UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

ASSESSING VACCINATION STATUS OF FIRST-TIME COLLEGE STUDENTS AT THE UNIVERSITY OF WISCONSIN-LA CROSSE

A Chapter Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Public Health in Community Health Education

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ASSESSING VACCINATION STATUS OF FIRST – TIME COLLEGE STUDENTS
AT THE UNIVERSITY OF WISCONSIN – LA CROSSE

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We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Public Health in Community Health Education.

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ABSTRACT

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Vaccination is one of the great public health achievements of the twentieth century. Yet infectious disease outbreaks continue to pose a risk to the public, necessitating sustained action focused on vaccination efforts. The college population is at particular risk for infectious disease due to frequent close contact with large groups. The purpose of this study was to establish the response rate of first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort to the vaccination records request from the campus student health center. Using secondary data from student health records, vaccination status for the hepatitis B, HPV, MMR, meningitis serogroups ACWY, Tdap, and varicella vaccines were also assessed. Additionally, vaccination rates and response to records request were compared based on respondents’ sex, race/ethnicity, and home state. Results indicated a 66% response rate to the vaccination records request. Vaccination rates were strong among responding students with the exceptions of the HPV and meningitis ACWY vaccines. Results were significant for a relationship between sex and HPV vaccination status. Female students were more strongly represented among students with completed HPV vaccine series. Educational and outreach efforts to improve vaccination rates should particularly focus on the HPV vaccine, especially for male students.
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- Maternal Characteristics
- Medical Practice Characteristics
- Personal Demographic Characteristics
- Barriers
- Solutions

Vaccination in Wisconsin

Vaccination in College

Healthy Campus 2020

Vaccination Rates

- National Immunization Survey – Teen
- National College Health Assessment – II
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CHAPTER I
INTRODUCTION
Background

The practice of vaccination has existed in the United States since the late 1800s and is considered to be one of the greatest public health achievements of the twentieth century (Centers for Disease Control and Prevention [CDC], 1999). Today, at least 20 different vaccines are widely available and protect against many previously common infectious diseases. In the U.S., widespread vaccination has even led to the eradication of a number of these diseases, such as smallpox, polio, and rubella (Immunization Action Coalition, 2018b; National Center for Immunization and Respiratory Diseases-Division of Viral Diseases, 2017). Vaccines prevent many deadly illnesses such as measles, rabies, and meningococcal meningitis, and may avert millions of deaths annually around the world. Additionally, vaccines reduce the risk for complications that may occur secondary to preventable infections and decrease the risk of developing chronic diseases (Andre et al., 2008).

Despite the many benefits of vaccination, negative perceptions about the safety of vaccines have gained popularity in recent decades. In fact, many in the U.S. are now choosing to forgo potentially lifesaving vaccinations for themselves and their children (Andre et al., 2008; Ventola, 2016). This not only puts the individual at risk, but also the local community and even the nation and world, as increased global interconnectivity
more easily and frequently brings people in contact with pathogens. Strong vaccination rates not only protect those receiving the vaccines, but also provide secondary protection for those too young, too elderly, or too ill to be immunized themselves (Andre et al., 2008).

A review of the professional literature indicated that multiple factors were associated with vaccination status. These included maternal characteristics, medical practice characteristics, and personal demographic characteristics, though the significance of personal demographics varied between studies and vaccines of study. Myers, Spracklen, Ryckman, and Murray (2015) found that Caucasian women were less likely than minority groups, except African American women, to vaccinate their newborn children against hepatitis B (HepB). Single mothers also were less likely to vaccinate their infants than married women. Willis, Wortley, Wang, Jacques-Carroll, and Zhang (2010) did not find any association between maternal race and infant vaccination status against HepB. However, individuals studied who carried Medicaid insurance were more likely to vaccinate their children than those with private health insurance. Maternal education level and number of children also were significantly associated with vaccination status. These findings were corroborated by a study by Luman, McCauley, Shefer, and Chu (2003), who similarly noted that children with mothers who had attained lower education levels were more likely to be undervaccinated, and that mothers with multiple children were less likely to have children who were vaccinated as recommended.

Characteristics of the medical practice itself also were found to be related to vaccination status. Hospitals located in a state which offered childhood vaccines at no cost had higher vaccination rates than hospitals located in states which did not offer free
vaccinations. Moreover, hospitals which had policies supportive of vaccination at birth were more likely to be compliant with HepB vaccination (Willis et al., 2010). Wooten, Janssen, Smith, and Pickering (2009) also studied how medical practice characteristics were associated with vaccination. Specifically, medical practices where fewer practitioners participated in the Vaccines for Children (VFC) program and where there was a low population of Medicaid eligible patients were more likely to have patients who were vaccinated on schedule. The race/ethnicity of children served at a medical practice also was related to vaccination rates. Children seen at medical practices which served a largely white population were less likely to completely miss a recommended vaccine series than children attending medical practices which largely served a black population.

In a study using the American College Health Association (ACHA) National College Health Assessment – II (NCHA – II) survey data, Thompson et al. (2017) reported personal demographics associated with vaccination status. Regarding the human papillomavirus (HPV) vaccine, white female students were most likely to be vaccinated. Among male students, African Americans were more likely to be vaccinated than other groups. The authors also found that having health insurance increased the likelihood of being vaccinated for individuals of any race or sex. Ganguly and Banerji (2000) likewise reported an association between race/ethnicity and vaccination status in a study of university students and HepB vaccination. White students were more likely to be vaccinated against HepB than students of other races. However, Cofie and colleagues (2018) did not find an association between race/ethnicity and vaccination against HPV among data from a national sample of women collected through the National Health Interview Survey. In a study of the impact of the VFC program, Walker, Smith, and
Kolasa (2014) reported an association between race/ethnicity and vaccination status for some vaccines and some racial/ethnic groups, but not for others. For the diphtheria, tetanus, and pertussis (DTaP) vaccine, the authors found that Hispanic and non-Hispanic black children had lower vaccination rates compared to non-Hispanic white children. However, for the measles, mumps and rubella (MMR) and polio vaccines, vaccination disparities were not present for Hispanics, non-Hispanic blacks, and American Indian/Alaska Natives compared to non-Hispanic white children.

Vaccination can affect the health of individuals and those around them. Due to the close contact with large and diverse groups typically inherent to the college experience, college students are at increased risk for the outbreak of communicable disease (U.S. Department of Health and Human Services, 2017a). Vaccination for the college population is a priority for the American College Health Association (ACHA). The ACHA’s Vaccine-Preventable Diseases Advisory Committee (2018) has laid out guidelines and recommendations for vaccination of college students based on best practice recommendations from the U.S. Centers for Disease Control and Prevention (CDC). The importance of vaccination to college health is further highlighted by inclusion of vaccination objectives within the ACHA’s Healthy Campus 2020 initiative. The objectives target six vaccines important to the health of college students for improvement in vaccination rates. Targeted vaccines included influenza, HepB, HPV, MMR, meningococcal serotypes ACWY (menACWY), and varicella (ACHA, 2018c).

**Statement of the Problem**

The U.S. college population is at increased risk for infectious disease outbreaks due to frequent close contact with large groups of people converging from all parts of the
country and the world. Vaccination against infectious diseases, like meningococcal meningitis and HepB, is particularly pertinent for this population. Additionally, some students may be unable to receive vaccines due to health issues. Strong vaccination rates of the campus population overall are especially important for these students as it is the only way in which vaccination can protect them (Prater et al., 2016; U.S. Department of Health and Human Services, 2017b). Data cited within the Healthy Campus 2020 objectives (ACHA, 2018c) indicate that nationally, college populations are vaccinated at rates below those recommended by the ACHA and CDC for most vaccines.

The Healthy Campus 2020 vaccination target rates were drawn from two sources (ACHA, 2018c). One was the 17-year-old group from the 2010 National Immunization Survey – Teen (NIS-Teen), which reviews provider-verified vaccination records to estimate vaccination rates. The other source was the ACHA NCHA – II survey from 2010. The NCHA – II is a national survey which relies on the self-report of college students at participating post-secondary institutions. Vaccination rates reported from the NIS-Teen survey were higher than those reported from the NCHA – II (ACHA, 2018c). Data from the 2017 NIS – Teen survey indicated that national rates are at target for the HPV and varicella vaccines, and below what is recommended for the HepB, MMR, and menACWY vaccines (Walker et al., 2018). However, based on the targets set for HPV and varicella vaccination, vaccination rates at target level still mean that about 40% of females and 60% of males are unvaccinated against HPV, and nearly 10% of the population is unvaccinated against varicella. While other prevention methods, like safe sex practices and hand hygiene, also can provide protection against infectious disease spread, vaccination is an important tool in preventing the spread of disease.
Data for Wisconsin also were available from the NIS-Teen. The report on state-specific data presented results in grouped age ranges, rather than for each age specifically, as with national data. The 13 to 17 year-old age group was most pertinent to the population of this study. Data for HPV vaccination indicated that Wisconsin males were vaccinated at a slightly higher rate than the target. However, Wisconsin females still fell below the ACHA target rate. For all other recommended vaccines, Wisconsin teens appeared to be outperforming the ACHA target rates (NCIRD, 2017c). However, as noted above, even state vaccination rates at or above the target rates set by the ACHA still leave portions of the population vulnerable to infection. Specific ACHA target rates can be found in Chapter II of this document.

Vaccination data for the HPV, menACWY, and tetanus, diphtheria, and pertussis (Tdap) vaccines also were available for La Crosse County. According to the Wisconsin Department of Health Services (2018b), vaccination rates for Wisconsin adolescents 13 to 18 years of age in La Crosse County were above 50% for both initiation and completion of the HPV vaccine series, but fell slightly below the target level set by the ACHA. For menACWY, though the rate for vaccine series initiation was above the ACHA target rate, the completion rate fell below target. No target level has been set by the ACHA for the Tdap vaccine, though county levels fell below those of the state for this vaccine. No vaccination data were publicly available from the University of Wisconsin System, or from University of Wisconsin System institutions. The researcher did have access to recent vaccination data for the University of Wisconsin-La Crosse (UWL) due to employment as a registered nurse with the Student Health Center (SHC) on campus. Accessible data was from the spring 2015 and spring 2018 NCHA-II surveys.
in which UWL participated. In 2015, vaccination rates of respondents were below ACHA NCHA – II target rates for HepB, MMR, and varicella, and above target for HPV and menACWY (ACHA, 2015). For 2018, vaccination rates of responding students were below ACHA NCHA – II target rates for HepB, but above target for HPV, MMR, meningococcal meningitis, and varicella (ACHA, 2018d).

**Need for the Study**

Prior to the beginning of each academic year at UWL, an Immunization History Form (IHF) is sent within the admissions information packet to each admitted student on behalf of the SHC. The language of the letter indicates that students are required to return the form completed with their vaccination history prior to coming to school. SHC staff do not have access to admissions records to verify from whom they should be expecting vaccination records, thus there is no system in place to track whether students comply with this request. At the time of this study, vaccination records had not been regularly reviewed for compliance nor completeness. For the fall 2018 first-time college student cohort, an attempt was made by SHC nursing staff to review returned records for missing vaccination doses and to contact students whose records indicated they were missing a recommended vaccine (P. Schneider, personal communication, September 7, 2018).

While this was in line with the SHC mission of providing patient centered care (University of Wisconsin-La Crosse Student Health Center, 2018), vaccination rates among the student body for key vaccines recommended by the CDC and the ACHA were unknown (Dr. A. Deyo, personal communication, June 7, 2018). Recent events at University of Wisconsin System institutions, including the meningococcal meningitis B outbreak at UW-Madison (Johnson, 2016) and the mumps outbreak at UWL (Kirwan,
2017), along with the lack of understanding of response rate to the vaccination records request, have brought to light the need for SHC staff to assess this aspect of the health of the student population.

