flu management were at or above 3. A comparatively left skewed distribution indicates that the domain of flu management was easier for students to grasp than flu transmission.

Responses on Individual Items and Misunderstandings

Specific understandings and misunderstandings about the flu were uncovered by examining how students responded to each question on the AUI (Table 18). On the questions with five options (A-E) it was assumed a null distribution of 82 correct guesses and 328 misses. Assuming this distribution would occur by random chance alone, and a critical chi square value of 3.841 at the critical alpha, $\alpha_c = 0.05$, df = 1, it can be concluded with 95% confidence that choices with fewer than 67 and greater than 97 responses did not occur by random chance alone. For the questions with three options (A-C), it was assumed a null distribution of 137 correct guesses and 273 misses. Assuming the same alpha level and critical chi square value, it can be concluded with 95% confidence that choices with fewer than 119 and greater than 155 responses occurred outside of chance. Incorrect choices with 98 or more responses on the five choice questions, and 156 or more responses on the three choice questions, were deemed, "misunderstandings." Tables 19 and 20 report the chi square and p-values for item responses.

Six items (Q26, Q27, Q29, Q30, Q31, and Q32) were analyzed for misunderstandings about flu transmission. On Q26 (A flu strain is least likely to infect you when…), 218 students (53.2%) chose the correct answer, A (…you have been previously exposed to that strain). The most common incorrect answer was C (…you have not been exposed to that strain), chosen by 87 students (21.2%). For Q27 (Ways that influenza is transmitted include…), 228 students (55.6%) chose the correct answer, E (…contact with droplets of saliva from a nearby person who coughs and sneezes). The most common incorrect answer was D (…going outside in cold, wet weather), chosen by 72 students (17.6%). For Q29 (The flu vaccination protects us from the flu by…), 241 students (58.8%) correctly chose C (…giving us killed or weakened flu which causes us to produce antibodies). The most common incorrect answer was B (…giving us antibiotics which will protect us from the flu), chosen by 100 students (24.2%), designating this as a misunderstanding. For Q30 (Getting the flu vaccine while infected with the flu…), 171 students (41.7%) chose the correct answer, D (…does not work to reduce symptoms or duration of the infection). The most common incorrect answer, C (…reduces the severity of symptoms, but doesn't reduce the duration of infection), was chosen by 67 students (16.3%). On Q31 (The reason we must get a flu shot every year is that…), 163 students (39.8%) correctly chose E (…the virus mutates every year, so new vaccines have to be developed). One hundred ten students (26.8%) chose A (…the vaccine wears off over time, so we must get a booster each year for it to be effective), revealing a misunderstanding in the sample. For Q32 (The flu vaccine is available as…), 176 students (42.9%) correctly chose E (…a shot and a nasal spray). One hundred forty students (34.1%) chose B (…a shot), revealing a general unawareness of the Flu Mist vaccination option.

Nine items (Q28, Q33, Q34, Q35, Q36, Q37, Q38, Q39, and Q40) were analyzed for misunderstandings about flu management. On Q28 (What effect does population density have on the spread of the influenza virus?), 297 (72.4%) correctly chose B (Influenza spreads most easily when there are a lot of people in an area). Fifty-two (12.7%) chose C (Number of people in an area has no effect on the ease at which influenza spreads), the most common incorrect response.

For Q33 (When is a person infected with the flu contagious?), 117 students (28.5%) correctly chose E (A person becomes contagious as soon as symptoms occur). One hundred seventeen students (28.5%) also chose B (A person becomes contagious 1-2 days after symptoms occur), revealing a misunderstanding. For Q34 (During hand washing, the Center for Disease Control recommends…), 299 students (72.9%) chose B (…covering your hands with soap and washing them for 15-20 seconds). The most common incorrect answer was C (…covering your hands with soap and washing them for 5 minutes), chosen by 40 students (9.8%). For Q35 (This year’s flu vaccine is…), 272 (66.3%) correctly marked C (…generally available for anyone who wants it). The most common incorrect answer was B (…generally only available to young children or elderly people who are at greater risk for flu), marked by sixty-two students (15.1%). For Q36 (Influenza primarily attacks the…), 224 students (54.6%) chose the correct answer, B (…respiratory system). Sixty-five students (15.9%) chose A (…digestive system), the most common incorrect answer. On Q37 (The best way to avoid getting sick with the flu is…), 308 (75.1%) marked the correct answer, A (…to wash your hands regularly). Thirty-five (8.5%)

marked C (…to take a shower everyday), the most common incorrect answer. On Q38 (Taking decongestant medicines such as Sudafed…), the correct answer, B (…reduces the severity of symptoms, but doesn't reduce duration of the flu) was selected by 241 students (58.8%). The most common incorrect answer, C (…reduces duration and symptoms of the flu), was selected by 93 students (22.7%). For Q39 (Taking fever reducing and pain relieving medications such as Tylenol or Ibuprofin…), 270 students (65.9%) chose the correct answer, B (…reduces the severity of symptoms, but doesn't reduce duration of the flu). Sixty-one students (14.9%) chose C (…reduces duration and symptoms of the flu). This was the most common incorrect answer. On Q40 (Taking zinc supplements…), 154 students (37.6%) chose the correct answer, A (…does not work to reduce symptoms or duration of the flu). The most common incorrect answer was B (…reduces the severity of symptoms, but doesn't reduce duration of the flu), chosen by 119 students (29.0%).

Four statistically significant misunderstandings were revealed in this sample through the AUI (Table 21), three dealing with flu transmission and one with flu management. The first is the idea that the flu vaccination protects us from the flu by giving us antibiotics. This misunderstanding could possibly result from confusing the words, "antibiotics" and "antibodies," or from the misunderstanding that antibiotics can be used to cure the flu. A second misunderstanding is the idea that the flu vaccine wears off over time, which is why we must get a new shot every year. A student choosing this option could have heard of certain vaccines, such as tetanus, wearing off over time, and has generalized this concept to all vaccines. This further indicates possible unfamiliarity with influenza's ability to change each year, and the impact this has on public health. A third misunderstanding about transmission is that the flu vaccine is available only as a shot, likely because the flu vaccine is most commonly called, "the flu shot." Although Flu Mist has been on the market for several years, unawareness of this option is apparently widespread.

Students had a comparatively better grasp of flu management. Only one misunderstanding, that a person with the flu becomes contagious 1-2 days after symptoms occur, was revealed. It is difficult to speculate on reasons behind this misunderstanding. However, one can logically speculate on the potential negative implications this may have for students' willingness to stay home during the early stages of illness.

Table 18.

Student responses on AUI items

Theme	Item	Choice A[a]		Choice B[a]		Choice C[a]		Choice D[a]		Choice E[a]		No Response	
Flu Transmission		n	%	n	%	n	%	n	%	n	%	n	%
	Q26	**218**	**53**	36	9	87	21	23	6	26	6	0	0
	Q27	28	7	39	10	42	10	72	18	**228**	**56**	1	0
	Q29	23	6	100[c]	24[c]	**241**	**59**	32	8	13	3	1	0
	Q30	64	16	64	16	67	16	**171**	**42**	44	11	0	0
	Q31	110[c]	27[c]	71	17	43	10	21	5	**163**	**40**	2	0
	Q32	23	6	140[c]	34[c]	31	8	40	10	**176**	**43**	0	0
Flu Management		n	%	n	%	n	%	n	%	n	%	n	%
	Q28	22	5	**297**	**72**	52	13	23	6	16	4	0	0
	Q33*	85	21	117[c]	29[c]	49	12	41	10	**117**	**29**	1	0
	Q34	27	7	**299**	**73**	40	10	31	8	12	3	1	0
	Q35	24	6	62	15	**272**	**66**	24	6	27	7	1	0
	Q36	65	16	**224**	**55**	36	9	59	14	25	6	1	0
	Q37	**308**	**75**	27	7	35	9	18	4	21	5	1	0
	Q38	48	12	**241**	**59**	93	23	18[b]	4[b]	7[b]	2[b]	3	1
	Q39	49	12	**270**	**66**	61	15	19[b]	5[b]	9[b]	2[b]	2	0
	Q40*	**154**	**38**	119	29	107	26	16[b]	4[b]	11[b]	3[b]	3	1

*Not used in score calculations
[a]Correct response in bold
[b]D and E were not options
[c]Misunderstanding ($\alpha = 0.05$)

Table 19.

Chi square values for student responses on AUI items

Theme	Item	Choice A[a]	Choice B[a]	Choice C[a]	Choice D[a]	Choice E[a]
Flu Transmission						
	Q26	**282.0**	32.3	0.4	53.1	47.8
	Q27	44.5	28.2	24.4	1.5	**324.9**
	Q29	53.1	4.9[c]	**385.4**	38.1	72.6
	Q30	4.9	4.9	3.4	**120.7**	22.0
	Q31	12.0[c]	1.8	23.2	56.7	**100.0**
	Q32	53.1	51.3[c]	39.6	26.9	**134.7**
Flu Management						
	Q28	54.9	**704.6**	13.7	53.1	66.4
	Q33*	0.1	18.7[c]	16.6	25.6	**18.7**
	Q34	46.1	**717.8**	26.9	39.6	74.7
	Q35	51.3	6.1	**550.3**	51.3	46.1
	Q36	4.4	**307.4**	32.3	8.1	49.5
	Q37	**778.6**	46.1	33.7	62.4	56.7
	Q38	86.8	**118.6**	21.2	NA[b]	NA[b]
	Q39	84.9	**193.9**	63.3	NA[b]	NA[b]
	Q40*	**3.2**	3.6	9.9	NA[b]	NA[b]

*Not used in score calculations
[a]Correct response in bold
[b]D and E were not options
[c]Misunderstanding ($\alpha = 0.05$)

Table 20.

Chi square p-values for student responses on AUI items

Theme	Item	Choice A[a]	Choice B[a]	Choice C[a]	Choice D[a]	Choice E[a]
Flu Transmission						
	Q26	**0.000**	0.000	0.537	0.000	0.000
	Q27	0.000	0.000	0.000	0.217	**0.000**
	Q29	0.000	0.026[c]	**0.000**	0.000	0.000
	Q30	0.026	0.026	0.064	**0.000**	0.000
	Q31	0.001[c]	0.174	0.000	0.000	**0.000**
	Q32	0.000	0.000[c]	0.000	0.000	**0.000**
Flu Management						
	Q28	0.000	**0.000**	0.000	0.000	0.000
	Q33*	0.711	0.000[c]	0.000	0.000	**0.000**
	Q34	0.000	**0.000**	0.000	0.000	0.000
	Q35	0.000	0.014	**0.000**	0.000	0.000
	Q36	0.036	**0.000**	0.000	0.005	0.000
	Q37	**0.000**	0.000	0.000	0.000	0.000
	Q38	0.000	**0.000**	0.000	NA[b]	NA[b]
	Q39	0.000	**0.000**	0.000	NA[b]	NA[b]
	Q40*	**0.075**	0.059	0.002	NA[b]	NA[b]

*Not used in score calculations
[a]Correct response in bold
[b]D and E were not options
[c]Misunderstanding ($\alpha = 0.05$)

Table 21.

Misunderstandings about influenza revealed by the AUI assessment

Theme	Misunderstanding
Flu Transmission	
	The flu vaccination protects us by giving us antibiotics.
	The flu vaccination wears off over time.
	The flu vaccination is available only as a shot.
Flu Management	
	A person becomes contagious with the flu 1-2 days after symptoms occur.

Correlations and Effect Sizes

The Kendall's tau correlation coefficients between outcome and predictor variables are in Table 22. Cohen's D effect sizes, a sample size independent measure of separateness of two distributions, are in Table 23. All precautions (Q1-Q8) and getting sick, had more than one statistically significant correlate, leading to rejection of the null hypothesis of no significant correlation for these correlates.

Propensity to get the flu vaccination (Q1) was significantly correlated with five variables. Significant positive correlations included experienced sickness severity (0.118, α = 0.01), knowledge of flu management (0.080, α = 0.05), and perceived risk (0.103, α = 0.05). Perceived barriers were negatively correlated with flu vaccination (-0.136, α = 0.01), as was School 6 (-0.096, α = 0.05). Estimated effect sizes of these variables show that they have a small relationship with flu vaccination.

Hand washing quality (Q2) was correlated with four other precautions, hand washing frequency (0.249, α = 0.01), personal distancing (0.176, α = 0.01), respiratory etiquette (0.116, α = 0.01), and hand sanitizer use (0.148, α = 0.01). Hand washing quality was negatively correlated with sickness severity (-0.109, α = 0.05). Being female was positively correlated with hand washing (0.099, α = 0.05), and perceived barriers (-0.143, α = 0.01) and School 3 (-0.133, α = 0.01) were negatively correlated. Effect sizes of these predictors were small to moderate.

Hand washing frequency (Q3) was correlated with five precautions, hand washing quality (0.249, α = 0.01), personal distancing (0.118, α = 0.01), respiratory etiquette (0.140, α = 0.01), not touching eyes, nose, and mouth (0.082, α = 0.05), and hand sanitizer use (0.102, α = 0.05). Hand washing frequency is significantly positively correlated with flu management (0.107,

$\alpha = 0.01$) being female (0.127, $\alpha = 0.01$), and School 2 (0.193, $\alpha = 0.01$), and negatively correlated with perceived barriers (-0.148, $\alpha = 0.01$) and School 4 (-0.181, $\alpha = 0.01$). These showed small to moderate effect sizes.

Personal distancing (Q4) was positively correlated with five precautions, hand washing quality (0.176, $\alpha = 0.01$) and frequency (0.118, $\alpha = 0.01$), not touching eyes, nose, and mouth (0.102, $\alpha = 0.05$), staying home when sick (0.118, $\alpha = 0.01$), and hand sanitizer use (0.134, $\alpha = 0.01$). Personal distancing is positively correlated with perceived complications (0.114, $\alpha = 0.01$). Effect sizes of these predictors ranged from small to moderate. Not touching the eyes, nose, or mouth (Q5) is positively correlated with two other precautions, hand washing frequency (0.082, $\alpha = 0.05$) and personal distancing (0.102, $\alpha = 0.05$). Not touching eyes, nose and mouth is positively associated with the races, Asian (0.091, $\alpha = 0.05$) and Other (0.108, $\alpha = 0.05$). Effects of these predictors on not touching the eyes, nose, or mouth were small. Respiratory etiquette (Q6) is positively correlated with hand washing quality (0.116, $\alpha = 0.01$) and frequency (0.140, $\alpha = 0.01$). It is also positively correlated with knowledge of flu transmission (0.167, $\alpha = 0.01$) and flu management (0.197, $\alpha = 0.01$) and being white (0.150, $\alpha = 0.01$). It is negatively correlated with perceived barriers (-0.154, $\alpha = 0.01$), grade (-0.104, $\alpha = 0.05$), and being black (-0.131, $\alpha = 0.01$). Respiratory etiquette is negatively correlated with Schools 3 (-0.147, $\alpha = 0.01$) and 4 (-0.116, $\alpha = 0.05$), and positively correlated with School 6 (0.130, $\alpha = 0.01$). These showed small to moderate effect sizes. Staying home when sick (Q7) is positively correlated with two precautions, personal distancing (0.118, $\alpha = 0.01$) and hand sanitizer use (0.101, $\alpha = 0.05$). It is also positively correlated with experienced sickness severity (0.095, $\alpha = 0.05$) and perceived complications (0.128, $\alpha = 0.01$). Effect sizes were small.

Table 22.