The SHC cannot rely solely on state or national data to gauge the vaccination health and infectious disease risk of the campus. While periodic university participation in the ACHA NCHA – II survey does allow some understanding of the vaccination health of the campus population, there are limitations to this approach. According to Justin Sullivan (personal communication, February 5, 2019), an Institutional Planner and UW System liaison for the NCHA – II assessment, a list of randomly selected students is generated based on the criteria of full-time, on-campus students who are 18 years of age or older. The generated list also is representative of the proportions of undergraduate class groups – freshman, sophomore, junior, and senior – at each institution. The survey uses an online platform called Qualtrics and survey invitations are sent out through this platform. The most recent assessment in which UWL participated was the spring 2018 survey. Specifically, survey invitations were sent to 3,000 students at UWL, along with two reminder emails to non-responding students. The survey was available for two weeks, and participation in the survey was voluntary. For the spring 2018 assessment, only 289 students responded for a response rate of 9.6% (ACHA, 2018d). The spring 2015 assessment had a response rate of 24.8% (ACHA, 2015). The survey also relies on self-report; if participants are unaware of their vaccination status, they may answer incorrectly or fail to answer at all. Finally, it should be noted that UWL participates in this survey approximately every three years. Therefore, annual assessments of the vaccination status of the UWL student population would not be available.
Rather than relying on a survey method using self-reported responses, the decision was made to assess the entire first-time college student cohort at UWL during the fall 2018 semester using secondary data from health records. This method provided a more comprehensive understanding of the vaccination status and communicable disease risks of this group. While results are not generalizable to the entire UWL student population, the study of an entire cohort offered a base on which to build future work. Student health service providers can utilize insights from this research to target prevention, education, intervention, and future assessment efforts.

**Purpose of the Study**

The purpose of this study was to assess the response rate to the SHC vaccination records request of first-time college students in the UWL fall 2018 cohort. An additional purpose of this study was to assess vaccination status against HepB, HPV, MMR, menACWY, Tdap, and varicella. The final purpose of this study was to assess whether response and vaccination rates differed based on sex, race/ethnicity, and home state. Response rate, vaccination status, and demographic data were collected by reviewing existing records present in the Point and Click electronic medical record (EMR) utilized by the SHC.

Within this study, student vaccination rates were assessed in accordance with vaccines targeted by Healthy Campus 2020 (ACHA, 2018c), with the addition of the Tdap vaccine at the request of the SHC Medical Director, Dr. Abby Deyo (personal communication, June 7, 2018). Classifications for vaccination status included no series, partial series, and complete series. Though influenza was included in the ACHA
objectives, it was not included in this study as it is required annually to be effective; historical receipt does not confer future immunity.

Research Questions

Research questions for this study were as follows:

1. What was the response rate to the vaccination records request from the Student Health Center for first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort?

2. What were the vaccination rates of responding first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort against hepatitis B, human papillomavirus, meningococcal serotypes ACWY, measles, mumps, and rubella, tetanus, diphtheria, and pertussis, and varicella?

3. What percentage of responding first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort were completely vaccinated as recommended?

4. How did vaccination rates of responding first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort compare based on sex, race/ethnicity, and home state?

5. How did response to the vaccination records request for first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort compare based on sex, race/ethnicity, and home state?

Delimitations

Delimitations for this study were as follows:

- The population of study was the UWL fall 2018 cohort of first-time college students.
• Only vaccines aligned with the ACHA’s Healthy Campus 2020 objectives were assessed, with the addition of the Tdap vaccine at the request of the SHC Medical Director.

• Though included in the ACHA’s Healthy Campus 2020 objectives, influenza was not included in the vaccines of study.

• Only secondary data available in the Point and Click EMR in use at the SHC were utilized for this study.

Limitations

• The SHC vaccination records request may not have been sent to or received by all first-time college students in the UWL fall 2018 cohort.

• Student vaccination records may not have been filled out or documented accurately.

• Vaccinations not listed within records for students with available vaccination history data may have occurred despite unavailability of documentation.

• Returned vaccination records may not have been accurately entered in the scanned documents section of the Point and Click EMR.

• The list of student identification numbers of first-time college students in the UWL fall 2018 cohort provided by the Office of Institutional Research, Assessment, and Planning may not have been accurate.

Assumptions

• The SHC IHF was sent to and received by all first-time college students in the UWL fall 2018 cohort.

• The SHC IHF was correctly filled out.
• All other student immunization records submitted to the SHC in place of the IHF were accurate.

• Vaccines were administered correctly (i.e., appropriate vaccine at appropriate time).

• Vaccinations not listed within records for students with available vaccination history records did not occur.

• The list of student identification numbers of first-time college students in the UWL fall 2018 cohort provided by the Office of Institutional Research, Assessment, and Planning was complete and accurate.

• All vaccination data received by the SHC were correctly entered in the scanned documents section of the Point and Click EMR.

**Definition of Terms**

• Completed HepB vaccine series: Three doses of the HepB vaccine comprised a complete series (CDC, 2016a; Wexler, 2016).

• Completed HPV vaccine series: For this study, three HPV vaccine doses were required prior to 2018. For those found to have initiated the series after 2018, two doses were considered acceptable (WDHS, 2018a; WDHS, 2018b). This definition is consistent with the SHC definition of a completed HPV series (UWL SHC, 2019).

• Completed menACWY vaccine series: Individuals who received their first menACWY dose prior to age 16 and a booster dose after age 16 were considered to have completed the series. However, if the first dose was received after age 16, no additional doses were required to be considered complete (WDHS, 2018a).

• Completed MMR vaccine series: Two doses of the MMR vaccine comprised a complete series (Immunization Action Coalition, 2018a).
• Completed Tdap vaccine series: One dose of Tdap vaccine was considered complete (WDHS, 2018a).

• Completed varicella vaccine series: Two doses of the varicella vaccine given after an individual’s first birthday were considered a complete series. Additionally, those born in the U.S. prior to 1980, and those diagnosed with varicella disease, or chickenpox, by a healthcare provider were considered compliant (Immunization Action Coalition, 2018c).

• First-time college student: A student who is enrolled in college for the first time since graduating from high school (N. Solverson, personal communication, October 1, 2018).

• Full series: Vaccination record contains dates for all required doses of a given series.

• No series: Vaccination record contains no dates of vaccination for a given series.

• Partial Series: Vaccination record contains at least one date of vaccination for a given series, but all required doses are not complete.

• UWL student vaccination record: Scanned documents within the SHC’s Point and Click EMR containing any vaccination information.

• Vaccination: “The act of introducing a vaccine into the body to produce immunity to a specific disease” (CDC, 2017a, para. 3).

• Vaccinated as recommended: Evidence of completed series for all vaccines of study which included HepB, HPV, menACWY, MMR, Tdap, and varicella.
CHAPTER II
LITERATURE REVIEW

Vaccination

History

Efforts to vaccinate against infectious disease have been occurring in the United States for over 200 years. Vaccination principally began with smallpox at the end of the 19th century and expanded to the twenty or so vaccinations currently available. These vaccines protect individuals and communities against infectious disease and in some cases have led to the eradication of diseases in the U.S., as with smallpox, polio, and rubella (Immunization Action Coalition, 2018b; National Center for Immunization and Respiratory Diseases-Division of Viral Diseases, 2017). Vaccines contain tiny amounts of dead or severely weakened bacteria, virus, or toxin, depending on which disease they were derived to protect against. They are administered by injection into the muscle or under the skin, or are taken orally in pill form. The intention of vaccination, or receiving a vaccine, is to create an immune system response to the vaccine, causing the immune system to create antibodies to protect the body. This process also is referred to as immunization. Vaccination and immunization are often used interchangeably (National Institute of Allergy and Infectious Diseases, 2008).

While individual immunity may be conferred from vaccination, the population also may benefit. Some groups, such as infants, people with health conditions that
weaken their immune system, and the elderly, may be unable to receive vaccines for health reasons. Herd, or community, immunity helps to protect individuals who are unable to receive vaccines against infectious diseases (NCIRD, 2018d). The U.S. Department of Health and Human Services (USDHHS), (2017b) described herd, or community, immunity as follows:

when enough people are vaccinated against a certain disease, the germs can’t travel as easily from person to person — and the entire community is less likely to get the disease. That means even people who can’t get vaccinated will have some protection from getting sick. And if a person does get sick, there’s less chance of an outbreak because it’s harder for the disease to spread. Eventually, the disease becomes rare — and sometimes, it’s wiped out altogether. (para. 2)

Community immunity helps to illustrate how vaccination affects and benefits the whole community (Figure 1).

![Figure 1. Illustration of Herd Immunity (Orenstein & Ahmed, 2017).](image)
**Benefits of Vaccination**

The benefits of vaccination are many. If given prior to exposure, vaccines can protect an individual against disease. Some, like the rabies, hepatitis A and B, measles, and varicella vaccines, may even afford this benefit when administered post exposure (Andre et al., 2008). The World Health Organization (WHO), (2017) estimated that between 2010 and 2015, ten million deaths globally were prevented because of vaccination. Estimates from the Centers for Disease Control and Prevention (CDC), (2014) indicated that among children born in the U.S. between 1993 and 2013, 21 million hospitalizations and 732,000 deaths were prevented because of vaccinations. Along with reductions in incidence and mortality, widespread vaccination has effected a reduction in complications and morbidity associated with the diseases vaccinated against (Figure 2).

<table>
<thead>
<tr>
<th>Disease</th>
<th>20th Century annual morbidity (2)</th>
<th>2016 Reported cases (3)</th>
<th>Percent decrease (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallpox</td>
<td>29,005</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>21,053</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Measles</td>
<td>530,217</td>
<td>69</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Mumps</td>
<td>162,344</td>
<td>5,311</td>
<td>97</td>
</tr>
<tr>
<td>Pertussis</td>
<td>200,752</td>
<td>15,737</td>
<td>92</td>
</tr>
<tr>
<td>Polio (paralytic)</td>
<td>16,316</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Rubella</td>
<td>47,745</td>
<td>5</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Congenital rubella syndrome</td>
<td>152</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Tetanus</td>
<td>580</td>
<td>33</td>
<td>94</td>
</tr>
<tr>
<td><em>Haemophilus influenzae</em></td>
<td>20,000</td>
<td>22*</td>
<td>&gt;99</td>
</tr>
</tbody>
</table>

* *Haemophilus influenzae* type b (Hib) < 5 y of age.

Figure 2. Comparison of 20th Century Annual Morbidity and Current Estimates of Vaccine – Preventable Disease (Orenstein & Ahmed, 2017).

Strong vaccination rates can reduce the severity of disease outbreaks that do occur in a population. Vaccination additionally protects against secondary infections and related
diseases. Other positive effects include possible reduction in the risk for chronic diseases like cancer, as with the human papillomavirus (HPV) and hepatitis B (HepB) vaccines, and reduced healthcare costs. Vaccination may even aid in reducing antibiotic resistance, as those who do not develop an infection because of vaccination do not need to take medication to treat it, thus reducing opportunities for pathogens to develop resistance (Andre et al., 2008).

Though some infectious diseases are rare or non-existent in the U.S., the increased global travel of goods and people maintains the need for strong vaccination rates, even among populations where certain diseases may be uncommon (Andre et al., 2008; NCIRD, 2018d; WHO, 2017). Lack of disease presence in a local population does not translate to an impossibility of reintroduction of the disease. Efforts at maintaining and increasing vaccination rates in the U.S. have been fruitful; estimates indicate a 99% reduction in the incidence of nine diseases long vaccinated against, translating to a significant improvement in death rates and complications from these diseases (Andre et al., 2008; Orenstein & Ahmed, 2017).