Null hypothesis tests for correlations of predictor variables with precautions and getting ill

Item Correlations (Kendall's τ-b)									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Sick
Q1		-0.075	-0.042	0.051	0.003	-0.015	0.038	-0.003	0.118**
Q2	-0.075		0.249**	0.176**	0.064	0.116**	0.061	0.148**	-0.109*
Q3	-0.042	0.249**		0.118**	0.082*	0.140**	-0.026	0.102*	-0.001
Q4	0.051	0.176**	0.118**		0.102*	-0.017	0.118**	0.134**	-0.002
Q5	0.003	0.064	0.082*	0.102*		-0.037	0.059	0.031	-0.015
Q6	-0.015	0.116**	0.140**	-0.017	-0.037		-0.062	0.002	-0.017
Q7	0.038	0.061	-0.026	0.118**	0.059	-0.062		0.101*	0.095*
Q8	-0.003	0.148**	0.102*	0.134**	0.031	0.002	0.101*		0.002
Sick	0.118**	-0.109*	-0.001	-0.002	-0.015	-0.017	0.095*	0.002	
Af1	0.004	0.010	0.052	-0.074	-0.073	0.167**	-0.017	-0.132**	0.010
Af2	0.080*	0.000	0.107**	-0.040	-0.032	0.197**	0.064	-0.004	-0.004
Sf1	0.103*	-0.078	-0.042	0.000	-0.038	-0.027	0.053	0.024	0.222**
Sf2	0.048	-0.004	-0.019	0.114**	-0.048	-0.077	0.128**	0.018	0.179**
Sf3	-0.136**	-0.143**	-0.148**	-0.009	0.056	-0.154**	0.077	-0.033	0.081
Grd	-0.023	0.022	-0.068	0.036	-0.022	-0.104*	0.001	-0.036	-0.061
Female	0.044	0.099*	0.127**	0.031	-0.059	0.038	-0.022	0.138**	0.122*
HP	0.020	0.028	-0.022	0.045	0.022	-0.058	0.068	0.037	0.120**
Black	-0.013	-0.025	-0.068	0.000	-0.017	-0.131**	0.044	0.115*	0.081
White	-0.015	0.008	-0.005	-0.028	-0.090	0.150**	-0.006	-0.024	-0.146**
Asian	-0.013	-0.007	0.000	-0.019	0.091*	-0.051	-0.036	-0.099*	0.056
Hisp	0.022	0.001	0.042	0.021	-0.007	-0.036	-0.038	-0.021	0.111*
Other	0.040	0.026	0.064	0.055	0.108*	-0.021	0.025	0.012	0.007
Schl1	-0.096*	-0.039	-0.020	0.003	0.004	0.056	-0.018	-0.147**	-0.010
Schl2	-0.057	0.068	0.193**	0.040	-0.046	0.028	0.052	0.088*	0.136**
Schl3	-0.019	-0.133**	-0.020	-0.013	0.076	-0.147**	-0.071	0.047	0.046
Schl4	0.087	0.026	-0.181**	0.025	0.044	-0.116*	0.026	0.035	-0.115*
Schl5	-0.039	0.024	0.047	-0.065	-0.023	0.065	-0.043	-0.144**	-0.012
Schl6	0.056	-0.035	0.015	-0.037	-0.036	0.130**	-0.019	0.024	-0.015

*p<0.05, **p<0.01

Table 23.

Effect sizes of predictor variables with precautions and getting ill

Cohen's D Effect Sizes									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Sick
Q1		-0.233	-0.132	0.160	0.008	-0.047	0.121	-0.009	0.362
Q2	-0.233		0.705	0.525	0.200	0.356	0.191	0.448	-0.336
Q3	-0.132	0.705		0.362	0.255	0.426	-0.083	0.315	-0.004
Q4	0.160	0.525	0.362		0.315	-0.055	0.362	0.409	-0.007
Q5	0.008	0.200	0.255	0.315		-0.117	0.184	0.097	-0.046
Q6	-0.047	0.356	0.426	-0.055	-0.117		-0.194	0.007	-0.054
Q7	0.121	0.191	-0.083	0.362	0.184	-0.194		0.312	0.294
Q8	-0.009	0.448	0.315	0.409	0.097	0.007	0.312		0.007
Sck	0.362	-0.336	-0.004	-0.007	-0.046	-0.054	0.294	0.007	
Af1	0.013	0.033	0.163	-0.231	-0.227	0.501	-0.054	-0.403	0.032
Af2	0.249	0.001	0.330	-0.124	-0.101	0.580	0.199	-0.013	-0.014
Sf1	0.318	-0.244	-0.130	0.001	-0.120	-0.084	0.165	0.076	0.642
Sf2	0.151	-0.013	-0.059	0.351	-0.150	-0.241	0.391	0.056	0.533
Sf3	-0.414	-0.434	-0.448	-0.030	0.175	-0.465	0.239	-0.103	0.251
Grd	-0.072	0.068	-0.213	0.112	-0.068	-0.321	0.004	-0.113	-0.192
Female	0.138	0.306	0.388	0.097	-0.186	0.121	-0.068	0.420	0.374
HP	0.063	0.086	-0.069	0.142	0.070	-0.180	0.212	0.117	0.368
Black	-0.041	-0.080	-0.212	0.000	-0.053	-0.400	0.137	0.353	0.253
White	-0.047	0.026	-0.017	-0.088	-0.279	0.454	-0.020	-0.077	-0.443
Asian	-0.042	-0.023	0.001	-0.060	0.282	-0.158	-0.114	-0.306	0.175
Hisp	0.070	0.003	0.132	0.065	-0.022	-0.112	-0.119	-0.066	0.342
Other	0.125	0.081	0.201	0.171	0.333	-0.067	0.078	0.036	0.021
Schl1	-0.297	-0.123	-0.064	0.010	0.012	0.176	-0.058	-0.446	-0.030
Schl2	-0.179	0.211	0.570	0.127	-0.144	0.089	0.162	0.273	0.414
Schl3	-0.059	-0.406	-0.062	-0.039	0.237	-0.446	-0.222	0.146	0.144
Schl4	0.270	0.082	-0.538	0.077	0.138	-0.356	0.082	0.110	-0.353
Schl5	-0.123	0.074	0.146	-0.201	-0.071	0.203	-0.135	-0.437	-0.038
Schl6	0.174	-0.110	0.047	-0.116	-0.111	0.397	-0.061	0.074	-0.047

Hand sanitizer use (Q8) is positively correlated with hand washing quality (0.148, $\alpha = 0.01$) and frequency (0.102, $\alpha = 0.05$), personal distancing (0.134, $\alpha = 0.01$), and staying home when sick (0.101, $\alpha = 0.05$). Being female (0.138, $\alpha = 0.01$), black (0.115, $\alpha = 0.05$), and from School 2 (0.088, $\alpha = 0.05$) have positive correlations. Knowledge of flu transmission (-0.162, $\alpha = 0.01$), being Asian (-0.099, $\alpha = 0.05$), and from Schools 1 (-0.147, $\alpha = 0.01$) and 5 (-0.144, $\alpha = 0.01$) correlate negatively. These showed small to moderate effect sizes.

Experienced severity of illness is positively correlated with two precautions, flu vaccination (0.118, $\alpha = 0.01$) and staying home when sick (0.095, $\alpha = 0.05$), and negatively correlated with hand washing quality (-0.109, $\alpha = 0.05$). Perceived risk (0.222, $\alpha = 0.01$) and complications (0.179, $\alpha = 0.01$) are positively correlated with sickness, as are being female (0.122, $\alpha = 0.05$) and number of family members who are health professionals (0.120, $\alpha = 0.01$). Being Hispanic (0.111, $\alpha = 0.05$) and from School 2 (0.136, $\alpha = 0.01$) are also positively correlated. Being white (-0.146, $\alpha = 0.01$) and from School 4 (-0.115, $\alpha = 0.05$) are negatively correlated with sickness. Effect sizes were small to moderate.

Logistic Regression Models

Variables that correlate significantly with a given factor were used to formulate a multinomial logistic regression model that best describes the data using the forward stepwise log likelihood method at the $\alpha = 0.05$ level of significance. Models are described below.

Flu Vaccination

Sickness ($\chi^2 = 12.11$, df = 4, p = 0.017), School 1 ($\chi^2 = 10.14$, df = 4, p = 0.038), and perceived barriers ($\chi^2 = 14.99$, df = 4, p = 0.005) were significant variables describing flu vaccination, leading to a well-fitting model ($\chi^2 = 80.13$, df = 72, p = 0.239). No interactions were significant. Odds ratios (Table 24) were calculated with respect to Category 5 (I make sure to get vaccinated against the flu every year). The reference category in multinomial logistic regression is similar to the zero, or baseline, in binary logistic regression. And as the value, one, is calculated with respect to the baseline, zero, in binary logistic regression, all integer values are calculated with respect to a chosen baseline integer in multinomial logistic regression.

Perceived barriers significantly increase the odds of being in lower categories, with statistically significant odds ratios of 2.122 and 1.726 for being in categories 1 and 3, respectively. Students in School 1 are also likely to be in lower categories, with a statistically significant odds ratio of 4.714 for being in category 2. Probability of getting vaccinated appears to increase with experienced sickness, as evidenced by odds ratios below 1. An odds ratio of 0.524 for being in category 2 as opposed to 5 is statistically significant

Table 24.

Logistic regression model for flu vaccination

Vaccination Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	-2.273	.615	13.677	1	.000	
	School 1	-.136	1.146	.014	1	.905	.872
	Sickness	-.464	.315	2.173	1	.140	.628
	Barriers	.752	.229	10.797	1	.001	2.122
2	Intercept	-.451	.465	.942	1	.332	
	School 1	1.551	.609	6.486	1	.011	4.714
	Sickness	-.646	.248	6.803	1	.009	.524
	Barriers	.340	.188	3.250	1	.071	1.404
3	Intercept	-.975	.463	4.434	1	.035	
	School 1	.794	.673	1.392	1	.238	2.212
	Sickness	-.455	.242	3.541	1	.060	.634
	Barriers	.546	.181	9.046	1	.003	1.726
4	Intercept	-.806	.452	3.181	1	.074	
	School 1	.185	.726	.065	1	.799	1.203
	Sickness	.054	.234	.054	1	.816	1.056
	Barriers	.298	.176	2.860	1	.091	1.348

[a]Reference category is 5

Hand Washing Quality

Perceived barriers (χ^2 = 19.85, df = 4, p = 0.001), hand washing frequency (χ^2 = 23.42, df = 4, p << 0.001), and personal distancing (χ^2 = 12.52, df = 4, p = 0.014) were significant predictors for hand washing quality in a well-fitting model (χ^2 = 1027.54, df = 1236, p = 1.000).

No interactions were significant. Odds ratios (Table 25) were calculated with respect to category 5 (I wash my hands by making sure they are covered with soap, rubbing them together for 15-20 seconds, and then rinsing). Students reporting high hand washing frequency were less likely to report lower washing quality. Odds ratios are 0.558 for being in category 3, 0.526 for being in category 2, and 0.272 for being in category 1. Reports were similarly associated with reports of personal distancing. Significant odds ratios are 0.722 for being in category 3, and 0.581 for being in category 2. Students with higher perceived barrier scores were more likely to report lower categories. Significant odds ratios for perceived barriers include 1.604 for reporting category 2 and 8.935 for reporting category 1.

Table 25.

Logistic regression model for hand washing quality

Hand Washing Quality Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	-7.161	3.508	4.168	1	.041	
	Barriers	2.190	.719	9.286	1	.002	8.935
	Distancing	.263	.428	.377	1	.539	1.301
	Frequency	-1.303	.621	4.404	1	.036	.272
2	Intercept	1.252	.975	1.649	1	.199	
	Barriers	.473	.239	3.923	1	.048	1.604
	Distancing	-.543	.193	7.916	1	.005	.581
	Frequency	-.643	.195	10.820	1	.001	.526
3	Intercept	1.633	.782	4.361	1	.037	
	Barriers	.254	.200	1.615	1	.204	1.290
	Distancing	-.325	.145	5.033	1	.025	.722
	Frequency	-.584	.156	13.937	1	.000	.558
4	Intercept	1.335	.630	4.491	1	.034	
	Barriers	-.042	.165	.065	1	.799	.959
	Distancing	-.139	.109	1.630	1	.202	.870
	Frequency	-.213	.120	3.160	1	.075	.808

[a]Reference category is 5

Hand Washing Frequency

Knowledge of flu management (χ^2 = 17.44, df = 4, p = 0.002), hand washing quality (χ^2 = 32.10, df = 4, p << 0.001), and School 2 (χ^2 = 15.79, df = 4, p = 0.003) were significant predictors for hand washing frequency in a well-fitting model (χ^2 = 1448.41, df = 1452, p = 0.552). No interactions were significant. Odds ratios (Table 26) were calculated with respect to category 5 (I wash my hands greater than 6 times per day). Students reporting high hand washing quality were less likely to report lower washing frequency. Significant odds ratios are 0.712 for being in category 3, 0.491 for being in category 2, and 0.320 for being in category 1. Likelihood for reporting low hand washing frequency also decreases with increasing knowledge of flu management, with a significant odds ratio of 0.417 for being in category 1 as opposed to 5. Students in School 2 are less likely to report lower hand washing frequencies; significant odds ratios of 0.383 for being in category 3, 0.279 for being in category 2, and 0.170 for being in category 4, were found.

Table 26.

Logistic regression model for hand washing frequency

Hand Washing Frequency Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	6.379	1.210	27.772	1	.000	
	FluMgmt	-.874	.241	13.154	1	.000	.417
	HndWshQ	-1.140	.248	21.154	1	.000	.320
	Schl2	-1.770	.705	6.298	1	.012	.170
2	Intercept	3.402	1.039	10.716	1	.001	
	FluMgmt	-.087	.170	.259	1	.611	.917
	HndWshQ	-.712	.192	13.747	1	.000	.491
	Schl2	-1.278	.431	8.810	1	.003	.279
3	Intercept	3.004	.930	10.422	1	.001	
	FluMgmt	-.156	.143	1.190	1	.275	.855
	HndWshQ	-.339	.170	3.977	1	.046	.712
	Schl2	-.959	.321	8.931	1	.003	.383
4	Intercept	1.044	1.096	.906	1	.341	
	FluMgmt	-.007	.170	.001	1	.969	.994
	HndWshQ	-.241	.200	1.448	1	.229	.786
	Schl2	-.394	.369	1.137	1	.286	.675

[a]Reference category is 5

Personal Distancing

Four precautions, hand washing quality (χ^2 = 13.50, df = 4, p = 0.009) and frequency (χ^2 = 19.23, df = 4, p = 0.001), not touching the eyes, nose, or mouth (χ^2 = 10.46, df = 4, p = 0.033), and hand sanitizer use (χ^2 = 20.76, df = 4, p << 0.001) were significant predictors. While perceived complications was not significant in the model, (χ^2 = 1.57, df = 4, p = 0.815), the interaction between perceived complications and hand washing quality (χ^2 = 14.46, df = 4, p = 0.006), and the interaction between perceived complications and hand washing frequency (χ^2 = 21.12, df = 4, p << 0.001) were significant. Model and actual distributions were not significantly different (χ^2 = 1372.78, df = 1460, p = 0.949), indicating a well-fitting model.

Odds ratios (Table 27) were calculated with respect to category 5 (I make sure to keep a safe distance from the student, to avoid touching the things he/she touches, and to wash my hands between each class). Students reporting high hand washing quality were more likely to report less personal distancing, with a significant odds ratio of 4.117 for reporting category 1 as opposed to 5. On the other hand, students reporting frequent hand washing were less likely to report lower personal distancing. Significant odds ratios of 0.078 for being in category 4 and 0.206 for being in category 1 were calculated. A similar trend is seen with hand sanitizer use, with a significant odds ratio of 0.718 for reporting category 2 as opposed to 5. While odds ratios for touching the eyes, nose, and mouth hint at a similar trend for categories 3 and below, none of these are significant.

Table 27.

Logistic regression model for personal distancing

Personal Distancing Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	.580	3.227	.032	1	.857	
	Complic	.543	1.043	.271	1	.603	1.721
	HndWshF	-1.580	.656	5.799	1	.016	.206
	HndWshQ	1.415	.722	3.845	1	.050	4.117
	Touching	-.339	.203	2.792	1	.095	.712
	HndSanit	.064	.144	.201	1	.654	1.067
	HndWshF * Complic	.476	.214	4.971	1	.026	1.610
	HndWshQ * Complic	-.660	.237	7.772	1	.005	.517
2	Intercept	3.856	2.546	2.294	1	.130	
	Complic	.421	.846	.247	1	.619	1.523
	HndWshF	.642	.515	1.552	1	.213	1.900
	HndWshQ	-.659	.593	1.237	1	.266	.517
	Touching	-.205	.130	2.489	1	.115	.815
	HndSanit	-.332	.102	10.598	1	.001	.718
	HndWshF * Complic	-.349	.174	4.007	1	.045	.705
	HndWshQ * Complic	.058	.200	.085	1	.770	1.060
3	Intercept	3.346	2.531	1.748	1	.186	
	Complic	-.082	.837	.010	1	.922	.921
	HndWshF	-.139	.489	.081	1	.776	.870
	HndWshQ	-.163	.576	.080	1	.777	.850
	Touching	-.108	.119	.825	1	.364	.898
	HndSanit	-.057	.093	.376	1	.540	.945
	HndWshF * Complic	-.019	.162	.014	1	.905	.981
	HndWshQ * Complic	-.047	.193	.060	1	.807	.954
4	Intercept	-3.412	6.147	.308	1	.579	
	Complic	.975	1.669	.341	1	.559	2.651
	HndWshF	-2.553	1.291	3.910	1	.048	.078
	HndWshQ	.910	1.317	.478	1	.489	2.485
	Touching	.410	.231	3.156	1	.076	1.506
	HndSanit	.234	.221	1.119	1	.290	1.263
	HndWshF * Complic	.413	.349	1.396	1	.237	1.511
	HndWshQ * Complic	-.272	.369	.542	1	.462	.762

[a]Reference category is 5

Although perceived complications is not significant, interactions were found between this and the hand washing precautions. The interaction between perceived complications and hand washing frequency is significant for categories 2 and 1, with odds ratios of 0.705 and 1.610, respectively. This is confounding in that it shows that a positive interaction between perceived complications and hand washing frequency decreases the likelihood of reporting category 2 as opposed to 5, but increases the likelihood of reporting category 1 as opposed to 5. The interaction between perceived complications and hand washing quality decreases the likelihood of reporting lower personal distancing efforts, with an odds ratio of 0.517 for reporting category 1.

Touching Eyes, Nose, and Mouth

The race, Other, was the only significant predictor for touching the eyes, nose, and mouth (χ^2 = 10.73, df = 4, p = 0.03). The model and actual distributions were not significantly different (χ^2 = 217.02, df = 188, p = 0.072), indicating a well-fitting model. Odds ratios (Table 28) comparing selected categories to category 5 (I rarely do any of these) are below 1. Significant odds ratios include 0.169 for reporting category 3, 0.221 for reporting category 2, and 0.146 for reporting category 1. This indicates that those who put “Other” for their race were significantly less likely to report low scores on touching eyes, nose, and mouth.

Table 28.

Logistic regression model for not touching eyes, nose, and mouth

Touching Eyes, Nose, and Mouth Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	.941	.208	20.381	1	.000	
	Other	-1.922	.708	7.361	1	.007	.146
2	Intercept	1.511	.195	59.851	1	.000	
	Other	-1.511	.537	7.923	1	.005	.221
3	Intercept	.797	.213	14.010	1	.000	
	Other	-1.778	.710	6.275	1	.012	.169
4	Intercept	.061	.246	.061	1	.806	
	Other	-1.447	.828	3.053	1	.081	.235

[a]Reference category is 5

Respiratory Etiquette

Four factors, hand washing frequency (χ^2 = 10.37, df = 4, p = 0.035), knowledge of flu management (χ^2 = 22.84, df = 4, p << 0.001), being white (χ^2 = 11.08, df = 4, p = 0.026), and being from School 3 (χ^2 = 18.85, df = 4, p = 0.001), were significant. No significant interactions were found for this model. Model and actual distributions were not significantly different (χ^2 = 238.90, df = 208, p = 0.070), indicating a well-fitting model. Odds ratios (Table 29) were calculated in comparison to category 5 (I usually cover my mouth with my shirt sleeve or a tissue that I throw away after sneezing).

Students reporting greater frequency of hand washing were less likely to report low respiratory etiquette. The significant odds ratio is 0.654 for being in category 2. Greater knowledge of flu management also lowered the probability of reporting lower respiratory etiquette, with significant odds ratios of 0.431 for reporting category 4, 0.680 for reporting category 2, and 0.266 for reporting category 1.

Table 29.

Logistic regression model for respiratory etiquette

Respiratory Etiquette Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	2.364	1.102	4.602	1	.032	
	Schl3	2.649	.980	7.311	1	.007	14.136
	FluMgmt	-1.323	.399	10.991	1	.001	.266
	HndWshF	-.466	.284	2.696	1	.101	.628
	White	-1.118	.684	2.666	1	.102	.327
2	Intercept	1.275	.699	3.330	1	.068	
	Schl3	1.259	.975	1.665	1	.197	3.520
	FluMgmt	-.386	.184	4.384	1	.036	.680
	HndWshF	-.424	.169	6.277	1	.012	.654
	White	-1.100	.392	7.863	1	.005	.333
3	Intercept	-.064	.559	.013	1	.909	
	Schl3	.943	.835	1.274	1	.259	2.568
	FluMgmt	-.168	.122	1.901	1	.168	.845
	HndWshF	-.143	.114	1.573	1	.210	.867
	White	.110	.295	.140	1	.709	1.117
4	Intercept	-.969	1.132	.733	1	.392	
	Schl3	3.292	.821	16.098	1	.000	26.902
	FluMgmt	-.841	.298	7.969	1	.005	.431
	HndWshF	.145	.240	.365	1	.546	1.156
	White	-.054	.603	.008	1	.929	.947

[a]Reference category is 5

Being white has a similar effect, with a significant odds ratio of 0.333 for reporting category 2. Being from School 3 increased the probability that a student would report lower respiratory etiquette, with significant odds ratios of 26.902 for reporting category 4 and 14.136 for reporting category 1.

Staying Home When Sick

Perceived complications (χ^2 = 15.72, df = 4, p = 0.003) was the only significant predictor for staying home when sick. The model fit the actual data distribution well (χ^2 = 648.21, df = 612, p = 0.151). Odds ratios for staying home when sick (Table 30) were calculated by comparing lower categories to reference category 5 (I almost always stay home when sick).

Increased perceived complications associated with the flu were found to lower the odds of reporting lower categories. The significant odds ratio was 0.524 for reporting category 3 as opposed to 5.

Table 30.

Logistic regression model for staying home when sick

Staying Home When Sick Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	-.598	.824	.528	1	.468	
	Complic	-.142	.272	.274	1	.601	.868
2	Intercept	.372	.702	.281	1	.596	
	Complic	-.339	.238	2.027	1	.154	.713
3	Intercept	2.465	.527	21.829	1	.000	
	Complic	-.647	.179	13.026	1	.000	.524
4	Intercept	1.182	.551	4.605	1	.032	
	Complic	-.267	.182	2.162	1	.141	.765

[a]Reference category is 5

Hand Sanitizer Use

Hand washing frequency (χ^2 = 18.07, df = 4, p = 0.001), staying home when sick (χ^2 = 10.69, df = 4, p = 0.030), and knowledge of flu transmission (χ^2 = 13.70, df = 4, p = 0.008) were significant factors in modeling hand sanitizer use. No interactions were significant. Model and actual distributions were comparable (χ^2 = 1375.70, df = 1348, p = 0.294). Odds ratios (Table 31) were calculated in comparison to reference category 5 (Whenever I walk past a hand sanitizer, I use it).

Table 31.

Logistic regression model for hand sanitizer use

Hand Sanitizer Use Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	1.364	.744	3.357	1	.067	
	Transmiss	.440	.135	10.617	1	.001	1.553
	HndWshF	-.294	.132	4.972	1	.026	.745
	StayingHome	-.382	.137	7.831	1	.005	.682
2	Intercept	.393	.888	.196	1	.658	
	Transmiss	.243	.160	2.307	1	.129	1.275
	HndWshF	-.272	.156	3.031	1	.082	.762
	StayingHome	-.167	.161	1.079	1	.299	.846
3	Intercept	.267	.916	.085	1	.771	
	Transmiss	.452	.166	7.387	1	.007	1.572
	HndWshF	-.234	.166	1.992	1	.158	.792
	StayingHome	-.399	.170	5.503	1	.019	.671
4	Intercept	-1.704	.994	2.937	1	.087	
	Transmiss	.158	.168	.879	1	.348	1.171
	HndWshF	.299	.164	3.350	1	.067	1.349
	StayingHome	-.094	.174	.292	1	.589	.910

[a]Reference category is 5

Students who reported favorable attitudes towards staying home when sick were less likely to report lower hand sanitizer use. Significant odds ratios included 0.671 for reporting category 3, 0.682 for reporting category 1. Students with high knowledge of flu transmission and high hand washing frequency were more likely to report low hand sanitizer use. Significant odds ratios for knowledge of flu transmission included 1.572 for reporting category 3 and 1.553 for reporting category 1. The significant odds ratio for hand washing frequency was 0.745 for reporting category 1 as opposed to 5.

Models for Sickness Severity

In addition to taking precautions, models were formulated for sickness severity. Hand washing quality (χ^2 = 13.37, df = 2, p = 0.001), perceived risk (χ^2 = 33.71, df = 2, p << 0.001) and complications (χ^2 = 11.10, df = 2, p = 0.004), being white (χ^2 = 9.03, df = 2, p = 0.011), and being from School 2 (χ^2 = 6.30, df = 2, p = 0.043) were significant predictors for sickness severity, as was the interaction between hand washing quality and being white (χ^2 = 7.69, df = 2, p = 0.021). The model distribution fit well with the data (χ^2 = 645.75, df = 662, p = 0.667).

Odds ratios (Table 32) for sickness were compared to not getting sick (category 0). Perceived complications contributed significantly predicting which students catch a cold-like illness, with a significant odds ratio of 1.421. This positive odds ratio indicates that students with higher perceived complications have a higher likelihood of catching a cold-like illness. Students with increased perceived complications and risk, and those from School 2, were more likely to report catching a flu-like illness, with odds ratios of 2.019, 2.904, and 2.378, respectively.

A binary model was used to examine more closely students who report catching a flu-like illness versus those who do not. As with the previous model, hand washing quality (χ^2 = 11.45, df = 1, p = 0.001), perceived risk (χ^2 = 33.24, df = 1, p << 0.001) and complications (χ^2 = 6.45, df = 1, p = 0.011), being white (χ^2 = 7.12, df = 1, p = 0.008), and being from School 2 (χ^2 = 6.20, df = 1, p = 0.013) were significant predictors for catching the flu, as was the interaction between hand washing quality and being white (χ^2 = 4.36, df = 1, p = 0.037). The model distribution fit well with the data (χ^2 = 305.47, df = 331, p = 0.840).

When only the flu is modeled (Table 33), odds ratios for all predictors become significant. Reporting high hand washing quality and being white appear to lower the odds of catching the flu, with odds ratios of 0.477 and 0.052, respectively. As with sickness severity, students reporting high perceived risk and complications, and being from School 2, were more likely to report catching the flu, with odds ratios of 2.679, 1.548, and 2.219, respectively.

Table 32.

Logistic regression model for sickness severity

Sickness Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	-1.368	1.178	1.349	1	.246	
	Complic	.351	.166	4.493	1	.034	1.421
	HndWshQ	.361	.259	1.948	1	.163	1.435
	Risk	.109	.154	.499	1	.480	1.115
	White	1.748	1.235	2.002	1	.157	5.742
	Schl2	.090	.331	.074	1	.785	1.094
	HndWshQ * White	-.557	.304	3.366	1	.067	.573
2	Intercept	-3.113	1.373	5.139	1	.023	
	Complic	.702	.217	10.467	1	.001	2.019
	HndWshQ	-.460	.299	2.371	1	.124	.631
	Risk	1.066	.222	23.085	1	.000	2.904
	White	-1.636	1.440	1.291	1	.256	.195
	Schl2	.866	.403	4.617	1	.032	2.378
	HndWshQ * White	.167	.367	.207	1	.649	1.182

[a]Reference category is 0

Table 33.

Logistic regression model for catching the flu

Flu Category[a]		B	Std. Error	Wald χ^2	df	Sig.	Exp(B)
1	Intercept	-2.648	1.084	5.964	1	.015	
	Complic	.437	.175	6.229	1	.013	1.548
	HndWshQ	-.740	.230	10.319	1	.001	.477
	Risk	.985	.189	27.267	1	.000	2.679
	White	-2.957	1.134	6.801	1	.009	.052
	Schl2	.797	.317	6.315	1	.012	2.219
	HndWshQ * White	.594	.290	4.189	1	.041	1.812

[a]Reference category is 0

Neural Network Predictions

The ten-fold cross validation technique ensured that the network was not over trained (it had not memorized the data), thus reflecting patterns that were general to the phenomenon, and not simply properties of the particular training data set. Data were divided into ten parts, nine sections of 35 points, plus one section containing the number of valid data that remained. The network was trained on nine parts at a time, and tested using the remaining part, for the ten parts.

The Kendall-tau coefficient measures the degree of association between predicted and actual values, and Cohen's D gives an estimate of practical effect size (Table 34).

Table 34.

Kendall-τ and Cohen's D measures of association between predicted with actual values

Predicted	τ	D	Effect Size
Flu vaccination	0.093	0.288	small
Hand washing quality	0.206	0.603	moderate
Hand washing frequency	0.205	0.600	moderate
Personal distancing	0.136	0.414	small
Touching face	0.035	0.110	negligible
Respiratory etiquette	0.136	0.414	small
Staying home	0.021	0.066	negligible
Hand sanitizer use	0.102	0.315	small
Sickness severity	0.098	0.303	small
Catching flu	0.129	0.394	small

Association between predicted and actual values for touching the face and staying home when sick were negligible, with τ values of 0.035 and 0.021, and D values of 0.110 and 0.066, respectively. Six variables had small associations: flu vaccination (τ = 0.093, D = 0.288), personal distancing (τ = 0.136, D = 0.414), respiratory etiquette (τ = 0.136, D = 0.414), hand sanitizer use (τ = 0.120, D = 0.315), sickness severity (τ = 0.098, D = 0.303), and catching the flu (τ = 0.129, D = 0.394). Hand washing quality and frequency had moderate associations, with τ values of 0.206 and 0.205, and D values of 0.603 and 0.600, respectively.

The five significant variables: experienced sickness severity, knowledge of flu management, perceived risk, perceived barriers, and School 6, were input into the network. Resulting predictions on student agreeability to the flu vaccination had a small relationship to the data. Table 35 shows how the neural network classified the data. It made the correct prediction 22% of the time, slightly better than the 20% correct prediction rate which would happen by random guessing. A “1” was predicted correctly 9% of the time; a “2” was predicted correctly 27% of the time; a “3” 44% of the time; a “4” 20% of the time, and a “5” 5% of the time. “3” was the most common prediction for all categories.

Table 35.