**Concerns about Vaccination**

Though vaccination has produced significant reductions in the spread of infectious diseases, continued attention to vaccination efforts is necessary among the U.S. population. Orenstein and Ahmed (2017) noted increased levels of fear in the U.S. surrounding vaccination, citing concerns about side effects and a lack of understanding of the potential severity of consequences stemming from the failure to vaccinate. The authors additionally stated,
It’s often said that vaccines save lives, but this is not strictly true; it is vaccination that saves lives. A vaccine that remains in the vial is 0% effective even if it is the best vaccine in the world. Thus, it is imperative that we all work together to assure that a high level of coverage is obtained among populations for whom vaccines are recommended. In some sense, vaccines have become victims of their own success. Diseases that once induced fear and sparked desire for vaccines are now rare, and there is a false and dangerous sense of complacency among the public. (p. 4032)

While some have been skeptical of vaccination since its inception, misguided safety concerns have grown in recent years due to research by Dr. Andrew Wakefield and colleagues published in The Lancet medical journal in 1998 (Whelan, 2016). The study purported to find a relationship between receipt of the MMR vaccine and negative health and developmental consequences for children. Multiple subsequent studies failed to corroborate Wakefield’s findings, and the study was retracted by The Lancet in 2010. By that time, however, fear, mistrust, and confusion regarding the safety of vaccinations had already diffused into the public (Whelan, 2016). While any medical intervention carries some level of risk, subsequent studies have shown vaccines to be safe for most individuals (National Center for Immunization and Respiratory Diseases [NCIRD], 2016a; NCIRD, 2016b; Institute of Allergy and Infectious Diseases, 2008; Whelan, 2016; WHO, 2017).

The WHO acknowledged that vaccine safety concerns garner more media attention than vaccine benefits or effectiveness but maintained that the organization and other experts around the world have contributed to a strong body of research supporting
the safety of vaccination (Andre et al., 2008). Respected health and governmental organizations like the WHO and CDC strongly recommend vaccination as medically possible for all individuals (NCIRD, 2018d; WHO, 2017). Continued pursuit of strong vaccination rates in the U.S. will guard against the re-emergence of vaccine-eradicated diseases and promote the eradication of other vaccine-preventable diseases.

**Review of Vaccine-Preventable Diseases**

Vaccines are available to prevent against more than twenty different diseases (Immunization Action Coalition, 2018b). What follows is a discussion of ten of these vaccine-preventable diseases, and the vaccines associated with each. The *Control of Communicable Disease Manual* (Heymann, 2015), published by the American Public Health Association, provides disease information for a multitude of communicable diseases, including those discussed below. This manual was a key resource in obtaining disease background, symptoms, transmission, and other relevant information.

**Hepatitis B**

HepB is a viral infection that affects the liver. Transmission of the virus occurs through contact with infected blood, semen, or other bodily fluids. Most commonly, this occurs through sexual contact, sharing of needles during intravenous drug use, or transmission from mother to baby. The infection may range from asymptomatic to fatal. Following the acute infection phase, chronic infection is possible; the likelihood of chronic hepatitis decreases as age of onset increases. Chronic infection may result in liver scarring (cirrhosis) or liver cancer (Heymann, 2015).

The case fatality rate for HepB viral infection is one percent and is greater in those over 40 years of age. Among those who progress to chronic HepB infection, 15 to
25% die early due to liver cancer or cirrhosis (Heymann, 2015). The USDHHS Office of HIV/AIDS and Infectious Disease Policy (2017) estimated 850,000 to 2.2 million prevalent cases of chronic HepB in the U.S. from 2011 to 2012. According to the National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention Division of Viral Hepatitis (2018), the incidence of HepB in 2016 in the U.S. was 1.0 per 100,000 persons. For 2016, estimates from the offices indicated that the number of new HepB infections was 20,900 (95% CI, 11,900 – 51,200).

The recombinant HepB vaccine widely used in the U.S. to prevent HepB infection and chronic disease was licensed in 1986. It is made from proteins from the HepB virus and cannot cause HepB infection. The vaccine is a three-part series given intramuscularly over a six-month period and has an average duration of immunity of twenty years. The vaccine series is approximately 90% effective when given to healthy adults and more than 95% effective if the series is completed between birth and 19 years of age. Efficacy in preventing infection ranges from 80% to 100% due to variations in the age, health status, and immune system function of a given individual (NCIRD, 2016b).

According to the Vaccine Information Sheet (VIS) for the HepB vaccine, most people who get the hepatitis B vaccine do not have any problems with it. Minor problems following hepatitis B vaccine include soreness where the shot was given and temperature of 99.9°F or higher. If these problems occur, they usually begin soon after the shot and last 1 or 2 days. (CDC, 2016a, p.1) While receipt of the vaccine is safe for most people, cases of anaphylaxis have been documented among children and adolescents. The estimated incidence of this event is one per 1.1 million vaccine doses. Other reported adverse side effects have included chronic
fatigue syndrome, neurological disorders, Guillain-Barré syndrome, and autoimmune disease. These reports have been rare, and no causal association has been established between the reported adverse events and receipt of the HepB vaccine (NCIRD, 2016b).

**Human Papillomavirus**

More than 100 types of HPV exist with potential clinical manifestations including genital warts and cancer of the anus, genitals, cervix, and throat. Many infections are asymptomatic. Though the types manifesting as genital warts, HPV 6 and HPV 11, are unpleasant, they generally are benign. The oncogenic (cancer-causing) types, HPV 16 and HPV 18, have the potential to result in cancer of the cervix, anus, penis, vagina, vulva, and throat. HPV types 16 and 18 are considered high risk types and account for more than 70% of cervical cancers. HPV generally is transmitted through direct contact with an infected person, often occurring during sexual intercourse (Heymann, 2015). Infection with HPV is common. In fact, most sexually active adults will become infected with some type of the virus during their lives. Estimates from the CDC indicated 79 million people in the U.S. may be infected with HPV, with an annual incidence of 14 million infections (NCIRD, 2016b). Half of new infections occur in individuals aged 15 to 24 years. Though the commonness of the virus makes obtaining firm incidence and prevalence rates challenging, studies do attempt to track prevalence rates for oncogenic types (National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention-Division of STD Prevention, 2017).

Using data from the National Health and Nutrition Examination Survey (NHANES), Markowitz and colleagues (2017) looked at the prevalence rates of HPV types 6, 11, 16, and 18 (4vHPV). The authors reported 4vHPV type prevalence rates of
between 4.3% and 12.1% for females aged 14 to 34 years. In a separate study also
drawing on data from the NHANES, Gargano and colleagues (2017) assessed prevalence
rates of 4vHPV types for U.S. males 14 to 59 years of age. The weighted overall
prevalence rate of 4vHPV for all men in the study was 7.9%. Weighted prevalence rates
Additionally were broken down by age group, resulting in a range between 1.8% for
males 14 to 19 years of age to 11.2% for males 25 to 29.

Three human papillomavirus vaccines commonly were used in the U.S. to prevent
infection with specific types of HPV. However, after 2016, only HPV9 was still in
distribution in the U.S. HPV9 protects against HPV types 6, 11, 16, 18, and an additional
five types associated with cancer risk (CDC, n.d.). Vaccination is recommended in both
males and females aged 9 to 26 years. The Wisconsin Department of Health Services
(WDHS) (2018a) and the UWL SHC (2019) both defined a completed HPV series as
three doses of the vaccine. However, according to the CDC (2016b), if beginning the
series between ages 9 and 14, two doses should be given six months apart. If beginning
the series after age 15, a second dose should be received one to two months after the first,
and a third six months after the first. According to the VIS for the HPV vaccine,
mild or moderate problems may occur following HPV vaccine and include
reactions in the arm where the shot was given, soreness (about 9 people in 10),
redness or swelling (about 1 person in 3), fever: -mild (100°F) (about 1 person in
10) - moderate (102°F) (about 1 person in 65), and headache (about 1 person in
3). (CDC, 2016b, p.1)

The NCIRD (2016a) reported a 56% decrease in prevalence of 4vHPV among adolescent
girls from when the vaccine first was recommended in 2006 through 2010. The
prevalence of genital warts also was reported to decline over this period. While the HPV vaccine is not a treatment for infections already acquired, the vaccine still can protect against infection with types not yet acquired. Since widespread HPV vaccination began in 2006, no evidence has yet been found of reduced immunity over time, though duration of vaccination protection is a subject of continued study.

**Measles**

Measles is a viral illness spread by droplet contact with nasal or oral secretions of an infected person. Signs of measles include fever, inflammation of the mucous membranes of the eye (conjunctivitis), cough, and a rash to the face. Complications of the illness may include pneumonia, ear infection (otitis media), croup, fever-induced seizures, and brain swelling (encephalitis). Measles was a common childhood illness prior to large scale vaccination efforts, with large metropolitan areas reporting epidemics every two to three years (Heymann, 2015).

Prior to widespread vaccination, approximately 90% of the population was infected with measles by 20 years of age; six million deaths were estimated to have occurred annually worldwide. Due to strong vaccine uptake in the U.S. and other developed countries, it is estimated that cases of measles have decreased by 99% worldwide. In developed countries, measles infection carries a case fatality rate of less than one percent; however, in developing countries, it is estimated at three to five percent and may be as high as 10 to 30% in some areas (Heymann, 2015). According to the National Center for Immunization and Respiratory Diseases-Division of Viral Diseases (NCIRD-DVD) (2018a), preliminary reports indicate 372 cases of measles occurred in the U.S. in 2018, while 120 cases were reported in 2017 and 86 cases in 2016. Since
2010, the year with the greatest number of cases was 2014, during which 667 cases of measles occurred. The 2014 spike was the result of 23 measles outbreaks which mostly occurred in unvaccinated individuals in Amish communities. Measles often is brought to the U.S. through foreign travel, where it can spread through groups of unvaccinated individuals.

The measles vaccine is given as a combination vaccine along with mumps and rubella, known as the MMR vaccine. None of the three are available as a single vaccine. Two doses of the MMR vaccine are required to complete a series. Children typically are first vaccinated around one year of age, with a second dose given between ages four and six. A third dose of the vaccine may be recommended in adults with the potential for exposure to measles, mumps, or rubella during an outbreak (CDC, 2018c). The MMR vaccine is a live virus vaccine, meaning the virus used in the vaccine is significantly weakened, but not completely dead. According to the VIS, possible side effects of the vaccine include

- sore arm from the injection, fever, redness or rash at the injection site, and
- swelling of glands in the cheeks or neck. If these events happen, they usually begin within 2 weeks after the shot. They occur less often after the second dose.

Moderate events (include) seizure (jerking or staring) often associated with fever, temporary pain and stiffness in the joints, mostly in teenage or adult women, temporary low platelet count, which can cause unusual bleeding or bruising, and rash all over body. (CDC, 2018c, p. 2)

According to the NCIRD (2018b), a single dose of the vaccine is approximately 93% effective at preventing measles. The full two-dose series boosts efficacy to 97%. For
mumps, a single dose of the MMR vaccine is 78% effective at preventing infection. A completed series of two doses has an efficacy of 88%. For rubella, just a single dose of the vaccine is 97% effective at preventing infection.