Classification of flu vaccination predictions

		Flu vacc. predicted					
		1	2	3	4	5	Total
Flu vacc. actual	1	3	9	15	5	2	34
	2	7	21	31	15	3	77
	3	7	16	35	18	3	79
	4	3	26	35	17	5	86
	5	4	20	37	30	5	96
	Total	24	92	153	85	18	372

The eight significant correlates with hand washing quality: hand washing frequency, personal distancing, respiratory etiquette, hand sanitizer use, sickness severity, being female, perceived barriers, and School 3, were submitted into the neural network. Predictions (Table 36) showed a moderate relationship with actual values, correct 30% of the time, ten percent better than random guessing. No “1’s” were predicted correctly. 34% of “2’s”, 43% of “3’s”, 36% of “4’s”, and 16% of “5’s” were correct. Correct predictions differed from most common predictions for categories 1 and 5. “3” was the most common prediction for category 1, and “4” for category 5.

Table 36.

Classification of hand washing quality predictions

		Hand washing quality predicted					
		1	2	3	4	5	Total
Hand washing quality actual	1	0	3	1	1	0	5
	2	3	12	12	5	3	35
	3	1	13	27	17	5	63
	4	1	16	43	47	23	130
	5	1	13	36	49	19	118
	Total	6	57	119	119	50	351

Ten significant correlates to hand washing frequency were input: hand washing quality, personal distancing, respiratory etiquette, not touching eyes, nose, and mouth, hand sanitizer use, knowledge of flu management, being female, Schools 2 and 4, and perceived barriers. The relationship between predicted and actual values for hand washing frequency (Table 37) was moderate, with 30% of predictions in the correct category, ten percent better than random guessing.

Table 37.

Classification of hand washing frequency predictions

		Hand washing freq. predicted					
		1	2	3	4	5	Total
Hand washing freq actual	1	5	10	6	3	1	25
	2	3	18	18	20	7	66
	3	7	30	52	46	15	150
	4	1	14	17	15	15	62
	5	2	11	14	20	23	70
	Total	18	83	107	104	61	373

The category, “1”, was predicted with 20% accuracy. 27% of “2’s”, 35% of “3’s”, 24% of “4’s”, and 33% of “5’s” were predicted correctly. Correct predictions differed from most common predictions for categories 1, 2, and 4. The most common prediction for category 1 was “2”. “4” was the most common prediction for category 2, and “3” for category 4.

Six significant correlates for personal distancing, hand washing quality and frequency, not touching eyes, nose, and mouth, staying home when sick, hand sanitizer use, and perceived complications, were submitted to this neural network. Personal distancing predictions (Table 38) showed low correlation with actual values, with 27% classified in the correct category, seven percent better than random guessing. “2’s, “3’s” and “4’s” were classified moderately well, with correct prediction rates of 26%, 35%, and 42%. Only 10% of “1’s” and 18% of “5’s” were classified correctly. In categories 1, 2, and 5, correct predictions differed from most common predictions. The most common prediction for category 1 was “4”, and “3” for categories 2 and 5.

Table 38.

Classification of personal distancing predictions

		Pers. dist. predicted					
		1	2	3	4	5	Total
Pers. dist. actual	1	3	8	7	11	2	31
	2	13	34	45	33	8	133
	3	4	30	55	48	22	159
	4	2	3	1	5	1	12
	5	2	13	23	22	13	73
	Total	24	88	131	119	46	408

Hand washing frequency, personal distancing, Asian, and Other were four significant correlates to not touching the face. Predictions for not touching the face (Table 39) showed negligible correlation with actual values, with a total of 26% correct classifications, six percent better than random guessing. Categories, “2” and “3” were predicted best, at 38% and 47% correct, respectively. “1’s”, “4’s”, and “5’s” were weakly classified, at 6%, 11%, and 5%, respectively. Correct and most common predicted category differed for categories 1, 2, 4, and 5. “3” was most commonly predicted for categories 1, 2, and 5. “2” was most commonly predicted for category 4.

Table 39.

Classification of predictions on not touching the eyes, nose, and mouth

		Not touching face predicted					
		1	2	3	4	5	Total
Not touching face actual	1	5	30	43	6	1	85
	2	8	58	70	12	5	153
	3	4	26	35	8	1	74
	4	2	15	14	4	1	36
	5	5	9	16	8	2	40
	Total	24	138	178	38	10	388

Ten correlates, hand washing quality and frequency, knowledge of flu transmission and flu management, white, perceived barriers, black, and Schools 3, 4, and 6 were used as inputs into the neural network for respiratory etiquette. Predictions (Table 40) had a small positive relationship to actual values, and a 19% total correct prediction rate, which is worse than the rate predicted by random guessing.

Table 40.

Classification of respiratory etiquette predictions

		Resp. etiquette predicted					
		1	2	3	4	5	Total
Resp. etiquette actual	1	0	5	3	2	2	12
	2	5	8	10	10	1	34
	3	11	10	23	30	7	81
	4	1	3	4	5	1	14
	5	20	25	66	90	36	237
	Total	37	51	106	137	47	378

Classifications of “1’s” and “5’s” were weak, at 0% and 15% correct. “2’s”, “3’s”, and “4’s” were classified moderately, at 24%, 28%, and 36%, respectively. Most common predictions were incorrect for categories 1, 2, 3, and 5. “2” was most commonly predicted for category 1; 3 and 4 (tied) for category 2; and “4” for categories 3 and 5.

Four significant correlates, personal distancing, hand sanitizer use, experienced sickness severity and perceived complications, were input as predictors for staying home when sick. Predictions for staying home when sick (Table 41) had negligible association to actual values. Total correct prediction rate was 25%, five percent better than random guessing. Categories 1 and 5 were classified poorly, at 4% and 15% correct. Categories 2, 3, and 4 were classified better, at 24%, 32%, and 27%, respectively. Most common predictions were incorrect for categories 1, 2, 4, and 5. “3” was most commonly predicted for category 1, “4” for category 2, and “3” for categories 4 and 5.

Table 41.

Classification of predictions on staying home when sick

		Staying home predicted					
		1	2	3	4	5	Total
Staying home actual	1	1	4	10	7	3	25
	2	5	9	7	13	4	38
	3	13	32	44	29	19	137
	4	8	23	30	28	15	104
	5	1	16	29	13	10	69
	Total	28	84	120	90	51	373

Eleven significant correlates, hand washing quality and frequency, personal distancing, and staying home when sick, female, black, Schools 1, 2, and 5, knowledge of flu transmission, and Asian, were input into the model for hand sanitizer use. Predictions (Table 42) showed a small relationship to the data, but only classified data with 17% accuracy, worse than a random chance prediction. Categories 1, 2, and 5 were classified poorly, at 7%, 20% and 18%, respectively; 3 and 4 were classified better, at 23% and 31% correct. Most common predictions were incorrect for all categories. “3” was most commonly predicted for category 1, “4” for categories 2, 3, and 5, and “3” for category 4.

Table 42.

Classification of hand sanitizer use predictions.

		Hand sanit. predicted					
		1	2	3	4	5	Total
Hand sanit. actual	1	8	26	36	35	16	121
	2	2	11	14	21	8	56
	3	1	11	11	16	9	48
	4	0	6	16	15	12	49
	5	3	13	22	32	15	85
	Total	14	67	99	119	60	359

Eleven significant correlates, flu vaccination, staying home when sick, hand washing quality, perceived risk and complications, female, number of family members who are health professionals, white, Hispanic, and Schools 2 and 4 were input as predictors for sickness severity and contraction of flu. Predictions of sickness severity (Table 43) and whether or not a student contracts influenza (Table 44) showed a small relationship to the data.

Table 43.

Classification of sickness severity predictions

		Sick predicted			
		0	1	2	Total
Sick actual	0	31	32	16	79
	1	61	108	33	202
	2	15	33	18	66
	Total	107	173	67	347

Table 44.

Classification of flu predictions

		Flu predicted		
		0	1	Total
Flu actual	0	208	73	281
	1	39	27	66
	Total	247	100	347

Sickness severity had a 45% correct prediction rate. Categories 0 (no sickness) and 1 (cold symptoms) were well-classified, with correct prediction rates of 39% (six percent better than random guessing) and 54% (four percent better than random guessing). Category 2 (flu symptoms) was classified less well, at 27% accuracy. Category 1 (cold symptoms) was most commonly predicted for all categories. Presence or absence of flu had a 68% correct prediction rate. Category 0 (absence) was classified with 74% accuracy; category 1 (flu) with 41% accuracy.

Summary

Data for this study were collected from 410 students from six high schools in the Midwest. Three assessments were used. Scores on the validated AUI and SOBER quantified students' knowledge of and experience with influenza. The IMBS collected information about students' mitigation behavior.

CFA indicated that the structure and reliability of the AUI and SOBER instruments differed from those derived from the pilot test on 205 students. While changes to the AUI amounted to transferring one item from measuring knowledge of flu transmission to measuring knowledge of flu management, necessary changes to the SOBER were more involved. Foremost, the theme, "Lack of Social Efficacy" did not fit with the instrument and was eliminated. Additionally, one item was moved from measuring perceived risk to measuring perceived complications, and another was moved from measuring perceived complications to perceived barriers. The CFI and RMSEA fit indices indicated acceptable fit with the data. Reliability measures indicate that the AUI and SOBER were acceptable for providing measures for categorical data analysis in this study (Schmidt, 1996). Reliability measures for the SOBER were above 0.6; those for the AUI were above 0.7.

Knowledge level distributions for the two AUI themes were both unimodal Gaussian. The distribution for knowledge of flu management was more left skewed than that for knowledge of flu transmission, indicating that the former was more familiar to students. Four significant misunderstandings were confirmed by the chi-square statistic for this sample at the 95% level of confidence: (1) the flu vaccination protects us by giving us antibiotics; (2) that we must get a new vaccination every year because the vaccine wears off over time; (3) that the flu vaccine is only available through an injection; and (4) that a person becomes contagious with the flu 1-2 days after symptoms occur. The first three misunderstandings dealt with flu transmission; the fourth with flu management.

The null hypotheses that there are no statistically significant relationships to practicing the precautions and contracting illness were rejected through the Kendall-tau test evaluated at the 95% level of confidence. Cohen's D, calculated from the Kendall-tau correlation coefficients, verified small-to-moderate effect sizes for statistically significant correlates (Table 45). Forward stepwise logistic regression models gave further insight into the effect of these correlates on behavior. Perceived barriers, sickness severity, and being from School 1 were the most significant predictors for compliance with vaccination. The most significant predictors for hand washing quality were perceived barriers, practice of personal distancing and hand washing frequency. Hand washing frequency was best modeled with hand washing quality, knowledge of flu management, and being from School 2.

Five variables and two interactions provided the best model for personal distancing: hand washing quality and frequency, not touching the face, hand sanitizer use, perceived complications, and the interactions between hand washing frequency and quality with perceived complications. Only the race, “Other,” was significant in modeling not touching the face. Four variables were significant in the model for respiratory etiquette: hand washing frequency, knowledge of flu management, being white, and from School 3.

Table 45.

Summary of rejected null hypotheses of no statistically significant correlation (α = 0.05)

Trait	Reject H_o for:
Vaccination	Sickness severity, Knowledge of flu management, Perceived risk, Perceived barriers, School 1
Hand Washing Quality	Hand washing frequency, Personal distancing, Respiratory etiquette, Hand sanitizer use, Sickness severity, Perceived barriers, Gender, School 3
Hand Washing Frequency	Hand washing quality, Personal distancing, Not touching face, Respiratory etiquette, Hand sanitizer use, Knowledge of flu management, Perceived barriers, Gender, School 2, School 4
Personal Distancing	Hand washing quality, Hand washing frequency, Not touching face, Staying home, Hand sanitizer use, Perceived complications
Not Touching Face	Hand washing frequency, Personal distancing, Asian, Other
Respiratory Etiquette	Hand washing quality, Hand washing frequency, Knowledge of flu transmission, Knowledge of flu management, Perceived barriers, Grade, Black, White, School 3, School 4
Staying Home	Personal distancing, Hand sanitizer use, Sickness severity, Perceived complications
Hand Sanitizer Use	Hand washing quality, Hand washing frequency, Personal distancing, Staying home, Knowledge of flu transmission, Gender, Black, Asian, School 1, School 2, School 5
Sickness Severity	Vaccination, Hand washing quality, Staying home, Perceived risk, Perceived complications, Gender, Health Professionals, White, Hispanic, School 2, School 4

Perceived complications was significant in the model for staying home when sick, and hand washing frequency, staying home when sick, and knowledge of flu transmission were significant predictors for hand sanitizer use. Five variables and one interaction were significant in the models for sickness severity and catching a flu-like illness. Hand washing quality, perceived complications, perceived risk, being white, and from School 2, was significant, as was the interaction between hand washing quality and being white.

Variables significant at the 95% confidence level through the Kendall-tau test were used as inputs into the neural networks for each behavior, sickness severity, and contraction of flu. Kendall-tau associations between predictions and actual data for touching the face and staying home when sick were negligible, with correct predictions 26% and 25% of the time, respectively. Six variables had small associations: flu vaccination (22% correct classification), personal distancing (27% correct), respiratory etiquette (19% correct), hand sanitizer use (17% correct), sickness severity (45% correct), and catching the flu (68% correct). Predictions for hand washing quality and frequency showed moderate associations to the data and correct prediction rates of 30% for both.

CHAPTER 5: SUMMARY OF STUDY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS FOR FUTURE STUDY

Introduction

Influenza has been a significant contributor to personal and social health problems (Rothman, 2006). Schools are no exception (Principi et al., 2006). While seasonal influenza primarily strikes between winter and early spring, pandemic infections can occur anytime, the most recent of which was the 2009 H1N1 Novel Swine Flu pandemic, which caused 8,000-18,000 deaths and 195,000-400,000 hospitalizations (CDC, 2009). Both seasonal and pandemic infections have significant negative consequences on students' education through decreased time on task and exclusion of students from benefits such as free or reduced lunch and adult supervision (Cauchemez et al., 2009). Viral shedding typically occurs for a week after contraction of the infection (Kay et al., 2011), which reduces a significant portion of a students' school year. If it spreads to those in close proximity, impact increases exponentially.

Epidemiological models show that influenza is not likely to be eradicated anytime in the near future (Small, Walker, & Tse, 2007). Under the assumption that influenza will be present within the student population, schools are faced with the challenge of reducing its impact by taking measures to minimize spread. According to the CDC (2009), vaccination is the most effective, reliable measure one can take to minimize the spread of influenza. Other important measures include thoroughly cleaning hands frequently with soap or alcohol-based hand sanitizers, social distancing, covering the mouth and nose with a tissue or shirt sleeve when sneezing and coughing, and avoiding manual contact with the eyes, nose, and mouth (CDC, 2009). But for these measures to be effective, students must put them into practice either voluntarily or in compliance with a school wide influenza mitigation policy.

Intervention measures require educating patients and citizens about disease prevention so they will implement the practices (Wensing, Van der Weijden, & Grol, 1998). But what measures should be taken by schools to best assist students in the choice to implement effective mitigation practices? Wensing, Van der Weijden, and Grol (1998) suggest that rules, incentive structures, and individual instruction are effective in comparison to more impersonal means like lecturing in classes and supplying reading materials. This study explores how knowledge and perceptions of influenza, and demographic factors correlate with students staying healthy and taking preventative measures against influenza. Using conclusions from this study, interventions can be designed more effectively, based on factors shown to motivate preventative practice.

Documented influenza-related interventions in high schools (Dumais & Hasni, 2009) focus on increasing students' understanding of influenza, but little to no explicit focus has been given to the importance of taking measures to prevent its spread. Further, factors that influence high school students' willingness to comply with preventative measures against influenza have not been explored. This study assists research related to knowledge, perceptions, and precautions students take regarding influenza. It provides two validated, reliable assessment tools for measuring knowledge and perceptions of influenza which can be used in future research, it quantifies misconceptions students have about influenza, and it establishes relationships between knowledge, perceptions, and sociodemographic variables and a range of preventative behaviors, and tests their efficacy in the formation of predictive models. These findings can be used as a guide to the future development of effective interventions in our high schools.