**Mumps**

Mumps is a viral illness spread by droplet or direct contact with the saliva of an infected person. Prior to widespread vaccination, mumps was a common childhood illness. The infection presents with fever along with swelling and tenderness of one or both salivary glands in the jaw. Less commonly, salivary glands in other locations may be affected. Other nonspecific symptoms include anorexia, a general feeling of being unwell (malaise), muscle aches (myalgia), and headache. Complications may result from mumps infection. Inflammation of the testes (orchitis) is one possible complication occurring in approximately 20 to 30% of post-pubertal affected males. Orchitis also is associated with increased risk for testicular cancer. Other potential complications of mumps infection are respiratory health issues, particularly in young children, and hearing loss in affected children and adults. Meningitis is a risk as well, occurring in up to 10% of cases. More rarely, in one to two out of 100,000 cases, encephalitis may occur, which carries a case fatality rate of about one percent. Pregnant women who become infected with mumps during their first trimester are at increased risk of spontaneous abortion (Heymann, 2015).

The NCIRD-DVD (2018c) cited significant contributors to mumps outbreaks as crowded environments like classrooms or dormitories, as well as behaviors that result in the sharing of saliva. Additionally, mumps may still affect vaccinated communities, possibly due to variations in vaccine effectiveness among individuals, reduced immunity over time, or intensity of exposure in close contact situations. However, strong
population vaccination rates likely limit the severity of outbreaks. In 2017, the number of reported mumps cases in the U.S. was 3,299, with an incidence rate of 10.4 per 100,000 population. Analysis by age group revealed the highest incidence to be in the 18 to 22-year-old age group. Seventy-three percent of cases had received at least two doses of the MMR vaccine. At least 40 known outbreaks occurred in 2017, with 19 occurring at universities (Marin, 2017).

Rubella

Also known as German measles, rubella is a viral illness spread by droplet or direct contact with the nasal or oral secretions of an infected person, or, for infants with Congenital Rubella Syndrome (CRS), through oral secretions and urine. Enlarged lymph nodes of the head or neck is the most characteristic, and earliest, sign of infection with rubella. Other symptoms usually include mild fever and widespread red rash, which may be flat or raised (maculopapular). Infection may be subclinical or occur without the characteristic rash in approximately 50% of cases. In adults, headache, malaise, inflammation of the nasal mucous membrane (rhinitis), and conjunctivitis are common. Children often present without these associated symptoms. Complications of infection among adults include joint pain and swelling (arthritis), especially among females. Otitis media is a common complication among children. Encephalitis occurs in one out of 6,000 rubella cases. The impact of infection can be especially severe if acquired during pregnancy, particularly during the first trimester. Anomalies may occur in the developing fetus, or spontaneous abortion or intrauterine death may occur. CRS encompasses the possible fetal anomalies occurring from the infection, which include congenital heart defects, developmental delay, hearing and vision impairments, and underdevelopment of
the brain (microcephaly), among others. Insulin-dependent diabetes also is associated with CRS (Heymann, 2015).

Though rubella was determined to be eliminated from the U.S. in 2004, it does remain a problem in other parts of the world and may be brought to the U.S. through foreign travel. In 1964, the last significant rubella epidemic occurred in the U.S.; an estimated 12.5 million became ill, 11,000 pregnancies were lost, 2,100 newborns died, and 20,000 infants were born with CRS (NCIRD-DVD, 2017). According to McLean, Fiebelkorn, Temte, and Wallace (2013), four to 18 cases were reported annually from 2005 to 2011, for a total of 67 cases. In 2011, an expert panel from the Pan American Health Organization upheld the status of the United States as having eliminated rubella, meaning there was no continuous disease transmission for 12 months or more in the U.S. (NCIRD-DVD, 2017). Since 2012, fewer than 10 cases of rubella have occurred annually, all of which have had evidence of infection during time spent outside the U.S. Vaccination of the U.S. population is important to maintain elimination of the disease (NCIRD-DVD, 2017).

**Meningococcal meningitis**

Meningococcal meningitis is caused by a bacterial infection with one of six serotypes of *Neisseria meningitidis* (*N. meningitidis*), with groups A, B, and C accounting for 90% of cases worldwide, and serogroup Y contributing about a third of cases in the U.S. It is transmitted through droplet or direct contact with respiratory secretions of an infected person. Signs and symptoms of infection include neck (nuchal) stiffness, fever, severe headache, nausea, vomiting, and sensitivity to light (photophobia). A petechial rash of small, flat, red or purple dots also is a common sign among U.S. cases.
Complications from meningococcal meningitis occur in 10 to 20% of cases and may include hearing loss, limb loss, and neurological deficiencies. Additionally, sepsis may result from infection with *N. meningitidis*; pneumonia, arthritis, and inflammation of the sac around the heart (pericarditis) also are possible, though less common (Heymann, 2015). The most recent case report data for meningococcal disease indicated 370 cases in the U.S. in 2016, with an incidence rate of 0.12 per 100,000. Rates of disease were highest among children less than one year old and young adults 16 to 23 years of age. For youth aged 15 to 18 years, the 2016 incidence rate for disease caused by serogroups A, C, W, and Y combined was 0.11 per 100,000. The incidence rate for those aged 19 to 22 years was 0.15 per 100,000. (NCIRD, 2018c).

There are two approved meningococcal conjugate vaccines covering serogroups A, C, W, and Y – Menactra and Menveo. The conjugate types of vaccines sometimes are abbreviated as MCV4. An earlier, polysaccharide type of the menACWY vaccine, abbreviated as MPSV4, still may be encountered, though it is less commonly used in children and adolescents. Currently, two doses of either Menactra or Menveo are recommended. The first dose typically is given at age 11, with a booster dose at age 16. If the vaccine series is initiated after age 16, only one dose is required. Vaccination against menACWY is encouraged for college freshman who live in residence halls (CDC, 2016c). According to the VIS,

As many as half of the people who get meningococcal ACWY vaccine have mild problems following vaccination, such as redness or soreness where the shot was given. If these problems occur, they usually last for 1 or 2 days. They are more
common after MenACWY than after MPSV4. A small percentage of people who receive the vaccine develop a mild fever (CDC, 2016c, p.2).

Due to the uncommonness of meningococcal infection, obtaining firm efficacy rates for the vaccines has been difficult. However, rates of immune system response suggestive of immunity have been studied. For the Menactra vaccine, eight to nine out of every ten adolescents vaccinated showed an immune response suggestive of efficacy one month after series completion, while seven to nine out of every ten adults vaccinated showed an immune response suggestive of efficacy one month after series completion. For the Menveo vaccine, seven to nine out of every ten adolescents vaccinated showed an immune response suggestive of efficacy one month after series completion, with the same result in adult recipients (NCIRD, 2017a).

**Tetanus**

Tetanus, commonly known as lockjaw, is a disease caused by toxins released from the *Clostridium tetani* (*C. tetani*) bacteria. *C. tetani* is a spore-forming bacterium commonly found in the outside environment, especially in soil. The toxin affects the nervous system, causing symptoms within two to fourteen days of initial contact (Faulkner & Tirwari, 2017). Symptoms of tetanus include painful muscle tensing and whole-body muscle stiffness. The stiffness and tightening particularly may affect the head and neck, preventing an individual from opening their mouth, swallowing, and/or breathing. Even with medical care, the mortality rate for those that contract tetanus is about 10% (CDC, 2015).

The most recent data reported by the CDC indicated 29 cases of the disease and two deaths in 2015 (Faulkner & Tirwari, 2017). One hundred ninety-seven cases of
tetanus resulting in 16 deaths were reported for the six-year period of 2009 through 2015.
Tetanus immunoglobulin, a dose of tetanus antibodies given intramuscularly, can offer protection if administered promptly following an injury suspicious for tetanus infection, like a deep puncture wound or a significant wound received while outdoors. This should be followed by a tetanus vaccine booster dose. Aside from this intervention, supportive hospital care is the only option available. Tetanus does not spread from person to person. Infection occurs only through environmental exposure in wounds which can host C. tetani and where it can produce toxins. This underscores the necessity of vaccination for as many individuals as possible. Further, defense against the disease wanes over time. Therefore, a booster dose is recommended every ten years to support continued immunity (Faulker & Tirwari, 2017).

Vaccination against tetanus is offered in combination with diphtheria in a vaccine known as Td, or with diphtheria and pertussis in vaccines known as Tdap or DTaP. The DTaP vaccine is a childhood vaccine routinely given as a series of five shots between ages two months and seven years. DTaP is not recommended for individuals over seven years of age (CDC, 2018b). The Tdap vaccine is recommended during adolescence; a single dose should be given around age 11. The Td formulation is recommended every ten years following the Tdap vaccine administration date or after a severe puncture injury or wound (CDC, 2017b). Typically, the Tdap vaccine is well-tolerated, but some side effects are possible. According to the Tdap VIS,

Mild problems following Tdap include pain where the shot was given (about 3 in 4 adolescents or 2 in 3 adults), redness or swelling where the shot was given (about 1 person in 5), mild fever of at least 100.4°F (up to about 1 in 25
adolescents or 1 in 100 adults), headache (about 3 or 4 people in 10), tiredness (about 1 person in 3 or 4), nausea, vomiting, diarrhea, stomach ache (up to 1 in 4 adolescents or 1 in 10 adults), chills, sore joints (about 1 person in 10), body aches (about 1 person in 3 or 4), or rash, swollen glands (uncommon). Moderate problems following Tdap may include pain where the shot was given (up to 1 in 5 or 6), redness or swelling where the shot was given (up to about 1 in 16 adolescents or 1 in 12 adults), fever over 102°F (about 1 in 100 adolescents or 1 in 250 adults), headache (about 1 in 7 adolescents or 1 in 10 adults), nausea, vomiting, diarrhea, stomach ache (up to 1 or 3 people in 100), or swelling of the entire arm where the shot was given (up to about 1 in 500). Rare severe problems may include swelling, severe pain, bleeding and redness in the arm where the shot was given (CDC, 2015, p.2).

According to the NCIRD (2016b), all of the complete tetanus toxoid series are approximately 100% effective at preventing tetanus infection as long as the most recent dose was within ten years. For diphtheria, vaccination is 95 to 97% effective at preventing infection. The vaccine has been reported to be 80 to 85% effective at preventing pertussis.

**Diphtheria**

Diphtheria is a bacterial disease spread by the secretions of an infected person through coughing or sneezing. The most significant symptom is a thick coating in the back of the throat. The disease may result in breathing difficulties, paralysis, heart failure, and death. Diphtheria is rare in the U.S., with only two cases reported between 2004 and 2015. However, over 7,000 cases were reported worldwide in 2014. Global travel still
may bring U.S. residents in contact with the disease. Treatment involves administration
of an antitoxin and antibiotics, along with supportive therapies. The case fatality rate is
approximately five to ten percent, though it may be over 20% for the very young and
those over the age of 40. Prior to the availability of treatment, the case fatality rate for
diphtheria was 50%. Widespread vaccination has significantly reduced the incidence of
the disease in the U.S., though booster doses are necessary every ten years due to a
decrease in immunity over time (National Center for Immunization and Respiratory
Diseases-Division of Bacterial Diseases [NCIRD-DBD], 2016).

Pertussis

Also known as whooping cough, pertussis is an infection of the *Bordetella
pertussis* bacterium, which spreads through contact with the oral or nasal secretions of an
infected person. The disease causes severe coughing fits which may result in difficulty
breathing, vomiting, poor sleep, or even rib fractures. Weight loss and incontinence also
may occur. As many as two in 100 adolescents and five in 100 adults with this illness
require hospitalization or have complications such as pneumonia or death (CDC, 2015).
In the U.S. in 2016 and 2017, 17,972 and 15,808 cases of pertussis were reported,
respectively (NCIRD-DBD, 2018b). Cases were further broken out by age for 2017. The
11 to 19-year-old age group accounted for 5,139 cases (32.5% of the total cases),
resulting in an incidence rate of 13.7 per 100,000. Of the 13 reported deaths, nine were in
those aged one year and older (NCIRD-DBD, 2018a).

Varicella

Infection with the varicella virus can result in two types of disease. Primary
infection presents as chickenpox, or varicella. The virus then retreats to the dorsal root
ganglia (the root of a spinal nerve), from which it may reactivate and manifest as latent
disease in the form of herpes zoster (shingles). Signs and symptoms of varicella include
fever and a rash characterized as itching (pruritic), generalized, and flat red areas
interspersed with raised red areas and small blisters (maculopapulovesicular). Lesions
most commonly appear on the torso and limbs, but may be present on the head, mucous
membranes, and membranes of the eye (conjunctivae). Complications include
pneumonia, secondary infections of lesions, bleeding issues, and encephalitis. Herpes
zoster vesicles typically occur unilaterally and are localized to the skin area along the
dermatome of the associated nerve root, typically thoracic, cervical, or ophthalmic.
Complications include chronic severe pain, occurring in about 10 to 15% of cases and
lasting for months to years, permanent neurological damage, or visual impairments if the
infection involves the ophthalmic area (Heymann, 2015).

According to Lopez, Leung, Schmid, and Marin (2018), prior to widespread
vaccination, infection with varicella was so common that “the number of cases
approximated the birth cohort over time” (p.1). Ninety percent of cases occurred in
children less than 15 years of age. Vaccination has produced a 97% decline in cases of
varicella. In cases that do still occur, most occur in those who are vaccinated. These cases
tend to be much milder than those of unvaccinated persons, with significantly fewer
lesions and a shorter duration of illness. National incidence rates have been difficult to
determine due to inconsistent state reporting practices. However, Lopez, Zhang, and
Marin (2016) reported approximately 21,378 cases of varicella among 40 states for the
2013 to 2014 time period, resulting in an incidence rate of approximately 3.4 per 100,000
population.
The varicella vaccine is recommended for children at one year of age, with a second dose between the ages of four and six. Adolescents and adults who are unvaccinated and have not had varicella disease also are recommended to receive the vaccine, as a two-dose series set one month apart. Like the MMR vaccine, the varicella vaccine is a live virus vaccine. According to the VIS, side effects might include sore arm from the injection, fever, redness or rash at the injection site. If these events happen, they usually begin within 2 weeks after the shot. They occur less often after the second dose. More serious events following chickenpox vaccination are rare. They can include seizure (jerking or staring) often associated with fever, infection of the lungs (pneumonia) or the brain and spinal cord coverings (meningitis), or rash all over the body. A person who develops a rash after chickenpox vaccination might be able to spread the varicella vaccine virus to an unprotected person. Even though this happens very rarely, anyone who gets a rash should stay away from people with weakened immune systems and unvaccinated infants until the rash goes away (CDC, 2018d, p.2).

The varicella vaccine is approximately 70 to 90% effective at preventing infection (NCIRD; 2016b). The vaccine also is 90 to 100% effective at preventing moderate to severe varicella disease, meaning that individuals who do contract the infection are much more likely to experience a milder course of illness if they have been vaccinated.

Factors Associated with Vaccination

Maternal Characteristics

Myers, Spracklen, Ryckman, and Murray (2015) conducted a retrospective study of newborn vaccination against HepB. They found that children with a single mother
were less likely to be vaccinated than children of married women. Also, Caucasian women were less likely to vaccinate their infants than women of Hispanic, Asian, and other minority groups. African American women were the exception; they showed no difference in likelihood of vaccination compared to Caucasian women.

Willis, Wortley, Wang, Jacques-Carroll, and Zhang (2010) also assessed receipt of the HepB vaccine. Findings indicated that children with mothers who carried Medicaid insurance were more likely to be vaccinated than those with private or other/unknown insurance carriers. Interestingly, maternal race was not significantly associated with vaccination status in this study. Luman, McCauley, Shefer, and Chu (2003) also studied maternal characteristics associated with the vaccination status of children. Characteristics associated with failure to vaccinate as recommended were less than a high school education, having had four or more children, and being eligible for the Women, Infants, and Children (WIC) program, but not participating in the program.

Medical Practice Characteristics

In addition to assessing maternal characteristics related to vaccination status, Willis, Wortley, Wang, Jacques-Carroll, and Zhang (2010) assessed hospital characteristics, specifically hospital policies and practices associated with vaccination status. Results indicated that the strongest predictors of HepB vaccination were a hospital policy supporting vaccination at birth, and residence of the infant in a state which offered childhood vaccinations at no cost.

Wooten, Janssen, Smith, and Pickering, (2009) also studied medical practice characteristics associated with vaccination status. They found that children who were white and who utilized non-Vaccines for Children (VFC) providers or received health
care at practices serving mostly non-Medicaid eligible patients were more likely to receive recommended vaccinations on schedule. The VFC program is a federal initiative to provide vaccines to children up to age 19 who do not have insurance, are Medicaid recipients, or are Native American or Alaska Natives (Schaffner, Brooks, Jenson, Juszczak, & Word, 2005). Children who were black and used VFC providers or visited practices with a higher Medicaid-eligible population were less likely to receive the recommended childhood vaccinations on schedule. However, children who were Black or Hispanic and did use a VFC provider were more likely to be appropriately vaccinated than those who visited a non-VFC provider. The size of the white population served at a medical practice also was significantly inversely associated with missing an entire vaccination series for white children. Those using a practice where more than 50% of the population were white were less likely to completely miss a vaccine series than those attending practices whose population was less than 50% white. However, this finding was not associated with an increased likelihood of having received all vaccinations on schedule for any group of children. Overall, researchers found that white children received recommended vaccines on schedule more often than black children.

**Personal Demographic Characteristics**

The demographic characteristics of the individual also have been linked to vaccination status. Utilizing a survey of parents, Seib and colleagues (2016) assessed vaccine receipt, chronic health conditions, and health insurance status of adolescents at 11 middle and high schools in Georgia for Tdap, HPV, meningococcal, and influenza vaccines. Results indicated that adolescents with chronic health conditions were more likely to be vaccinated than their peers without chronic conditions. Furthermore,
adolescents with any type of health insurance were more likely to be vaccinated than those without health insurance.

Cofie and colleagues (2018) studied data obtained from a national sample of women aged 18 to 35 from the National Health Interview Survey from 2013 to 2015. The authors found that, among women studied who were born in the U.S., race and ethnicity were not associated with initiation of the HPV vaccine series. Conversely, Ganguly and Banerji (2000) noted an association between race/ethnicity and vaccination status when studying undergraduate and graduate students at the University of South Florida – Tampa. Researchers used a survey-educate-survey method to assess students’ knowledge and attitudes about HepB and the HepB vaccine. The authors found that factors associated with HepB vaccination were race, health insurance status, and sex. Students who had health insurance, were female, and were white were most likely to have received the vaccine.

Walker, Smith, and Kolasa (2014) reported mixed findings when studying racial/ethnic disparities in receipt of the MMR, polio, and DTaP vaccines. The research was undertaken to assess the impact of implementation of the VFC program and looked at data beginning in 1995 and ending in 2011. Results indicated a significant reduction in disparities between non-Hispanic white children and children of other racial/ethnic groups. For the MMR and polio vaccines, vaccination disparities were found to be absent for Hispanics, non-Hispanic blacks, and American Indian/Alaska Natives compared to non-Hispanic white children. Some disparities between groups did exist for the DTaP vaccine; Hispanic and non-Hispanic black children had lower vaccination rates compared to non-Hispanic white children.
Using data from the 2012 National Health Interview Survey (NHIS), Lu and colleagues (2015) assessed the interaction of race/ethnicity and vaccination status for five common adult vaccines: influenza, tetanus, pneumococcal, HPV, and shingles. The researchers found that overall vaccination coverage was lower among non-Hispanic blacks, Hispanics, and non-Hispanic Asians when compared to non-Hispanic whites, despite corrections for socio-demographic factors and factors related to access to care. Other than race/ethnicity, factors affecting vaccination status included age, sex, level of education, access to health insurance, and having an established healthcare provider relationship. Authors commented that racial disparities in childhood vaccinations have significantly improved or even become unobservable for some vaccines, but that racial/ethnic disparities have persisted for vaccines recommended during adulthood. They speculated that the reduction in racial disparities for childhood vaccines may be due to the VFC program and school requirements for vaccines.

In a separate study using data from the 2012 NHIS, Lu and colleagues (2014) assessed overall vaccination status among individuals born in the U.S. compared to those born outside the U.S. Among individuals studied, vaccine coverage was higher for native-born respondents than foreign-born respondents for the pneumonia, Td, Tdap, and HPV vaccines after adjusting for confounders. Similarly, when studying vaccination coverage among adult populations in the U.S., Williams and colleagues (2016) found that native-born respondents had significantly higher vaccination coverage than those born outside the U.S.

Cofie and colleagues (2018) also examined the vaccination status of native and foreign-born U.S. residents, specifically for HPV. Data were obtained from a national
sample of women aged 18 to 35 gathered from the NHIS from 2013 to 2015. Vaccine initiation and series completion were used as the outcome variable of interest. Researchers found that foreign-born women were about half as likely to initiate HPV vaccination compared to U.S.-born women; though for either group, only 9% reported completion of the series. Among foreign-born women, those born in Europe and South America were more likely to be vaccinated than other foreign-born groups; women born on the Indian subcontinent were least likely to have initiated the series. Logistic regression analysis was used due to the interaction of health insurance status and foreign-born status, as a factor significant for series initiation was access to health insurance. In this study, U.S.-born women were more likely to have access to health insurance.

The interaction of health care provider and patient characteristics was studied by Faherty, French, and Fiks (2016). Researchers analyzed whether relationships existed between the gender of the child, the guardian, and the clinician, and receipt of three common adolescent vaccines: Tdap, HPV, and menACWY. Findings indicated that female clinicians were more likely than male clinicians to administer Tdap, HPV, and menACWY vaccinations to their patients at acute clinical visits, though this distinction did not hold true for preventive clinical visits. Female patients were more likely to receive the HPV vaccine than male patients, regardless of the gender of their clinician. However, that gap was shown to narrow over time; the most significant gap occurred in 2010 data, collected at the beginning of the study period. By 2014, the end of the study period, the gender gap was no longer present. The gender of the guardian attending the health care visit with the patient was not associated with HPV vaccine receipt.
A link between gender and HPV vaccination also was reported by Thompson and colleagues (2017). Researchers used self-reported data from students who participated in the American College Health Association (ACHA)’s National College Health Association – II (NCHA – II) survey in fall 2012 to discover factors associated with HPV vaccination status at U.S. colleges and universities. Among the 18,919 surveyed students, 47.9% reported having received the HPV vaccine series. The authors reported that white female students were more likely than students of all other races and ethnicities studied to have received the vaccine. For male students, African American men were more likely than white men to report being vaccinated. Additionally, students of either sex who were insured were more likely to have had the vaccine.