Overview of the Study

This study has three purposes: first, to design and validate assessments of flu knowledge and perceptions; second, to explore how flu knowledge, social background, and demographic variables correlate with student health and mitigation behaviors, and how mitigation behaviors correlate with each other; and third, to test the efficacy of these variables as predictors for behavior and illness. The following research questions were addressed:

1. What do students know about influenza transmission and management?
2. What is the relationship of student knowledge, social background, and demographic variables to ability and/or willingness to take measures to protect oneself and others from influenza?
3. What is the relationship of student knowledge, social background, and demographic variables to the probability of getting sick with influenza?
4. What are the best predictors of each precaution and illness, and how do they impact the model?
5. Can reported precautionary behavior, student knowledge, social background, and demographic variables be used effectively to predict behavior and illness?

Items for the AUI assessment were developed based on themes from the literature on flu misconceptions, while those for the SOBER were developed with respect to the Health Belief Model (Rosenstock, 1966). Outcome behaviors assessed were those deemed important by the CDC (2009) for flu mitigation. Content validity of items was established through a review by a panel of five experts, all of whom had a background in infectious disease, including physicians and researchers. Face validity was established through a review by five former secondary science teachers, and through linking items to Missouri's Health Education GLE's and Biology CLE's. Items on the pilot versions of the AUI and SOBER were clustered based on extracted themes through full information factor analysis, and construct validity of items in each theme was established under the Rasch paradigm.

A pilot test of the AUI and SOBER instruments included 205 students enrolled in grades 9-12 in a rural school district. Instruments were modified based on pilot results. Data were then collected from 410 students enrolled in grades 9-12 from five school districts. Three large, urban schools were sampled, with 29, 186, and 25 participants, respectively. One small, rural school was sampled for a total of 16 participants. One hundred students from a medium-sized school, and 54 students from a large, suburban school also participated.

Construct validity was established with respect to the Rasch model in two ways: (1) fit of the item characteristic curve was compared to the ideal characteristic curve defined by the Rasch model to verify that each item appropriately measured and discriminated between high and low ability students; (2) difficulty scores for items were calculated and compared to the distribution of student ability scores to verify that theme difficulties were appropriate for high school students. Internal consistency of items in each theme served as the definition of reliability used in this study, for which Chronbach's alpha was the measure.

Confirmatory factor analysis (CFA) via structural equation modeling was used to test the structure of the final assessment against the structure derived from pilot data, and Chronbach's alpha was calculated for items belonging to each theme. The two-parameter logistic model from IRT was used to calculate ability scores for each theme on the AUI and SOBER, and the k-means algorithm was used to cluster each student into one of five ability domains. Specific responses on the AUI were also observed to identify misunderstandings about influenza by students. Kendall-tau correlations were used to test the null hypotheses at the 95% confidence level that there is no relationship with other precautions, flu knowledge, social background, and demographics, and multinomial logistic regression was used to find the best predictors and possible interactions in each case. Correlates significant at the $\alpha = 0.05$ level of significance or higher were used as inputs in neural network predictive models for taking precautions, sickness severity, and contraction of influenza. Level of association between actual and predicted outcomes was measured with the Kendall-tau correlation statistic, and classification tables were used to evaluate the percentage of correct predictions at each level of compliance or illness.

Conclusions

On the basis of the data, assumptions, analyses, and limitations, the following conclusions can be made:

1. The AUI measures reliable scores for knowledge of flu transmission and management for high school students based on Missouri's Health Education GLE's and Biology CLE's.
2. The reliability of the SOBER assessment is acceptable for collecting data which will be treated categorically (Schmidt, 1996).
3. Students hold misconceptions related to influenza transmission and management related to the vaccination and when influenza is contagious.
4. Students reporting recent past experience with flu-like symptoms are more likely to get vaccinated.
5. Constructs measured by the AUI are significantly related to students' preventative practices. Students with higher knowledge of flu transmission are more likely to practice good respiratory etiquette, but less likely to use hand sanitizers, and students with better knowledge of flu management are more likely to get vaccinated, wash hands frequently, and practice good respiratory etiquette.
6. Constructs measured by the SOBER are significantly related to students' preventative practices. Students with higher perceived risk from influenza are more likely to have been sick, and are more likely to get vaccinated. Students with higher perceived complications

from influenza are more likely to stay home when sick and practice personal distancing, and are more likely to have experienced illness. Students with higher perceived barriers against influenza treatment are less likely to take the precautions of vaccination, hand washing, and practicing good respiratory etiquette.

7. Females are more likely to take precautions related to hand sanitation, and to report contracting the common cold and flu.
8. Ethnicity significantly affects willingness to take precautions and experiencing illness with symptoms of the common cold or flu. Black students have decreased likelihood of practicing good respiratory etiquette, but are more likely to use hand sanitizers. White students have greater likelihood of practicing good respiratory etiquette, and decreased likelihood of reporting illness. Asian students are more likely to avoid touching the face with the hands, as are students reporting “other” for their race. Asian students also have decreased likelihood of hand sanitizer use. While Hispanic students do not have differential likelihood for taking precautions, their likelihood of reporting illness is greater.
9. When used in neural network models, statistically significant correlates provide prediction rates better than random chance for illness and most precautions, indicating that data from these assessments can be used to formulate reasonable predictive schemes for behavior and contraction of cold- and flu-like illnesses.

Discussions

The AUI and SOBER Instruments

Two instruments were developed and used in this study, the AUI and the SOBER. The AUI is designed to measure the latent traits of knowledge of influenza transmission and management, and is considered to be the first validated assessment of flu knowledge.

Knowledge related to the flu vaccine was assessed in a study by Martinello, Jones, and Topal (2003), and the CDC (2011) has a true-false online assessment called "Flu IQ." While these assessments are appropriate for their respective uses, lack of information on dimensionality, validity, and reliability makes them unsuitable for measurement of knowledge as a latent trait for research purposes.

The AUI has several advantages for a researcher wishing to measure knowledge of influenza. Multiple choice assessments lend themselves to quick, efficient administration and scoring. Completion of the AUI requires only 10 minutes. The fact that common misconceptions were used as distracters also makes the AUI potentially useful for identifying misunderstandings. However, specific misconceptions can be better assessed through other assessment designs, including multi-tiered tests (Treagust, 1988) and concept inventories. Individual theme reliabilities at above 0.7, and total test reliability of 0.8, indicate relatively high accuracy in measuring each trait. Although no other validated flu assessments exist, similar reliabilities were achieved in a 23-item assessment of diabetes knowledge (Fitzgerald et al., 1998). A 20-item two-tiered test of understanding of Malaria, the MalariaTT2 (Cheong et al., 2010), reported reliabilities above 0.6.

Constructs similar to those in the SOBER have been measured by other researchers in the context of flu vaccination. In investigating the relationship between risk perception and rates of influenza vaccination, Weinstein et al. (2007) developed an assessment to measure beliefs about risk probability, including risk magnitude, beliefs about risk, and feeling at risk, reporting reliabilities between 0.8 and 0.9. In an exploration of the role of sociodemographic factors in the decision to get the flu vaccination, Chen et al. (2007) asked a series of perception questions related to severity of influenza, susceptibility to getting influenza, and barriers to influenza vaccination. Measures of factorization, validity, and reliability were not addressed for the questions developed by Chen et al. Like the SOBER, the assessments by Weinstein et al. and Chen et al. used the Health Belief Model as a central framework. An advantage of the SOBER over other existing instruments is its measurement of perceived risk, complications, and barriers general to the flu, which is potentially useful for researchers wishing to explore motivations for preventative behaviors outside of vaccination.

Although low reliability is a hindrance to accurate measurement, the magnitude of hindrance is often exaggerated—even reliabilities as low as 0.5 do not seriously attenuate validity in an assessment with defined dimensionality and structure (Schmidt, 1996). A decision regarding whether or not to use any instrument, including the SOBER, should not be made exclusively based on its value of alpha. Cortina (1993) argues that researchers who use alpha as a measure of adequacy of a scale are missing the point of the reliability statistic. The appropriate level of alpha depends on the fineness of distinction that needs to be made between scorers (Cortina, 1993). The limitations of the SOBER in making fine distinctions can easily be accounted for through use of clustering techniques or analyzing data categorically instead of continuously.

Limitations of the Instruments and Recommended Use

In light of the unique characteristics of the AUI and SOBER, several factors should be considered by those who wish to use these instruments. The AUI can be characterized as a short multiple choice assessment that reliably measures the continuous latent traits of knowledge of flu transmission and management in high school students. Further, these latent traits can be combined into one "knowledge of flu" latent trait for even higher reliability if a simpler model is sought. IRT statistics show that items measure the appropriate latent trait, and that difficulty of items is appropriate for the high school students in this study. Due to the non-randomized design, this conclusion cannot be generalized to the Midwest in general. Further, the AUI as is may not be suitable for drawing conclusions about students within vastly different cultural backgrounds and levels of education. Due to the wide range of schools sampled, one could reasonably assume items to be culturally valid in the United States. This may not be the case in other countries however. While it is likely that many of these items would be appropriate for other high school and introductory college students, they may be too easy for upper level biology and medical students, and too difficult for students at the elementary and middle school levels. Comparative validity of items and assessment structure for samples outside of the United States high school can be established through CFA or differential item functioning (DIF).

Many recommendations for the AUI also apply to the SOBER. It is likely that the SOBER will be more consistent than the AUI across cultures, ages, and levels of education since perceptions regarding infectious disease and its prevention develop more readily than knowledge, are more resistant to change, and are more uniform across cultures (Curtis & Biran, 2001). However, validity and reliability should still be assessed before using the SOBER to draw conclusions from populations with cultures vastly different from the Midwest, and levels of education outside of secondary. The reliability of the SOBER, while not seriously hindering validity, should be considered during data analysis since attempts to model fine distinctions between students using a metric with moderate reliability may lead to erroneous conclusions. Use of the SOBER is appropriate for studies seeking a categorical treatment of scores for perceived risk, complications, and barriers.

Misconceptions

Three misconceptions about influenza transmission, and one about influenza management, were revealed through analysis of responses on the AUI. The only other study of high school students' misconceptions about influenza is Dumais and Hasni (2009). Dumais and Hasni focus on misconceptions about the makeup of the influenza virus and how it is transmitted. For example, they found the misunderstanding that influenza's surface proteins act like spikes, which open the cell membrane and allow the virus to pass though and that viruses such as influenza attack the immune system. The three misconceptions about influenza transmission in this study relate to how vaccination works, which is unique to this study. These include that the vaccine protects us by giving us antibiotics, that we need a new flu vaccine every year because it wears off over time, and that the vaccine is available only as a shot. The idea that the flu vaccine gives us antibiotics is somewhat consistent with the confusions between viruses and bacteria uncovered by Dumais and Hasni, including that a virus is a cell that contains bacteria, and that viruses divide like bacteria to proliferate. The misconception about influenza management, that one becomes contagious 1-2 days after symptoms occur, is unique to this study in that Dumais and Hasni do not address misconceptions related to management of influenza.

The Role of Knowledge in Mitigation Behavior

A general positive association between knowledge and compliance with flu mitigation was found in this study. Data show that both knowledge of flu transmission and management play a role in improving respiratory etiquette. Knowledge of flu management also associates positively with getting vaccinated and washing hands frequently. The only confounding variable was hand sanitizer use, which appeared to decrease in students with better knowledge of flu transmission.

Studies expressing relationships between knowledge of the flu and preventative behavior are limited, and these are confined primarily to health care settings. In a study of health care workers, Martinello, Jones, and Topal (2003) found that misconceptions about the influenza vaccine played a statistically significant role in refusal of the vaccine among nursing staff. No significant correlation between vaccination and knowledge was found of hospital doctors. Pittet et al. (2000) found a similar effect in regards to hand washing. They describe a knowledge-based intervention where 250 posters describing nosocomial infection, cross transmission, hand carriage and hygiene, and disinfection with creams were posted in a hospital in an attempt to improve hand washing. Through the intervention, they documented significant gains in compliance among nurses and their assistants, but no gains among doctors. A possible reason that knowledge-based interventions are less likely to be effective for doctors is that their decisions for not complying are already informed, and are based on other factors besides knowledge (Martinello, Jones, & Topal, 2003). Failure of knowledge-based intervention strategies to increase compliance in doctors is perhaps analogous to the student population in that interventions focusing on knowledge may be less likely to work with high-achieving, well-informed students and teachers who are well aware of the consequences of particular behaviors, making it necessary to explore other reasons for noncompliance.

The Role of Perceived Risk, Complications, and Barriers

In addition to knowledge, perceptions of risk, complications, and barriers were found to play a large part in certain decisions to comply with preventative practices. Students with high perceived risks were more likely to get vaccinated, which is a finding corroborated by Chen et al.

(2006). Perceived complications from influenza were positively correlated to staying home when sick and practice of personal distancing. The link with willingness to stay home is also found in Kiviniemi et al. (2011). Students reporting recent experience with cold- and flu-like symptoms held these perceptions more strongly. A significant challenge for interventions aiming to raise vaccination rates and social distancing is to heighten perception of risk and complications from influenza before students directly experience the illness. There is no literature linking specific intervention strategies to resulting perceptions of risk and complications from the flu.

Results from this study imply that interventions focusing on factual knowledge are unlikely to be effective in changing many preventative behaviors related to hygiene and social distancing. Meers (2009) suggests a more authentic approach, encouraging students to reflect on different ways that their lives are positively and negatively affected by the flu, including prior illnesses and pandemics that students and their families have experienced, and the impact influenza had on different parts of their lives. For students to understand the risks and complications due to influenza, myths and misconceptions should be addressed in an explicit, authentic way through probing questions like, "What can businesses do to stay competitive during times of excessive absenteeism?" (Meers, 2009, p. 23). Perceived risks and complications can likely be heightened through strategies which focus on student experience as opposed to knowledge alone.

Perceived barriers were a consistent contributor to students choosing not to partake in preventative practices. Students with higher perceived barriers were less likely to take the precautions of vaccination, hand washing, and practice of good respiratory etiquette. A majority of the studies on perceived barriers are confined to the health care community rather than to schools. Kretzer and Larson (1998) and Pittet (2000) cite skin irritation, the belief that hand washing supplies are inaccessible, wearing gloves, "being too busy," and "not thinking about it" as reported barriers in health care workers. Additionally, some report unawareness as a barrier; that some health care workers believed they washed their hands although observations indicated otherwise (Dubbert et al., 1990). Pittet (2000) suggests that efforts to minimize these barriers may be one of the most effective intervention strategies, including providing easy access to skin care lotion and alcohol-based hand rub. Pittet also suggests that addressing self-reported and observed reasons for non-compliance at the individual, group, and institutional levels is necessary to increase compliance. A study by White et al. (2003) shows that a measure as simple as installing hand sanitizers in college dormitories, restrooms, and dining halls significantly improved hand hygiene and reduced rates of illness and absenteeism.

Primary barriers related to vaccination are associated cost (Harbarth et al., 1998), doubts about the efficacy of the vaccine (Nicholson, 1993), belief that the vaccine hurts or is harmful, and that it is inconvenient (Chen et al., 2006, Virseda et al., 2010). As with hand washing, vaccination rates can be improved when reported and observed concerns over getting vaccinated are addressed directly, and efforts are taken to make the vaccine more convenient, including reducing cost and having an on-site vaccination nurse present (Harbarth et al., 1998). Both Pittet (2000) and Harbarth et al. (1998) found that education to improve knowledge is an important intervention strategy to improve hand washing and vaccination, respectively. This finding is corroborated with data from this study, showing knowledge of flu management improves attitude towards vaccination and hand washing frequency.