Bendik, Mayo, and Parker (2011) surveyed female undergraduate students aged 18 to 24 at Clemson University and used the Health Belief Model to assess the perceived severity and perceived susceptibility to HPV and cervical cancer. Perceived barriers to vaccine receipt also were assessed. Results indicated that older women and minorities were less likely to be vaccinated than younger women and white women. Further, an individual’s decision to receive the HPV vaccine was associated with parent, partner, and social group approval, as well as personal perceptions of HPV and cervical cancer, and health care provider recommendations. Jones and Cook (2008) also utilized the Health Belief Model in assessing HPV vaccine acceptance among college students in a convenience sample of 340 undergraduate students at a northeastern university in the U.S. Researchers found that factors associated with intention to receive the HPV vaccine were having had an STD, having a healthcare provider recommend the vaccine, being sexually active, having had more than five sexual partners, and knowing someone who
had HPV. Those with higher perceived susceptibility were more likely to indicate intention to receive the vaccine, as were those whose parent, partner, or social group approved of the vaccine. Acceptance of the HPV vaccine was not found to be related to age, race, personal history of HPV, or perceived severity of having HPV. The cost of the vaccine was reported as a barrier to vaccination acceptance.

**Barriers**

In a literature review of barriers to vaccination, Ventola (2016) noted common themes related to non-compliance with the recommended vaccination schedule. Concerns about vaccine side effects was one of the most common reasons given by parents for failing to vaccinate their children on schedule or at all. Specific concerns cited included apprehension about the contents of the vaccine itself, worry that the vaccine would cause their child to develop an infectious disease, and fear that vaccination would lead their child to develop autism, attention-deficit/hyperactivity disorder, or autoimmune diseases. Parents also voiced concerns about the number and frequency of injections. Moral and religious objections were cited, particularly in relationship to the HPV vaccine, as HPV is a virus transmitted through sexual contact. Lack of access and education were important barriers as well. Lack of access may be physical in that some parents may be unable to get transportation to a clinic for vaccination or may be unable to visit during normal clinic hours due to work schedules. Cost also may bar access, especially for uninsured individuals. Though assistance is available through the VFC program, many may not know that they qualify for this program. Lack of education regarding the benefits and importance of vaccination represents an additional barrier to access, especially for non-native English speakers.
In a report from the National Foundation for Infectious Diseases, Schaffner, Brooks, Jenson, Juszczak, and Word (2005) discussed the barriers to vaccination among adolescents. One barrier explored by the authors particularly significant to the educational setting was the “failure to adequately enforce current vaccination requirements, especially after initial school entry” (p.12), though the authors asserted that penalties for failure to comply are not difficult to enforce. Lack of uniformity in state laws regarding required vaccinations, a decrease in provider/patient contact during the adolescent/young adult years, and lack of education about available vaccines also were cited as barriers to complete vaccination. Among the solutions recommended by the authors, provider reminders, school-based vaccination and awareness programs, and provider awareness of the VFC program stood out as options for future action.

Barriers to HPV vaccination uptake among adolescents were studied by Farmar and colleagues (2016) at Denver Health in Colorado as well. Researchers reported known parental barriers from the literature, including long-term safety concerns, low perceived severity and susceptibility to harms associated with HPV, fears that receipt of the vaccine will encourage sexual activity, and lack of understanding of the benefits of giving the HPV vaccine to males. Provider-related barriers from within the body of literature included failure to strongly recommend the HPV vaccine, concerns about receiving reimbursement for providing the vaccine, and missed opportunities to provide education or the vaccine itself.

**Solutions**

In the same study, Farmar and colleagues (2016) offered solutions to reduce barriers to vaccination among adolescents. The use of an adolescent vaccine ‘bundle’
intervention to include the Tdap, menACWY, and HPV vaccines was encouraged. Additionally, medical assistants were given a standardized process to allow them to offer any necessary vaccines to the patient at any acute care visit, without requiring a provider to sign off as long as the situation was routine. Following the implementation of these interventions, researchers found that adolescent vaccination rates were significantly higher compared to those of the nation or state.

A recent CDC (2018a) publication, reportedly adapted from Khatib (2015), echoed the provider recommendations by Farmar and colleagues for improving vaccination rates. The title of Khatib’s unpublished manuscript, *The 10 Immunization Success Factors: Practical Strategies for Providers*, indicated a focus on vaccinations in general; however, the CDC adapted the recommendations specifically for HPV. A recommendation of primary importance was for clinicians to strongly recommend the HPV vaccine to their patients. According to the CDC (2018a), clinician recommendation was the primary reason that parents decided to vaccinate their children for HPV. This underscores the influence that the health care community can wield in terms of reducing infectious disease risk in the community. The publication additionally recommended bundling age-appropriate vaccinations, highlighting the importance of vaccination receipt within health center culture, and having knowledge of the vaccination rates for all people served by the clinic.

Ventola (2016) assessed measures shown to improve compliance with the recommended vaccination schedule through a review of literature. Measures of high importance were recommendations, education, and interventions from primary care providers and other health providers. Clear provider communication about the benefits of
vaccination, improving the ease of access to vaccination for patients already in the clinic, and opportunity for patient counseling regarding vaccination were found to be instrumental in improving vaccination rates. Patient reminders and the use of electronic medical record (EMR) alerts to remind health care staff of a patient’s need for vaccination also were recommended. Finally, community outreach around vaccination and providing opportunities for vaccination at locations other than a clinic also contributed to compliance.

Recommendations from the Immunization Action Coalition (IAC) (2008) closely echoed those referenced by Ventola. With support from the CDC, the IAC created a checklist for clinics working to improve their vaccination services. Highlighted opportunities to improve vaccination services included keeping clinic staff updated on vaccine recommendations, keeping accurate patient records, maintaining a sufficient supply of vaccines, utilizing every interaction as an opportunity to discuss vaccination, communicating clearly with patients regarding vaccine recommendations, and evaluating the clinic’s performance and outcomes for patient vaccinations.

Hurley, Turner, and Butler (2001) specifically studied strategies to improve vaccination rates among college students for the HepB vaccine. The population studied was students attending the University of Kentucky. As HepB vaccination had only become mandatory to enter public schools in 1992, many college students at the time of this study were unvaccinated. The researchers conducted an awareness campaign including letters and interactions with new students at orientation sessions and conducted a Hepatitis Awareness Week event at which vaccinations were given at a discount. The authors concluded that coupling education with increased ease of, and opportunity for,
vaccination resulted in a large uptake of the vaccine among students. Thompson and colleagues (2017) also sought solutions in their study of HPV vaccinations in college populations. Based on their findings, the authors recommended that campus health officials at colleges and universities increase their efforts to educate students about the HPV vaccine as part of their regular health services. They also suggested including information as part of college health fairs to promote social norming of HPV discussions. Peer health ambassadors were noted to be particularly valuable for the latter educational opportunity.

**Vaccination in Wisconsin**

Middle and high school students are required by Wisconsin state law to show proof of vaccination against Tdap, Polio, HepB, MMR, and varicella (Moyer & Wilson, 2018). Proof of history of varicella disease also is considered acceptable in place of the varicella vaccine (Immunization Action Coalition, 2018c). Students are considered compliant if they receive the first dose of a required vaccine by the thirtieth day of school (Moyer & Wilson, 2018). Legal notices are sent for students who are behind schedule or have no record. However, requirements can be waived for health, religious, or personal convictions. For 2017, 1.7% of Wisconsin K-12 students received no immunizations at all and had a waiver for all vaccines. However, nearly five percent of students had a waiver on file for at least one vaccine. Medical and religious waivers represented less than one half percent of these (Moyer & Wilson, 2018). Vaccination rates for common adolescent vaccines were reported by the WDHS for adolescents 13 to 18 years of age for Wisconsin (2018b) and for La Crosse County (2018a) in 2017 (Table 1). Data were
drawn from the Wisconsin Immunization Registry (WIR), which has been shown to be an accurate source of immunization history data (Koepke et al., 2015).

Table 1. Vaccine Coverage of Adolescents 13 to 18 Years of Age in Wisconsin and La Crosse County, 2017 (WDHS, 2018b; WDHS, 2018a)

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Percent vaccinated in Wisconsin</th>
<th>Percent vaccinated in La Crosse County</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPV ≥ 1 dose</td>
<td>53.26</td>
<td>63.31</td>
</tr>
<tr>
<td>HPV complete</td>
<td>39</td>
<td>50.44</td>
</tr>
<tr>
<td>menACWY ≥ 1 dose</td>
<td>70.93</td>
<td>76.76</td>
</tr>
<tr>
<td>menACWY complete</td>
<td>43.94</td>
<td>49.74</td>
</tr>
<tr>
<td>Tdap ≥1 dose</td>
<td>78.82</td>
<td>80.27</td>
</tr>
</tbody>
</table>

Vaccination in College

All individuals may be affected by their vaccination status and the status of others. However, the college population is at particular risk for communicable disease outbreaks such as mumps, measles, and meningitis. College students often are living in close contact with large groups of people and may be sharing bathrooms, food services, and living quarters, increasing the likelihood and ease of coming into contact with pathogens (CDC, 2012; Golwalkar, Pope, Stauffer, Snively, & Clemmons, 2018; McAndrew, 2018; Prater et al., 2016; Strunk & Rocchiccioli, 2010; USDHHS, 2017b). The increased contact with large groups inherent to the college experience puts students at risk; this risk may be even greater for students who are unable to receive vaccinations due to other health issues and who must rely on herd immunity for protection from vaccine-preventable diseases.
According to the American College Health Association (ACHA) Vaccine-Preventable Diseases Advisory Committee (VPDAC) (2018), “immunizations offer safe and effective protection from vaccine-preventable diseases and outbreaks” (p.1). The ACHA strongly supports vaccination for all college students as is medically possible to ensure the health of all individual students as well as campus populations overall.

Immunization guidelines for college students were created by the committee based on best practice recommendations from the CDC. College and university institutions are encouraged to implement comprehensive immunization policies in accordance with the guidelines set forth by the ACHA. The ACHA-VPDAC guidelines recommend vaccines specifically for the college population to prevent outbreaks of contagions which may cause disruptions to students’ learning, and financial and emotional burdens for students and their families. Vaccines should be obtained upon or prior to college entrance and should include influenza, MMR, menACWY, Tdap, and varicella. Additionally, vaccination against hepatitis A, HepB, HPV, and polio for all adults is recommended (ACHA-VPDAC, 2018).

**Healthy Campus 2020**

Adherence to these guidelines is further encouraged by the inclusion of objectives related to vaccination rates in the Healthy Campus 2020 initiative supported by the ACHA (2018c). According to the ACHA (2018a), Health Campus 2020 was created to provide and support measurable goals and objectives aimed at improving the health of campus populations across the country. Explicit goals include creating an environment supportive of health for all and supporting initiatives to allow students to live healthful lives free from preventable disease. Specific to immunization and infectious disease,
student objectives include increasing the proportion of students reporting receiving the HepB, HPV, influenza, MMR, meningococcal, and varicella vaccines.

The ACHA’s Healthy Campus objectives provide baseline and target vaccination rates for each vaccine of interest (ACHA, 2018c). Baseline vaccination rates were obtained from the ACHA’s National College Health Assessment – II (NCHA-II) survey from spring 2010. Post-secondary institutions self-select to participate in the NCHA-II survey, which is offered once in the spring semester and once in the fall semester. National reference groups are created by aggregating scores from institutions where the entire student body is surveyed, or where random sampling is used to select survey participants. All responses are self-reported by participating students (ACHA, 2018b).

The initial NCHA survey underwent extensive pilot testing and, according to the ACHA (2019), has been found to be valid and reliable. However, “because the schools are self-selecting, the ACHA-NCHA databases cannot be said to be generalizable to all schools and students in the United States” (ACHA, 2019, para. 1). No discussion of validity and reliability of the updated version, NCHA – II, was found.

An additional source from which the ACHA drew baseline rates was the CDC’s National Immunization Survey – Teen (NIS – Teen) from 2010 (ACHA, 2018c). This survey used vaccination records verified by healthcare providers. According to the National Center for Immunization and Respiratory Diseases (NCIRD) (2017b),

the NIS-Teen uses a nationally-representative sample to estimate vaccination coverage weighted to represent the entire population for the nation, each HHS region, state, and selected local areas. (para. 4)
Data from 17-year-old participants were compiled by the ACHA to establish baseline and target rates. The ACHA (2018c) specified a target of 10% improvement in rates of vaccination for each vaccine. How this improvement goal was determined was not discussed. Though each vaccine objective specifically stated a target of a 10% improvement in vaccination rate, the 2020 target rate for each vaccine did not reflect this statement (Table 2). It should be noted that the baseline rate for varicella vaccination drawn from the 2010 NIS – Teen survey additionally included those with a documented history of varicella disease.

Table 2. Baseline and Target Vaccination Rates from ACHA Healthy Campus 2020 Objectives (ACHA, 2018c)

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Baseline vaccination rates NIS-Teen/NCHA II</th>
<th>Target vaccination rates NIS-Teen/NCHA II</th>
</tr>
</thead>
<tbody>
<tr>
<td>HepB</td>
<td>88.6/73.0</td>
<td>97.5/80.3</td>
</tr>
<tr>
<td>HPV</td>
<td>53.1/33.2</td>
<td>58.4/36.5</td>
</tr>
<tr>
<td>MMR</td>
<td>88.6/70.9</td>
<td>97.5/78.0</td>
</tr>
<tr>
<td>Meningococcal</td>
<td>57.1/54.7</td>
<td>62.8/60.2</td>
</tr>
<tr>
<td>Varicella</td>
<td>79.1/43.4</td>
<td>87.0/47.7</td>
</tr>
</tbody>
</table>

Aside from the importance placed on vaccination by the ACHA, vaccination for college students also is supported by Wisconsin state law. Per 2003 Wisconsin, Act 61, schools within the University of Wisconsin (UW) System must provide information to students and parents regarding the importance of vaccination against meningococcal disease and HepB. They also must ask students living in residence halls to confirm whether they are vaccinated against these diseases and to provide dates of vaccination.
UW System schools must retain these records in a confidential manner (Wisconsin State Legislature, 2018). However, unlike the reports from Wisconsin school districts, no aggregated vaccination data for the UW System were found to be publicly available.

**Vaccination Rates**

**National Immunization Survey – Teen.** The most recent U.S. vaccination coverage reported from the NIS – Teen was from 2017 (Walker et al., 2018). Vaccination rates in Table 3 were shown for the 17-year-old age group specifically, consistent with the source and criteria of data cited by the ACHA in the Healthy Campus 2020 objectives.

Table 3. Estimated Vaccination Coverage Among Adolescents 17 Years of Age, 2017 (Walker et al., 2018)

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Estimated vaccination rate % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MenACWY ≥ 1 dose</td>
<td>84.4 ± 2.7</td>
</tr>
<tr>
<td>MenACWY ≥ 2 doses</td>
<td>44.3 ± 2.9</td>
</tr>
<tr>
<td>HPV ≥ 1 dose</td>
<td>72.0 ± 3.9 Female</td>
</tr>
<tr>
<td></td>
<td>64.3 ± 3.7 Male</td>
</tr>
<tr>
<td>HPV series completion</td>
<td>58.7 ± 4.5 Female</td>
</tr>
<tr>
<td></td>
<td>46.4 ± 3.9 Male</td>
</tr>
<tr>
<td>MMR ≥ 2 doses</td>
<td>91.3 ± 1.9</td>
</tr>
<tr>
<td>HepB ≥ 3 doses</td>
<td>91.7 ± 1.8</td>
</tr>
<tr>
<td>Varicella (Hx disease or ≥ 2 doses)</td>
<td>87.8 ± 2.3</td>
</tr>
<tr>
<td>Tdap</td>
<td>88.1 ± 2.7</td>
</tr>
</tbody>
</table>

\( n = 3,807 \)
The NIS – Teen survey also assessed vaccination rates by state. Vaccination rates for Wisconsin specifically are provided in Table 4 (NCIRD, 2017).

Table 4. Estimated Vaccination Rates among Wisconsin Adolescents 13 to 17 Years of Age, 2017 (NCIRD, 2017)

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Vaccination rate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MenACWY ≥ 1 dose</td>
<td>83.8 ± 4.9</td>
</tr>
<tr>
<td>HPV ≥ 1 dose</td>
<td>73.5 ± 8.4 Female</td>
</tr>
<tr>
<td></td>
<td>65.1 ± 8.4 Male</td>
</tr>
<tr>
<td>HPV completed series</td>
<td>43.5 ± 9.4 Female</td>
</tr>
<tr>
<td></td>
<td>38.1 ± 8.7 Male</td>
</tr>
<tr>
<td>MMR completed series</td>
<td>96.2 ± 2.2</td>
</tr>
<tr>
<td>HepB completed series</td>
<td>94.7 ± 2.9</td>
</tr>
<tr>
<td>Varicella completed series or Hx of disease</td>
<td>96 ± 2.1</td>
</tr>
<tr>
<td>Tdap ≥ 1 dose</td>
<td>90.3 ± 3.8</td>
</tr>
</tbody>
</table>

**National College Health Assessment – II.** More recent national data for college vaccination rates also were available from the ACHA NCHA – II survey assessment. Among 63,497 responding students for the spring 2017 survey, 70% reported HepB vaccination, 56.3% had been vaccinated against HPV, 77.9% against MMR, 69.5% against meningococcal meningitis, and 65.7% against varicella (ACHA, 2017). For the spring 2018 survey, data from 73,912 undergraduate students at 140 schools were used to compile vaccination rates. Sixty-seven percent reported vaccination against HepB, 57.9% against HPV, 71.6% against MMR, 65% against meningococcal meningitis, and 66.8% against varicella. Tdap was not included in the vaccines of inquiry (ACHA, 2018c).
University of Wisconsin-La Crosse. Vaccination data available for the University of Wisconsin-La Crosse (UWL) include the spring 2015 and spring 2018 NCHA-II survey reports. The online survey had 745 respondents and relied on self-report. Vaccination questions were phrased as follows: “Have you received the following vaccinations (shots or series of shots)?” HepB, HPV, influenza, MMR, meningococcal meningitis, and varicella vaccinations were assessed (ACHA, 2015). Table 5 details student responses for each vaccine from the spring 2015 assessment.

Table 5. Vaccination Rates for UWL Respondents to the spring 2015 NCHA-II Survey (ACHA, 2015)

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Yes</th>
<th>No</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>HepB</td>
<td>71.2%</td>
<td>7.9%</td>
<td>20.9%</td>
</tr>
<tr>
<td>HPV</td>
<td>59.9%</td>
<td>24.9%</td>
<td>15.1%</td>
</tr>
<tr>
<td>MMR</td>
<td>78.7%</td>
<td>9%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Meningococcal</td>
<td>72.9%</td>
<td>9.1%</td>
<td>18%</td>
</tr>
<tr>
<td>Varicella</td>
<td>61.3%</td>
<td>26.9%</td>
<td>11.8%</td>
</tr>
</tbody>
</table>

n = 745

UWL also participated in the NCHA-II survey in spring 2018, with 289 student respondents. Results indicated that 79.4% of students were vaccinated against HepB, 72.1% against HPV, 81.6% against MMR, 79.9% against meningococcal meningitis, and 74.7% against varicella (ACHA, 2018d). While these numbers were an improvement over the 2015 survey, the small sample of the student population limited the ability to generalize findings to the population as a whole.
CHAPTER III

METHODS AND PROCEDURES

Introduction

College populations are at particular risk for certain infectious diseases in part due to close quarters and sharing of food and bathroom facilities (U.S. Department of Health and Human Services, 2017a). Vaccination can reduce the risk of infectious disease spread among college students. Vaccines of particular importance for the health of college students include hepatitis B (HepB), human papillomavirus (HPV), meningitis serogroups ACWY (menACWY), measles, mumps, and rubella (MMR), and varicella. These vaccines have been targeted by the American College Health Association (ACHA) in their Healthy Campus 2020 initiative (ACHA, 2018c). The Student Health Center (SHC) at the University of Wisconsin-La Crosse (UWL) requests vaccination records from incoming first-time students. This practice is consistent with Wisconsin state law, which requires that students be asked about vaccination status overall and particularly for the vaccines against HepB and menACWY (Wisconsin State Legislature, 2018).

However, at the time of this study, no process was in place to assess the response rate for the vaccination records request, nor were the vaccination rates of respondents evaluated. The purpose of this retrospective study was to assess vaccination rates of first-time students in the UWL fall 2018 cohort for HepB, HPV, menACWY, MMR, Tetanus, diphtheria, and pertussis (Tdap), and varicella. Assessing the response rate to the vaccination records request was additionally of primary importance. Inferential statistical
analyses were performed to investigate whether relationships were present between records returned or vaccination status and student sex, race/ethnicity, and home state. Because of the novel nature of this investigation and limited ability to make directional predictions, research questions formed the foundation of this study.

**Subject Selection**

Subjects selected for this study included the entire cohort of first-time college students starting at UWL during the fall semester of 2018. First-time college students were chosen as the population of study through conversation with Dr. Abby Deyo, Student Health Center (SHC) Medical Director. Once students arrive on campus, they have the opportunity to interact with the SHC and potentially remedy gaps in vaccination status if the SHC is aware that gaps exist. This may occur in the population of current students when they visit the SHC for other health concerns. As students already present on campus may have interacted with the SHC in this way, the most accurate way to understand the vaccination health and infectious disease risks of incoming students was to assess vaccination status immediately before arrival on campus (Dr. A. Deyo, personal communication, June 7, 2018). As this study occurred during the fall 2018 semester, the most recent first-time college student cohort at UWL was chosen as the population of study.

At the time of this study, there was no process in place to track students who did not respond to the vaccination information request. While the information request was made on behalf of the SHC, students physically received the information request and SHC Immunization History Form (IHF) within the admissions packet sent by the UWL Admissions Office. Therefore, the SHC did not have access to a master list of all
incoming students against which to compare the returned vaccine information forms. Given this fact, obtaining a response rate to the records request was of primary importance in this study. Thus, the census sampling method was chosen. The list of first-time college students in the UWL fall 2018 cohort was obtained from the Office of Institutional Research, Assessment, and Planning at UWL, following study approval from the UWL Institutional Review Board (IRB). The 2,170 students on the list were identified by the office as new, first-year, first-time students for the fall 2018 semester (M. Sturm, personal communication, November 29, 2018).

**Instrumentation**

Vaccination information was gathered for each student from the scanned Portable Document Format (PDF) section of the Point and Click Electronic Medical Record (EMR) system used by the UWL SHC. When vaccination records are returned, they are scanned into the scanned documents section of each student’s personal EMR by SHC staff. Student vaccination data are only accessible as scanned PDF documents under this tab in the EMR; integration into the immunizations tab or into the health record as a whole does not occur. According to a Point and Click EMR representative, there is no way to search the EMR system as a whole by vaccine, vaccination status, or demographics (K. Kindschy, personal communication, June 10, 2018).

The option to seek additional vaccination record information from state registries consistent with the student’s home state was considered for this study. However, the SHC only has access to records through the Wisconsin and Minnesota state registries. Therefore, the researcher would not have had the option to access additional vaccination data for students with home states other than these. Additionally, data collection for this
study occurred months after the vaccination record data should have been returned to the SHC. State registry records can, and should, be continually updated as individuals receive new vaccine doses. The intention of this study was to capture only the vaccines obtained by students prior to entry to the university.