While studies on what affects compliance with respiratory etiquette are absent, one could reasonably deduce that strategies will be similar to documented efforts to improve hand washing and vaccination. Barriers to practicing effective respiratory etiquette should be addressed directly. Having tissues readily available in classrooms is one measure that would make the practice of respiratory etiquette easier for students. An example of the positive impact of knowledge is explaining that using the shirt sleeve to cover the mouth and nose while sneezing is much safer than using the hands (CDC, 2009). Since a shirt sleeve is more accessible than a tissue in most situations, and is as easy to use as the hands, knowledge of this mitigation procedure may be valuable in helping students reduce this barrier to proper respiratory etiquette.

Sociocultural Impacts

Results from this study indicate that a student's cultural and school environments may have a significant effect on reported mitigation practice. These include gender, ethnicity, and the school which students attend. The effect of gender was significant for hand hygiene; females were significantly more likely to practice proper hand hygiene than males. This finding that females are more likely than males to report and practice effective hand washing was corroborated by Pittet (2000) and the American Society for Microbiology (2000).

In addition to gender, students' ethnic background appeared to play a role in certain behaviors. Black students reported lower respiratory etiquette, but increased use of alcohol-based hand sanitizers. Reports of respiratory etiquette by white students, on the other hand, were significantly higher. Being Asian and "other" was positively correlated with not touching the face, and Asian students appeared less likely to use hand sanitizers than other students. While being Hispanic was positively correlated with illness severity, no other effects were observed.

Ethnographic studies have found that although ideas and objects that people find unhygienic vary slightly from culture to culture, ideas are more alike than different, and possibly originate from instincts for disease prevention that humans have developed through their evolution (Curtis & Biran, 2001). Perhaps this explains why many of the precautions associated with hygiene, such as hand washing, showed little change across cultural categories in this study. Despite this, the concept of what constitutes dirty hands, reasons for washing hands, and attitudes towards alcohol-based hand sanitizers, can vary by a person's religious faith. For Hindu, Buddhist, and Islamic students, the concept of "dirty hands" can extend into the spiritual realm. Further, proximity to alcohol is prohibited by many religions of Asia, including Buddhism, Hinduism, Islam, and Sikhism, which could possibly explain why Asian students were less likely to use alcohol-based hand sanitizers in this study (Allegranzi et al., 2009).

Cultural differences in attitude toward the flu vaccination are documented. Racial and ethnic barriers to the flu vaccination are discussed by Chen et al. (2006) in a study of parishioners in a variety of faith-based congregations. They report that people of Black and Hispanic origin have significantly lower vaccination rates than other ethnic groups. They found that low household income and lack of health insurance were barriers against vaccination for Black and Hispanic households. In addition, the belief that the vaccine causes influenza and other harmful side effects was a significant barrier for Blacks. Hispanics were more concerned with lack of access and high cost of the vaccine (Chen et al., 2006). Despite the documentation of sociocultural impacts on vaccination, none were observed in this study. Perhaps this can be attributed to the homogenization of culture in the schools sampled, or to the fact that the study design did not control for factors such as household income.

School environment had comparatively broad impacts on mitigation behavior in this study. The measures related to social distancing (personal distancing and staying home when sick) and not touching the face were the only precautions unaffected by the school students attended. Students from School 1, which was a large school in a Midwestern college town, reported significantly lower scores on attitude towards vaccination and hand sanitizer use. Lower hand sanitizer use was also reported by students in School 5, a school of similar size to School 1, and in the same city. School 4, a large high school in a medium-sized Midwestern city, and School 3, a small rural located in a small town approximately 20 miles from School 4, also reported lower hygiene practices. Reported respiratory etiquette was also significantly lower in these schools. School 3 was negatively correlated with hand washing quality, and School 4 with hand washing frequency. Comparatively better hand hygiene was reported by School 2, another large high school in a Midwestern college town, having significant positive correlations with hand washing frequency and hand sanitizer use. School 6, a large high school near a metropolitan area in the Midwest, reported significantly higher respiratory etiquette.

These differences between schools can perhaps be expected since the threat of illness and standards for hygiene could differ from community to community. A number of intervention options exist for schools wishing to take measures to reduce the impact of influenza. Establishing hand washing regimens in schools is an important step in increasing compliance with hand washing for younger students (Early et al., 1998). Attitudes towards hygiene and other preventative behaviors can be improved by taking measures to reduce barriers, such as the measure of installing hand sanitizers in places where students frequent (White et al., 2003) and educating students about using their sleeve when they sneeze.

Although efforts to increase hygiene have been shown to reduce transmission, vaccination is the most effective measure that can be taken to significantly reduce cost and absenteeism due to influenza (CDC, 2009; White, Lavoie, & Nettleman, 1999). Given the common barriers of expense and inconvenience, the low cost of the vaccination, and the high cost of student illness and absences to schools (Nichol et al., 1994), the effort of schools to offer the vaccination free of charge via the school nurse may prove to be a lucrative effort to prevent illness and save money.

No effects of school on social distancing were observed in this study indicating that this is an issue common to many schools, and one that has uniformly not been addressed. This study shows that, on average, students' willingness to stay home from school when sick is higher than willingness to keep a safe distance from those who are visibly sick. This finding, coupled with the difficulty of identifying a visibly sick person, indicates that the best option for encouraging social distancing is indeed encouraging students to stay home when they are sick. Easily implemented incentives may include not penalizing students for absence and not rewarding perfect attendance. Encouraging and enforcing social distancing is complex, however, due to social incentives students have which are more out of the schools' control, including spending time with friends and access to free or reduced meals (Blendon et al., 2008). Further, parents often have the incentive of free child care, and not having to take off work, in sending sick students to school. Addressing these issues in an ethical manner presents a significant challenge for school systems wishing to improve social distancing.

Recommendations for School Health Programs

The relationship of knowledge and perceptions of the flu, and sociodemographic variables, is well-established through the results of this study as well and those undertaken within the health care setting. These imply several recommendations for health care coordinators, administrators, and teachers who wish to implement interventions seeking to improve students' ability and willingness to comply with preventative measures against influenza. First, since knowledge of the flu appears to play an important role in willingness to get vaccinated and wash hands, but not other precautions, knowledge should be a focus only if vaccination and hand washing are the target behaviors. Further, the literature implies that factual knowledge-based interventions are most effective for students coming into the intervention with lower levels of prior knowledge. Explicit reflective teaching strategies using probes related to how influenza directly affects students' lives (Meers, 2009) will likely improve the effectiveness of all knowledge-based interventions, especially for higher achieving students.

Interventions seeking to improve vaccination rates can be enhanced through emphasis on the specific risks influenza poses to students as well as measures to eliminate barriers against being vaccinated. Relatively easy measures may include reducing the cost of the vaccination or supplying it free of charge, and having the vaccine visibly and readily available to students at any time throughout the flu season. Similarly, attempts to reduce barriers against hand hygiene and respiratory etiquette are necessary to increase compliance with these practices, including having alcohol-based hand sanitizers and tissues readily available to students. Although knowledge of flu transmission and management was shown to have negligible effect on social distancing, increasing students' perceptions of complications due to influenza through reflection probes and case studies focusing on the potential severity of the disease to students, their friends, and their families, may increase compliance with social distancing. Schools wishing to promote personal distancing at school and staying home when sick should also implement flexible policies regarding attendance and assignment due dates. Finally, sociodemographic factors need to be considered when designing interventions. For example, males should be targeted in interventions designed to improve hygiene, and students' religious beliefs should be considered and addressed before installing hand sanitizers in schools with a significant number of Asian students. Lastly, reported barriers, especially lack of money and misconceptions about the danger of the vaccine, should be considered and addressed before implementation of interventions that strongly encourage vaccination.

Recommendations for Future Studies

A goal of future studies may be to explore how the SOBER and AUI can be adapted to different settings. For example, the accuracy of the SOBER, with reliabilities between 0.6 and 0.7, is appropriate for measurement of perceptions provided the lower accuracy is taken into account through categorical treatment. If fine distinctions need to be made between students, the reliability of the SOBER will need to be improved while retaining its structural validity. This can be done through adding and piloting new items related to perceived risk, complications, and barriers. Future studies can also explore different adaptations for the AUI. For example, the AUI can be modified into a concept inventory focusing on measuring misconceptions related to influenza, and the existence of knowledge traits outside of flu transmission and management can be explored via development and piloting of a larger bank of potential items. With regards to both assessments, researchers may wish to test their validity in measuring knowledge and perceptions in different cultures and academic levels.

Use of these instruments in the college population may be useful since mitigation of illness is also an important challenge at this level. The college environment is unique in that the student population is very diverse, with a wide range of interests and knowledge backgrounds. Using the AUI and SOBER to find distinctions between science versus non-science majors, and pre-med versus non pre-med majors would be instructive, and may prove informative to a university's efforts to target interventions. Understanding influenza knowledge and perceptions of education majors may also be informative since these students will eventually be working with students in our schools, encountering the school health issues that accompany.

This study quantified how knowledge, perception, and sociodemographic variables relate to preventative behavior. The next step is exploring specific reasons behind these relationships, which could possibly be addressed through case study designs. A number of questions are raised. What aspects affect proneness of certain cultures to engage in certain preventative practices, but not others? What aspects of a student's school environment encourage or inhibit practice of certain preventative behaviors? How does the structure of a students' community outside of school encourage or inhibit practice of certain preventative behaviors?

Researchers should also consider using the AUI and SOBER to evaluate the effect of different types of instruction on knowledge and perceptions related to influenza. For example, the impact of instruction can be assessed in a pre-post, delayed-post fashion, and repeated measures analysis of variance (ANOVA) or hierarchical linear modeling (HLM) can be used to evaluate the effect of the instruction on students over time. Further, since the influenza season is demarcated by certain time boundaries (December through April) throughout the year, it may be worth exploring whether time of year that instruction happens makes a significant impact on the effectiveness of the instruction. One may expect that delivering instruction amidst the authentic backdrop of the flu season may increase its effectiveness.

Results of experiments described above can further inform the design and implementation of influenza-related instruction and intervention efforts for high school students. Findings from this study are valuable for curriculum and intervention development given that the most successful curriculum/intervention efforts tend to be well-tailored to the culture of the target student body (Wallace & Louden, 1992; Shepard, 2000). Studies about knowledge and behavior deficits, and how students perceive influenza, will be essential to developing successful curricular interventions. Findings from this study open up several possibilities for future research related to assessment as well as the effects of knowledge and social background on preventative practice related to influenza and other infectious diseases.

Appendix A

Items on the Student Influenza Survey pilot, with Coding Schemes and Links Missouri’s Health Education GLE’s and Biology CLE’s

Student Influenza Survey Pilot

This survey is intended to measure your awareness of and responses to the risk of influenza. The information you provide may be used to develop better health education for students.

DO NOT write your name on this survey. The answers you give will be kept private. No one will know what you write. The questions that ask about your background will be used only to describe the types of students completing this survey. The information will not be used to find out your name. No names will ever be reported.

Make sure to read every question carefully. Circle or check the answers completely. Answer the questions honestly, based on your knowledge and experience. This survey is optional. Whether or not you answer the questions will not affect your grade. When you are finished, turn it in to your teacher or instructor.

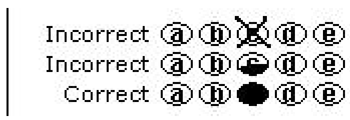
Thank you very much for your help.

Before you take this test, make sure you:

1. Fill in the bubble corresponding to your grade on the “GRADEorEDUC” column.
2. Fill in the bubble corresponding to your gender on the “SEX” column (M = male; F = female).
3. DO NOT put your name on the bubble sheet.
4. Leave “BIRTHDATE,” “IDENTIFICATION NUMBER,” and “SPECIAL CODES” blank.

While marking on this test, make sure you:

1. Use a #2 pencil. DO NOT use ink or ballpoint pen.
2. Make heavy, black marks that fill in the circle completely.



3. Don’t make any stray marks on the answer sheet.
4. Cleanly erase any answer you wish to change.

While reading through this test, make sure you:

5. Read each question carefully and answer it honestly based on your experience and beliefs.
6. Make your best guess if you don’t know the answer to a question.
7. Fill in the correct bubble for the question you are on and the answer you are selecting.

1: Influenza Mitigation Behavior Survey (IMBS)

This section will be scored polytomously (score = 1,2,3,4,5 based on quality of practice reported. Response order is randomized. Coding is described below each question)

Please select the statement that you agree with the most. (GLE's: Personal Health, Preventative Care, Decision Making and Problem Solving)

1. Which statement best describes how you feel about the flu vaccine?
a. I will never be vaccinated for the flu no matter what.
b. I will only get the flu vaccine in the event of a serious outbreak.
c. I try to get the flu vaccine most years, but sometimes it's not convenient.
d. I make sure to get vaccinated against the flu every year.
e. I've had the flu vaccine before, but don't get it now.

This question will be scored (a = 1, b = 2, c = 4, d = 5, e = 3)

2. Which statement best describes how you wash your hands?
a. I wash my hands by rubbing them on my clothes or a dry towel or tissue.
b. I wash my hands by soaping them for a second or two and rinsing.
c. I wash my hands by making sure they are covered with soap, rubbing them together for 15 to 20 seconds and then rinsing
d. I wash my hands by with water—I normally don't use soap.
e. I wash my hands by making sure they are completely covered with soap and rubbing them together for a few seconds, and then rinsing.

This question will be scored (a = 1, b = 3, c = 5, d = 2, e = 4)

3. Which statement best describes how you wash your hands?
a. I wash my hands greater than 6 times per day
b. I wash my hands one or two times per day
c. I seldom wash my hands.
d. I wash my hands 3 or 4 times per day
e. I wash my hands 5 or 6 times per day

This question will be scored (a = 5, b = 2, c = 1, d = 3, e = 4)

4. When I see a sick person at school,
a. Since the person chose to come to school, I talk them like any other student.
b. I make sure to keep a safe distance from the student, to avoid touching the things he/she touches, and to wash my hands between each class.
c. I often talk with that person to offer support because they are sick.
d. I ask the teacher so I can move so I don't get coughed or sneezed on.
e. I try to keep a distance from him/her because I don't want to get sick.

This question will be scored (a = 2, b = 5, c = 1, d = 4, e = 3)

5. Of the following actions (rubbing my nose and eyes, biting my fingernails, resting my head in my hand or on the desk, and chewing on my pencil):
a. I do one or more of these multiple times per day.
b. I do one or more of these almost all the time.
c. I rarely do any of these.
d. I do one or more of these most days, but not all the time.
e. I do one or more of these occasionally during the week, but not every day.

This question will be scored (a = 2, b = 1, c = 5, d = 3, e = 4)

6. When I cough or sneeze
a. I usually cover my mouth with my hand.
b. I usually cover my mouth with a tissue or handkerchief that I have in my pocket.
c. I usually cover my mouth with my shirt sleeve or a tissue that I throw away after sneezing.
d. I seldom cover my mouth, but try to turn my head away from people around me.
e. I seldom cover my mouth.

This question will be scored (a = 3, b = 4, c = 5, d = 2, e = 1)

7. When I have symptoms of the flu, such as coughing, sneezing, body aches, and fever,
a. I almost always go to school when I am sick, but I tell people to stay away from me
b. I almost always stay home when sick.
c. I stay home from school when I am sick unless I have a very important reason to attend.
d. I almost always go to school when I am sick and socialize with my friends
e. I go to school if I have the minor symptoms, such as coughing and sneezing, because these don't interfere too much with my studies.

This question will be scored (a = 2, b = 5, c = 4, d = 1, e = 3)

8. When I am in a building with hand sanitizers available,
a. Whenever I walk past a hand sanitizer, I use it.
b. I use them one or more times per week.
c. I seldom use them.
d. I use them once a day
e. I use them multiple times per day

This question will be scored (a = 5, b = 2, c = 1, d = 3, e = 4)

2: Survey of Background, Experience, and Risk (SOBER)

This section will be scored polytomously (score = 1,2,3,4,5 based on degree adherence to the measured trait.)

9. Please select the statement that best defines your family's experience with the flu.
a. Nobody in my family has been sick with the flu.
b. Someone in my family had the flu once that I can remember, but not more than that
c. Someone in my family is sick with the flu occasionally, but not every year.
d. Someone in my family is sick with the flu at least once a year.
e. Multiple people in my family become sick with the flu each year.

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

10. Please select the statement that best defines your personal experience with the flu.
a. I have never gotten sick with the flu.
b. I've had the flu once, but not more than that.
c. I get sick with the flu occasionally, but not every year.
d. I usually get sick with the flu once a year.
e. I get sick with the flu multiple times per year.

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

11. The flu can cause severe complications in some individuals. I feel that the risk of the flu causing severe complications for one or more of my family members is:
a. Very High
b. High
c. Low
d. Very Low
e. Zero

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

12. The flu can cause severe complications in some individuals. I feel that the risk of the flu causing severe complications for myself is:
a. Very High
b. High
c. Low
d. Very Low
e. Zero

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

13. I feel my risk of becoming sick with the flu is
a. Very High
b. High
c. Low
d. Very Low
e. Zero

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

14. How effective is the flu vaccine is at preventing the flu?
a. The flu vaccine does not prevent the flu.
b. The flu vaccine very rarely works to prevent the flu.
c. The flu vaccine sometimes works to prevent the flu.
d. The flu vaccine works most of the time to prevent the flu.
e. The flu vaccine always works to prevent the flu.

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

15. It is easy for me to get the flu vaccine.
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

16. Vaccines such as the flu shot are bad for me, and can cause severe repercussions.
a. Almost always
b. Often
c. Sometimes
d. Rarely
e. Almost never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

17. The money it costs to get the flu vaccination prevents me from wanting to get it.
a. Almost always
b. Often
c. Sometimes
d. Rarely
e. Almost never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

18. I don’t want to get the flu vaccine because I am afraid of shots.
a. Almost always
b. Often
c. Sometimes
d. Rarely
e. Almost never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

19. How effective at preventing the flu is washing hands with soap?
a. Hand washing does not work to prevent the flu.
b. Hand washing very rarely prevents the flu.
c. Hand washing sometimes prevents the flu.
d. Hand washing prevents the flu most of the time.
e. Hand washing always prevents the flu.

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

20. It is easy for me to wash my hands.
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

21. How effective at preventing the flu are hand sanitizers?
a. Hand sanitizers not prevent the flu.
b. Hand sanitizers very rarely prevent the flu.
c. Hand sanitizers sometimes prevent the flu.
d. Hand sanitizers prevent the flu most of the time.
e. Hand sanitizers always prevent the flu.

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

22. Hand sanitizers are accessible and easy to use
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

23. How effective in preventing the flu is keeping hands away from your eyes, nose, and mouth?
a. Keeping hands away does not prevent the flu.
b. Keeping hands away very rarely prevents the flu.
c. Keeping hands away sometimes prevents the flu.
d. Keeping hands away prevents the flu most of the time.
e. Keeping hands away always prevents the flu.

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

24. It is difficult for me to keep my hands away from my eyes, nose, and mouth.
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

25. How effective is staying away from people who are coughing and sneezing at preventing the flu?
a. Staying away does not work to prevent the flu.
b. Staying away very rarely works to prevent the flu.
c. Staying away sometimes works to prevent the flu.
d. Staying away works most of the time to prevent the flu.
e. Staying away always works to prevent the flu.

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

26. Staying away from people who are coughing and sneezing is difficult for me to do.
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

27. I have no control over whether or not I get the flu.
a. Strongly disagree
b. Disagree
c. I am not sure
d. Agree
e. Strongly agree

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

28. The actions I take can prevent others from getting the flu.
a. Strongly disagree
b. Disagree
c. I am not sure
d. Agree
e. Strongly agree

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

29. When a friend or family member gets sick, I often don't know what to do.
a. Strongly disagree
b. Disagree
c. I am not sure
d. Agree
e. Strongly agree

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

30. When I get sick, I am good at taking care of myself.
a. Strongly disagree
b. Disagree
c. I am not sure
d. Agree
e. Strongly agree

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

31. My parents put a lot of pressure on me to stay healthy.
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

32. I am worried that getting sick will negatively affect my school work.
a. Almost always
b. Often
c. Sometimes
d. Rarely
e. Almost never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

33. If I didn't clean my hands, cover my mouth when I cough, or get vaccinated, my friends would remind me to do so.
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

34. When I get sick and fall behind on work, I am concerned that my teachers will feel disappointed.
a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

This question will be scored (a = 5, b = 4, c = 3, d = 2, e = 1)

35. What is your age?
a. 15 or under
b. 16
c. 17
d. 18
e. Over 18

This question will be scored (a = 15, b = 16, c = 17, d = 18, e = 19)

36. What is your gender?
a. Male
b. Female

This question will be scored (a = 0; b = 1)

37. How many health professionals do you have in your immediate family?
a. None
b. 1
c. 2
d. 3
e. More than 3

This question will be scored (a = 0, b = 1, c = 2, d = 3, e = 4)

38. Please select the statement that best defines your ethnicity
a. African American (Black)
b. Caucasian (White)
c. Asian
d. Hispanic
e. Other

This question will be scored (a = 1, b = 2, c = 3, d = 4, e = 5)

3: Assessment of Understanding of Influenza (AUI)

These questions will be scored dichotomously (0 = incorrect; **1 = correct**). Correct answers to each question are in **BOLD**.

Please choose the best answer to each of the following questions.

39. A flu strain is least likely to infect you when (GLE's: Body Defenses and Recovery, CLE's: Strand 3)
a. **you have been previously exposed to that strain.**
b. you have no physical injuries.
c. you have not been exposed to that strain.
d. you spend time with family and friends.
e. you stay inside, out of the cold.

40. Ways that influenza is transmitted include (GLE's: Preventative Care, Types of Pathogens and Transmission, CLE's: Strand 3)
a. eating undercooked chicken or pork.
b. getting mosquito bites.
c. getting the flu shot.
d. going outside in cold, wet weather.
e. **contact with droplets of saliva from a nearby person who coughs or sneezes.**

41. What effect does population density have on the spread of the influenza virus? (GLE's: Types of Pathogens and Transmission, CLE's: Strand 3)
a. Influenza spreads most easily when there are fewer people in an area.
b. **Influenza spreads most easily when there are a lot of people in an area.**
c. Number of people in an area has no effect on the ease at which influenza spreads.
d. Influenza has a hard time spreading when there are a lot of people in an area.
e. Number of people in an area has a small, but almost negligible effect on the spread of influenza.

42. When is a person infected with the flu contagious? (GLE's: Types of Pathogens and Transmission, Preventative Care, Body Defenses and Recovery, CLE's: Strand 3)
a. A person becomes contagious 5-7 days before symptoms occur.
b. A person becomes contagious 1-2 days after symptoms occur.
c. A person becomes contagious up to two weeks after symptoms occur.
d. A person becomes contagious up to 2 days after getting the flu vaccine.
e. **A person becomes contagious as soon as symptoms occur.**

43. The flu vaccination protects us from the flu by (GLE's: Personal Health, Preventative Care)
a. reducing our body temperature.
b. giving us antibiotics which will protect us from the flu.
c. **giving us killed flu, which causes us to produce antibodies**.
d. giving us a substance that is harmless to us but toxic to the flu.
e. improving our nutrition.

44. Getting the flu vaccine while infected with the flu (GLE's: Preventative Care)
a. works sometimes to reduce symptoms
b. works sometimes to reduce duration of infection
c. reduces the severity of symptoms, but doesn't reduce duration of infection
d. **does not work to reduce symptoms or duration of infection**
e. reduces the duration of infection

45. This year's flu vaccine is (GLE's: Preventative Care, Consumer Rights and Issues, Decision Making and Problem Solving)
a. generally only available to doctors, nurses, and people who work close to diseases.
b. generally only available to young children or elderly people who are at greater risk for flu
c. **generally available for anyone who wants it**
d. generally available, but costs hundreds of dollars.
e. Is not available to anyone.

46. The reason we must get a flu shot every year is that (GLE's: Lymphatic-Immune System, Body Defenses and Recovery, CLE's: Strand 4)
a. the vaccine wears off over time, so we must get a booster each year for it to be effective.
b. the flu inside our cells develops immunity to the vaccine.
c. our body slowly gets rid of the vaccine
d. every time we get sick, its effect gets a little bit weaker
e. **the flu virus mutates every year, and so new vaccines have to be developed**

47. Which statement best describes the flu vaccine? (GLE's: Preventative Care, Lymphatic-Immune System)
a. The vaccine can make us sick with the flu.
b. The vaccine often causes problems with the nervous system.
c. The vaccine prevents us from getting colds.
d. **The vaccine only gives us immunity against the flu strains contained in the vaccine.**
e. The vaccine many side effects.

48. At most clinics, the cost of the influenza vaccine is: (GLE's: Consumer Rights and Issues, Decision Making and Problem Solving)

a. 10-30 dollars
b. 30-50 dollars
c. 50-70 dollars
d. 70-90 dollars
e. Over 100 dollars.

49. The flu vaccine is developed from (GLE's: Preventative Care, Community Services)

a. last year's flu strains
b. antibiotics
c. **the top three flu strains scientists expect to see in the coming year**
d. the most dangerous flu strains
e. antiviral medications

50. Which statement best explains the function of antibodies? (GLE's: Lymphatic-Immune System, CLE's: Strand 3)

a. Antibodies consume the influenza infection.
b. **Antibodies prevent the infection from binding and entering your cells and reproducing.**
c. Antibodies encourage the infection to exit your body.
d. Antibodies raise the temperature of your body, which helps fight the infection.
e. Antibodies encourage you to cough and sneeze.

51. The flu vaccine is available as (GLE's: Decision Making and Problem Solving, Preventative Care, Community Services)

a. A pill
b. A shot
c. A nasal spray
d. Both a and b
e. **Both b and c**

52. The flu strains are named by (GLE's: Types of Pathogens and Transmission)

a. the proteins they contain.
b. their size.
c. the cells they infect.
d. the first person they infect.
e. the vaccine that is used.

53. Which statement best describes influenza? (GLE's: Types of Pathogens and Transmission)
a. **Influenza is a micro-organism smaller than a bacterium.**
b. Influenza is a protein larger than a bacterium.
c. Influenza is a parasitic animal.
d. Influenza is a cell that contains bacteria.
e. Influenza is a bacterium that attacks our immune system.

54. The flu reproduces by (GLE's: Types of Pathogens and Transmission, CLE's: Strand 3, Strand 4)
a. dividing into pieces.
b. distributing spores throughout the body.
c. asexual reproduction.
d. **using the cell's protein reproductive mechanisms.**
e. sexual reproduction.

55. Influenza primarily attacks the (GLE's: Personal Health, Types of Pathogens and Transmission, CLE's: Strand 3)
a. digestive system
b. **respiratory system**
c. nervous system
d. circulatory system
e. skeletal system

How often do the following symptoms occur in healthy adults who have the flu (questions 55-63)? (GLE's: Personal Health, Body Defenses and Recovery, Communicable vs. Non-communicable Diseases, CLE's: Strand 3)

56. High fever (greater than 100 deg F)
a. **Most of the time**
b. Sometimes
c. Very rarely

57. Dry cough
a. **Most of the time**
b. Sometimes
c. Very rarely

58. Thick mucous from nasal passages.
a. Most of the time
b. Sometimes
c. **Very rarely**

59. Stomach aches and vomiting
a. Most of the time
b. Sometimes
c. **Very rarely**

60. Sore throat
a. **Most of the time**
b. Sometimes
c. Very rarely

61. Body aches
a. **Most of the time**
b. Sometimes
c. Very rarely

62. Headache
a. **Most of the time**
b. Sometimes
c. Very rarely

63. Diarrhea
a. Most of the time
b. Sometimes
c. **Very rarely**

64. Onset of symptoms within a few hours.
a. **Most of the time**
b. Sometimes
c. Very rarely

65. Which condition below is a potentially serious complication of influenza? (GLE's: Personal Health, Body Defenses and Recovery, Communicable vs. Non-communicable Diseases, CLE's: Strand 3)
a. Ear infection
b. **Pneumonia**
c. Extreme sinus congestion
d. Dehydration
e. Digestive problems

66. The best way to avoid getting sick with the flu is (GLE's: Preventative Care, Decision Making and Problem Solving)
a. **to wash your hands regularly.**
b. to wear plenty of clothes when you go outside.
c. to take a shower everyday.
d. to stay dry.
e. to stay inside.

67. Which of the following is NOT effective for preventing the spread of flu? (GLE's: Preventative Care, Decision Making and Problem Solving)
a. Washing hands with soap after sneezing or coughing.
b. **Covering your mouth with your hand when you sneeze or cough.**
c. Avoiding touching your eyes and nose.
d. Not going to school if you have flu symptoms.
e. Sneezing into your shirt sleeve.

68. Which of the following is NOT effective at eliminating the flu from your hands? (GLE's: Preventative Care, Decision Making and Problem Solving)
a. Alcohol-based foam hand sanitizers.
b. Alcohol-based gel hand sanitizers.
c. Soap and water.
d. **Warm water.**
e. Alcohol-based towelettes.

69. During hand washing, the Center for Disease Control (CDC) recommends (GLE's: Preventative Care, Decision Making and Problem Solving, Community Services)
a. covering your hands with soap, and rinsing them completely.
b. **covering your hands with soap and washing them for 15-20 seconds.**
c. covering your hands with soap and washing them for 5 minutes.
d. putting your hands under fast moving water so it rinses off the flu.
e. using really hot water, which will kill influenza.

Circle the best description of the effectiveness of the following treatments for influenza. (GLE's: Decision Making and Problem Solving, Communicable vs. Non-communicable Diseases, Body Defenses and Recovery)

70. Taking antibiotics within 24-48 hours of onset of flu symptoms
a. **does not work to reduce symptoms or duration of the flu.**
b. reduces the severity of symptoms, but doesn't reduce duration of the flu.
c. reduces the duration and symptoms of the flu.

71. Taking antiviral medications such as Tamiflu and Relenza within 24-48 hours of onset of flu symptoms
a. does not work to reduce symptoms or duration of the flu.
b. reduces the severity of symptoms, but doesn’t reduce duration of the flu.
c. **reduces the duration and symptoms of the flu.**

72. Staying home from work or school and getting rest.
a. does not work to reduce symptoms or duration of the flu.
b. **reduces the severity of symptoms, but doesn’t reduce duration of the flu.**
c. reduces the duration and symptoms of the flu.

73. Taking decongestant medications such as Sudafed
a. does not work to reduce symptoms or duration of the flu.
b. **reduces the severity of symptoms, but doesn’t reduce duration of the flu.**
c. reduces the duration and symptoms of the flu.

74. Taking fever reducing and pain relieving medications such as Tylenol or Ibuprofin
a. does not work to reduce symptoms or duration of the flu.
b. **reduces the severity of symptoms, but doesn’t reduce duration of the flu.**
c. reduces the duration and symptoms of the flu.

75. Taking zinc supplements
a. **does not work to reduce symptoms or duration of the flu.**
b. reduces the severity of symptoms, but doesn’t reduce duration of the flu.
c. reduces the duration and symptoms of the flu.

76. Taking Vitamin C
a. **does not work to reduce symptoms or duration of the flu.**
b. reduces the severity of symptoms, but doesn’t reduce duration of the flu.
c. reduces the duration and symptoms of the flu.

Appendix B

The Student Influenza Survey Final Assessment

Student Influenza Survey Final

This survey is intended to measure your awareness of and responses to the risk of influenza.

The information you provide may be used to develop better health education for students.

DO NOT write your name on this survey. The answers you give will be kept private. No one will know what you write. The questions that ask about your background will be used only to describe the types of students completing this survey. The information will not be used to find out your name. We will not know your names, or who took the test. No names will ever be reported.

Make sure to read every question carefully. Circle or check the answers completely. Answer the questions honestly, based on your knowledge and experience. This test is optional. Whether or not you answer the questions will not affect your grade. When you are finished, turn it in to your teacher or instructor.

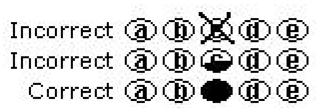
Thank you very much for your help.

Before you begin, make sure you:

1. DO NOT put your name on the bubble sheet.
2. Leave “BIRTHDATE,” “IDENTIFICATION NUMBER,” “SEX,” “GRADEorEDUC” and “SPECIAL CODES” blank.

While marking on this survey, make sure you:

1. Use a #2 pencil. DO NOT use ink or ballpoint pen.
2. Make heavy, black marks that fill in the circle completely.



3. Don’t make any stray marks on the answer sheet.
4. Cleanly erase any answer you wish to change.

While answering, make sure you:

1. Read each question carefully and answer it honestly based on your experience and beliefs.
2. Make your best guess if you don’t know the answer to a question.
3. Fill in the correct bubble for the question you are on and the answer you are selecting.

IMBS:

For questions 1-25, please select the statement that you agree with the most.

1. Which statement best describes how you feel about the flu vaccine?
a. I will never be vaccinated for the flu no matter what.
b. I will only get the flu vaccine in the event of a serious outbreak.
c. I try to get the flu vaccine most years, but sometimes it's not convenient.
d. I make sure to get vaccinated against the flu every year.
e. I've had the flu vaccine before, but don't get it now.

Scoring: a = 1, b = 2, c = 4, d = 5, e = 3

2. Which statement best describes how you wash your hands?
a. I wash my hands by rubbing them on my clothes or a dry towel or tissue.
b. I wash my hands by soaping them for a second or two and rinsing.
c. I wash my hands by making sure they are covered with soap, rubbing them together for 15 to 20 seconds and then rinsing
d. I wash my hands by rinsing them with water—I normally don't use soap.
e. I wash my hands by making sure they are completely covered with soap and rubbing them together for a few seconds, and then rinsing.

Scoring: a = 1, b = 3, c = 5, d = 2, e = 4

3. Which statement best describes how you wash your hands?
a. I wash my hands greater than 6 times per day
b. I wash my hands one or two times per day
c. I seldom wash my hands.
d. I wash my hands 3 or 4 times per day
e. I wash my hands 5 or 6 times per day

Scoring: a = 5, b = 2, c = 1, d = 3, e = 4

4. When I see a sick person at school,
a. Since the person chose to come to school, I talk them like any other student.
b. I make sure to keep a safe distance from the student, to avoid touching the things he/she touches, and to wash my hands between each class.
c. I often talk with that person to offer support because they are sick.
d. I ask the teacher so I can move so I don't get coughed or sneezed on.
e. I try to keep a distance from him/her because I don't want to get sick.

Scoring: a = 2, b = 5, c = 1, d = 4, e = 3

5. Of the following actions (rubbing my nose and eyes, biting my fingernails, resting my head in my hand or on the desk, and chewing on my pencil):
a. I do one or more of these multiple times per day.
b. I do one or more of these almost all the time.
c. I rarely do any of these.
d. I do one or more of these most days, but not all the time.
e. I do one or more of these occasionally during the week, but not every day.

Scoring: a = 2, b = 1, c = 5, d = 3, e = 4

6. When I cough or sneeze
a. I usually cover my mouth with my hand.
b. I usually cover my mouth with a tissue or handkerchief that I have in my pocket.
c. I usually cover my mouth with my shirt sleeve or a tissue that I throw away after sneezing.
d. I seldom cover my mouth, but try to turn my head away from people around me.
e. I seldom cover my mouth.

Scoring: a = 3, b = 4, c = 5, d = 2, e = 1

7. When I have symptoms of the flu, such as coughing, sneezing, body aches, and fever,
a. I almost always go to school when I am sick, but I tell people to stay away from me.
b. I almost always stay home when sick.
c. I stay home from school when I am sick unless I have a very important reason to attend.
d. I almost always go to school when I am sick and socialize with my friends.
e. I go to school if I have the minor symptoms, such as coughing and sneezing, because these don't interfere too much with my studies.

Scoring: a = 2, b = 5, c = 4, d = 1, e = 3

8. When I am in a building with hand sanitizers available,
a. Whenever I walk past a hand sanitizer, I use it.
b. I use them one or more times per week.
c. I seldom use them.
d. I use them once a day.
e. I use them multiple times per day.

Scoring: a = 5, b = 2, c = 1, d = 3, e = 4

SOBER:

Factor 1—Perceived Risk of Becoming Sick

9. Please select the statement that best defines your family's experience with the flu.

a. Nobody in my family has been sick with the flu.
b. Someone in my family had the flu once that I can remember, but not more than that
c. Someone in my family is sick with the flu occasionally, but not every year.
d. Someone in my family is sick with the flu at least once a year.
e. Multiple people in my family become sick with the flu each year.

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

10. Please select the statement that best defines your personal experience with the flu.

a. I have never gotten sick with the flu.
b. I've had the flu once, but not more than that.
c. I get sick with the flu occasionally, but not every year.
d. I usually get sick with the flu once a year.
e. I get sick with the flu multiple times per year.

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

11. I feel my risk of becoming sick with the flu is

a. Very High
b. High
c. Low
d. Very Low
e. Zero

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

Factor 2—Perceived Complications

12. The flu can cause severe complications in some people. I feel that the risk of the flu causing severe complications for one or more of my family members is:

a. Very High
b. High
c. Low
d. Very Low
e. Zero

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

13. The flu can cause severe complications in some people. I feel that the risk of the flu causing severe complications for myself is:

a. Very High
b. High
c. Low
d. Very Low
e. Zero

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

14. The money it costs to get the flu vaccination prevents me from wanting to get it.

a. Almost always
b. Often
c. Sometimes
d. Rarely
e. Almost never

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

Factor 3—Perceived Barriers to Prevention

15. Vaccines such as the flu shot are bad for me, and can cause severe repercussions.

a. Almost always
b. Often
c. Sometimes
d. Rarely
e. Almost never

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

16. How effective at preventing the flu is washing hands with soap?

a. Hand washing does not work to prevent the flu.
b. Hand washing very rarely prevents the flu.
c. Hand washing sometimes prevents the flu.
d. Hand washing prevents the flu most of the time.
e. Hand washing always prevents the flu.

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

17. It is easy for me to wash my hands.

a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

18. How effective at preventing the flu are hand sanitizers?

a. Hand sanitizers do not prevent the flu.
b. Hand sanitizers very rarely prevent the flu.
c. Hand sanitizers sometimes prevent the flu.
d. Hand sanitizers prevent the flu most of the time.
e. Hand sanitizers always prevent the flu.

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

19. Hand sanitizers are accessible and easy to use

a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

20. Staying away from people who are coughing and sneezing is difficult for me to do.

a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

21. My parents put a lot of pressure on me to stay healthy.

a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

Scoring: a = 5, b = 4, c = 3, d = 2, e = 1

Factor 4—Perceived Lack of Efficacy (Lack of Control/Lack of Social Responsibility)

22. I have no control over whether or not I get the flu.

a. Strongly disagree
b. Disagree
c. I am not sure
d. Agree
e. Strongly agree

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

23. I am worried that getting sick will negatively affect my school work.

a. Almost always
b. Often
c. Sometimes
d. Rarely
e. Almost never

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

24. If I didn't clean my hands, cover my mouth when I cough, or get vaccinated, my friends would remind me to do so.

a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

25. When I get sick and fall behind on work, I am concerned that my teachers will feel disappointed.

a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

Scoring: a = 1, b = 2, c = 3, d = 4, e = 5

AUI:

Scoring: correct = 1, incorrect = 0

For questions 26-40, please fill in the bubble for the best answer.

Factor 1—Understanding Flu Spread

26. A flu strain is least likely to infect you when

a. you have been previously exposed to that strain.
b. you have no physical injuries.
c. you have not been exposed to that strain.
d. you spend time with family and friends.
e. you stay inside, out of the cold.

27. Ways that influenza is transmitted include

a. eating undercooked chicken or pork.
b. getting mosquito bites.
c. getting the flu shot.
d. going outside in cold, wet weather.
e. contact with droplets of saliva from a nearby person who coughs or sneezes.

28. What effect does population density have on the spread of the influenza virus?

a. Influenza spreads most easily when there are fewer people in an area.
b. Influenza spreads most easily when there are a lot of people in an area.
c. Number of people in an area has no effect on the ease at which influenza spreads.
d. Influenza has a hard time spreading when there are a lot of people in an area.
e. Number of people in an area has a small, but almost negligible effect on the spread of influenza.

29. The flu vaccination protects us from the flu by

a. reducing our body temperature.
b. giving us antibiotics which will protect us from the flu.
c. giving us killed or weakened flu, which causes us to produce antibodies.
d. giving us a substance that is harmless to us but toxic to the flu.
e. improving our nutrition.

30. Getting the flu vaccine while infected with the flu

a. works sometimes to reduce symptoms
b. works sometimes to reduce duration of infection
c. reduces the severity of symptoms, but doesn't reduce duration of infection
d. does not work to reduce symptoms or duration of infection
e. reduces the duration of infection

31. The reason we must get a flu shot every year is that

a. the vaccine wears off over time, so we must get a booster each year for it to be effective.
b. the flu inside our cells develops immunity to the vaccine.
c. our body slowly gets rid of the vaccine.
d. every time we get sick, its effect gets a little bit weaker.
e. the flu virus mutates every year, and so new vaccines have to be developed.

32. The flu vaccine is available as

a. A pill
b. A shot
c. A nasal spray
d. Both a and b
e. Both b and c

Factor 2—Understanding Flu Management

33. When is a person infected with the flu contagious?

a. A person becomes contagious 5-7 days before symptoms occur.
b. A person becomes contagious 1-2 days after symptoms occur.
c. A person becomes contagious up to two weeks after symptoms occur.
d. A person becomes contagious up to 2 days after getting the flu vaccine.
e. **A person becomes contagious as soon as symptoms occur.**

34. During hand washing, the Center for Disease Control (CDC) recommends

a. covering your hands with soap, and rinsing them completely.
b. covering your hands with soap and washing them for 15-20 seconds.
c. covering your hands with soap and washing them for 5 minutes.
d. putting your hands under fast moving water so it rinses off the flu.
e. using really hot water, which will kill influenza.

35. This year's flu vaccine is

a. generally only available to doctors, nurses, and people who work close to diseases.
b. generally only available to young children or elderly people who are at greater risk for flu.
c. generally available for anyone who wants it.
d. generally available, but costs hundreds of dollars.
e. is not available to anyone.

36. Influenza primarily attacks the

a. digestive system
b. respiratory system
c. nervous system
d. circulatory system
e. skeletal system

37. The best way to avoid getting sick with the flu is

a. to wash your hands regularly.
b. to wear plenty of clothes when you go outside.
c. to take a shower every day.
d. to stay dry.
e. to stay inside.

For questions 38, 39, and 40, choices d and e are not included. There are only three choices: a, b, and c.

38. Taking decongestant medications such as Sudafed

a. does not work to reduce symptoms or duration of the flu.
b. reduces the severity of symptoms, but doesn't reduce duration of the flu.
c. reduces the duration and symptoms of the flu.

39. Taking fever reducing and pain relieving medications such as Tylenol or Ibuprofin

a. does not work to reduce symptoms or duration of the flu.
b. reduces the severity of symptoms, but doesn't reduce duration of the flu.
c. reduces the duration and symptoms of the flu.

40. Taking zinc supplements

a. does not work to reduce symptoms or duration of the flu.
b. reduces the severity of symptoms, but doesn't reduce duration of the flu.
c. reduces the duration and symptoms of the flu.

Demographic Information

For questions 41-46, please select the response that best describes you.

41. What is your age?
a. 15 or under
b. 16
c. 17
d. 18
e. Over 18

Coding: a = 15, b = 16, c = 17, d = 18, e = 19

42. What is your grade? (Select a, b, c, or d)
a. Freshman
b. Sophomore
c. Junior
d. Senior

Coding: a = 1, b = 2, c = 3, d = 4

43. What is your gender? (Select a or b)
a. Male
b. Female

Coding: a = 0, b = 1

44. Which statement best describes your experience with illness this year? (Select a, b, or c)
a. I have not been sick all year.
b. I experienced symptoms of a cold, including sore throat, cough, and sniffles, but not the flu.
c. I experienced symptoms of the flu, including high fever, severe body aches, and extreme tiredness.

Coding: a = 0, b = 1, c = 2

45. How many health professionals do you have in your immediate family?
a. None
b. 1
c. 2
d. 3
e. More than 3

Coding: a = 0, b = 1, c = 2, d = 3, e = 4

46. Please select the statement that best defines your ethnicity
a. African American (Black)
b. Caucasian (White)
c. Asian
d. Hispanic
e. Other

Coding: a = 1, b = 2, c = 3, d = 4, e = 5

Appendix C

IRB Permission Letter

Campus IRB Exempt Approval Letter: IRB # 1105397

Dear Investigator:

Your human subject research project entitled Maps in Medicine Research and Evaluation Phases I, II, and III meets the criteria for EXEMPT APPROVAL and will expire on November 30, 2011. Your approval will be contingent upon your agreement to annually submit the "Annual Exempt Research Certification" form to maintain current IRB approval. Exempt Category: 45 CFR 46.101.b.1.

You must submit the Annual Exempt Research Certification form 30 days prior to the expiration date. Failure to timely submit the certification form by the deadline will result in automatic expiration of IRB approval.

Study Changes: If you wish to revise your exempt project, you must complete the Exempt Amendment Form for review. Please be aware that all human subject research activities must receive prior approval by the IRB prior to initiation, regardless of the review level status.

If you have any questions regarding the IRB process, do not hesitate to contact the Campus IRB office at (573) 882-9585. Campus Institutional Review Board.

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Vita

William Romine was born November 1, 1980 to Marc Romine and Cathy Schafer in Macon, Missouri. He attended public schools in Cole and Callaway Counties, Missouri, graduating from Jefferson City High School (1999). He received a B.A. in Physics (2003) and M.A. in Science Education (2004) from Truman State University, and an M.S. in Geology (2008) and a Ph.D in Curriculum and Instruction with an emphasis on Science Education (2011) from University of Missouri.

William's teaching experience includes English in China (2004-2005) at Anhui University of Science and Technology, high school Chemistry and Physics (2005-2006) at Macon High School, and the lab portion of the Introduction to Geology class (2006-2008) at University of Missouri. He also serves as an adjunct faculty member for University of Phoenix, and is currently mentoring undergraduate students from China and India with College of Engineering. His research experience at University of Missouri includes research assistantships with Department of Geological Sciences (*Thesis: Rheology of Mono Craters Rhyolites: Effects of Temperature, Water Content, and Crystallinity*), Literacy Education, and the Maps in Medicine Program.

William's community service endeavors have included serving as a founder and sponsor for University of Missouri's Homeschool Science Club (2007-2010) and a judge for Missouri's State Science Olympiad competition (2007, 2008). He was named Outstanding Graduate Student in Educational Outreach in 2011 by the Science Education Center at University of Missouri. He currently enjoys giving presentations on Physics and Geology for student education and teacher professional development, and runs a small martial arts club in Columbia, Missouri.

William is married to Tanvi Banerjee and they live in Columbia, Missouri.