The SHC’s IHF is a five-page document with fill-in-the-blank boxes (Appendix A). Identifying information requested at the top includes the student’s name, address, phone number, birth date, and sex. The subsequent boxes request vaccination dates for TD/Tdap, MMR, varicella, hepatitis A, HepB, meningitis, meningitis B, influenza, DPaT, polio, and HPV. For varicella, a history of disease also is considered acceptable. Dates and results of recent tuberculosis (TB) skin testing also are requested. Recommendations for each vaccine series are given. At the bottom of the first page of the IHF, students are notified that it is acceptable to attach a recent copy of their home state’s immunization record. Additional information requested within the document includes an emergency contact, past medical history including allergies, medications, chronic health conditions, and health insurance information. A consent for treatment statement is included on the second page of the IHF. The third page is a TB screening questionnaire intended to assess the student’s need for TB testing prior to or upon entry to the university. The fourth and final page of the document provides disease and vaccination information about meningitis and HepB. It begins with a notification that, as of January 1, 2004, by law, universities must provide all residence hall students with information about hepatitis B and meningitis diseases and the effectiveness and availability of vaccines against the diseases. No mention is made of the aspect of this law, 2003 Wisconsin, Act 61, which
requires students living in residence halls to report their vaccination status against these diseases to the university (Wisconsin State Legislature, 2018).

It is also common that students return a copy of their state immunization registry record. As the majority of students at UWL are Wisconsin residents (UWL Office of Institutional Assessment, Research, and Planning, 2019), the document returned often is from the Wisconsin Immunization Registry (WIR) (Appendix B). This document usually includes basic identifying information such as name, birth date, and mother’s maiden name. It lists vaccines obtained along with the date of each dose. It also summarizes vaccines recommended for the individual at the bottom of the page, based on the individual’s age and their current vaccination status as recorded in the registry. Doses should be entered in the registry by the clinic or practitioner providing the vaccination. Some clinics and practitioners utilize EMRs that can interface with the WIR and other health records and automatically upload vaccinations entered into a person’s medical record to their state registry record. However, because there is not a consistent connection between all EMRs and state registries, it may fall upon a clinician to enter the vaccination manually and there is a chance that a vaccination will be missed or incorrectly entered. Despite this possibility, the WIR has been shown to be an accurate source of immunization history data (Koepke et al., 2015).

Finally, some students return personal medical records. Many are printed from the medical records maintained by the students’ primary care providers (PCP). The formatting of these records varies, though many are in a list form by either date of vaccination or by vaccination type. Another type of record sometimes provided is vaccination record cards supplied by local health departments in which blank spaces are
provided for PCPs or nursing staff to record vaccinations and then return the card to the patient.

Data Collection

Prior to commencing data collection, the researcher obtained the necessary human subjects training (Appendix C) and study approval was obtained from the UWL IRB (Appendix D). Data collection began with the list of first-time UWL students provided by the Office of Institutional Research, Assessment, and Planning. A random number generator was utilized to generate a non-repeating sequence of numbers in random order (Haahr & Haahr, 2018). The numbers from this sequence, in their random order, then were assigned as the random number identifiers for the list of UWL student identification numbers in the password-protected Excel spreadsheet in which they were stored. The list of random identification numbers then was copied into a separate password-protected document into which the vaccination and demographic data for students were entered.

As noted, sources of data utilized were those available under the ‘scanned documents’ section of the EMR. Documents scanned into the EMR prior to the start of the fall 2018 semester and up to thirty days following the commencement of the fall 2018 semester were considered for this study, consistent with the compliance standards to which Wisconsin middle and high school students are held regarding vaccination requirements (Moyer & Wilson, 2018). The first data point gathered was whether a vaccination history record was available for a student identification number. When records were present, vaccination data were entered into an Excel spreadsheet for each vaccine of study, along with the associated demographic information of sex,
race/ethnicity, and home state. When records were absent, only demographic information
available on the home page of the EMR was entered into the Excel document.

Within the Excel document, the absence of a vaccination record was coded as 1,
while the presence of a vaccination record was coded as 2. HepB, HPV, menACWY,
MMR, Tdap, and varicella vaccination series dates were reviewed for completeness.
Vaccination series for which there was no evidence of initiation were coded as 1.
Vaccination series for which there was evidence of initiation, but not completion, were
coded as 2. Vaccination series for which there was evidence of completion were coded as
3. At times, more than one set of scanned vaccination records were available within the
prescribed timeframe. The first available record was initially reviewed for dates of
vaccines selected for study. If gaps in series completeness were observed after reviewing
the first record, any additional vaccination records also were reviewed. For example, the
SHC IHF may have been returned in early summer, followed by official vaccination
records from a student’s state registry or PCP days or weeks later. If additional
vaccination dose dates were noted, these were included in the data collection, unless the
vaccination occurred after the date of the initial record. If vaccination occurred after the
date of the initial record, there was no way to tell whether the student had received the
vaccine due to intervention by the SHC staff who reviewed returned records for
completeness. Therefore, if the vaccination in question occurred after the date of the
initial vaccine record, the dose was not counted. Additionally, returned SHC IHFs on
which ‘up-to-date’ or ‘scheduled on (a given date)’ had been written were not accepted as
proof of vaccination receipt.
Demographic data were assigned codes. Sex held two categories – male and female. While recognizing that some individuals may not identify with either of these categories, in this study, the categories of male and female were used consistent with the options presented in the SHC IHF. Male was coded as 1 and female as 2. Racial/ethnic categories selected were consistent with those used in research by the UWL Office of Residence Life (Figueroa, 2019; Skyfactor, 2017). Black/African American was coded as 1, Asian as 2, Latino/Hispanic as 3, Two or more races as 4, American Indian/Alaska Native as 5, White as 6, and Not Identified/Unknown as 7. The original list of racial/ethnic categories from UWL Office of Residence Life included the category of ‘Prefer Not to Identify.’ However, as this study did not include a survey or student contact component, and as designations were made by the researcher based on student demographic information from the EMR, the decision was made not to list a ‘Prefer Not to Identify’ category.

Student racial/ethnic classifications within in the EMR were more diverse than those utilized by the UWL Office of Residence Life. Additional student racial/ethnic classifications included Cambodian, Cuban, Hawaiian/Pacific Islander, Hmong, Laotian, Mexican/Chicano, Other Asian, Puerto Rican, and Vietnamese. To fit the seven racial categories chosen, Cambodian, Hmong, Laotian, Other Asian, and Vietnamese were classified as Asian, and Cuban, Mexican/Chicano, and Puerto Rican were classified as Latino/Hispanic. Hawaiian/Pacific Islander was classified as Asian consistent with information from the White House Initiative on Asian Americans and Pacific Islanders (n.d.). Data were collected for each individual racial/ethnic group. However, as 89% of the UWL population identifies as White (UWL Office of Institutional Assessment,
Research, and Planning, 2019), for statistical purposes, racial/ethnic classifications were then grouped into White and Non-White, consistent with previous research among populations with a White majority (Groessl et al., 2019; Mann et al., 2014; Ramachandran et al., 2015).

Home state was coded as 1 for Wisconsin, 2 for Minnesota, and 3 for Other state. For respondents, home state was most often collected from the home address provided on the SHC IHF. In instances where the home state was not filled out on the form, or only vaccination records were returned, the address listed under student demographics on the home page of the EMR was used. Often, this address is the student’s home address. However, the address visible is the one on file with the Office of Records and Registration and can be changed by the student to reflect their local address rather than their home address (K. Kindschy, personal communication, December 19, 2018). If only an on-campus address was listed, the state vaccination registry records or personal health records were used to attempt to determine the student’s home state. Both types of records sometimes included the home address. At minimum, registry records indicated from which state they originated. If the home state was unable to be obtained through these methods, the data point was considered unknown.

For non-respondents, the only source for home state was the address listed in the demographic section of the EMR home page. If only an on-campus address was given, this data point was considered unknown. For both respondents and non-respondents, a local campus address was defined as an address in a residence hall on campus. According to UWL (2018a), about 98% of first year students live in the residence halls on campus. This definition was intended to avoid misrepresenting students who happened to be local
La Crosse residents attending UWL. Therefore, if a student record listed a local La Crosse address that was not an on-campus address, it was assumed that the La Crosse address was their home address.

**Statistical Analysis**

Nominal and ordinal data were generated within this study. Data were collected in Excel and uploaded for analysis with the IBM Statistical Package for the Social Sciences (SPSS) Version 23 program. Initially, the response rate of the first-time college students in the UWL fall 2018 cohort for the SHC vaccination records request was calculated. Descriptive statistical analyses, including frequencies and percentages, were calculated to summarize the selected demographic characteristics of sex, race/ethnicity, and home state. Percentages of completed series, partial series, and no series for the HepB, HPV, menACWY, MMR, and varicella vaccines were calculated for responding students. The percentage of students who were completely vaccinated as recommended was also calculated. As the Tdap vaccine is a single dose vaccine, only percentages of completed series and no series were calculated for responding students.

Inferential statistical analyses consisted of Pearson’s chi-square tests within two–way contingency tables. Chi-square tests were conducted to determine whether a relationship was present between two categorical variables (Field, 2009), consistent with similar research studies (Dempsey, Cohn, Dalton, & Ruffin, 2011; Farmar et al., 2016). Relationships were analyzed between vaccination series and response to records request among student demographics. For significant bivariate results, post hoc tests were conducted for pairwise comparisons of columns (McDonald, 2014). The contingency
table approach allowed for visualization of the distribution of one variable at the levels of the other variable (Howell, 2010).

The two underlying assumptions of a chi-square test, that observations are independent of each other and that analyses are conducted with a large sample size, were initially assessed and deemed acceptable through robustness of data sources and descriptive statistics. However, expected cell frequencies of less than five, or cells with observed counts of zero, would violate these assumptions (Field, 2009; Green, Salkind, & Akey, 2000). Continuing to use a chi-square test while not meeting the assumptions of the test may increase the risk of a Type II error, in which the researcher fails to find an existing significant result (Howell, 2010). Therefore, a statistical test better suited to low expected or observed counts was sought in case the assumptions for a chi-square test were not met when running inferential statistics.

The recommended statistical test in cases of low expected or observed counts was Fisher’s exact test (Field, 2009; Pallant, 2007). For this study, in cases where the second assumption of the chi-square test was not met, the Fisher’s exact test was instead used for analysis. Assumptions of the Fisher’s exact test include the independence of the observations and fixed row and column totals. The second assumption was not met in this case, as it was not known how many students of each demographic variable category would fall into each variable level of vaccination status. This changed the specificity of the test from exact to conservative, thereby somewhat reducing the power of the test, resulting in an increased risk that the researcher failed to find an existing significant result. However, the use of the Fisher’s exact test is still common practice in the field of statistics even when the second assumption is not met (McDonald, 2014). Therefore,
while acknowledging the reduction in the power of the test, the Fisher’s exact test was used in place of chi-square when appropriate.

When conducting inferential statistics, a Bonferroni correction was used to modify the alpha level of significance to reduce the risk of a Type I error, which is the likelihood that a seemingly significant finding actually is due to chance. The risk for Type I error increases when multiple tests are run on the same dataset (Field, 2009; Pallant, 2007). A Bonferroni correction can be calculated by dividing the significance level typically selected, (i.e., $p < .05$), by the number of statistical tests (Field, 2009; McDonald, 2014). In this study, a Bonferroni correction was applied by dividing .05 by the number of statistical tests run on the sample, which was 24. This calculation produced a much more conservative alpha level of significance of $< .002$. When a chi-square test indicated that there was a significant relationship between a demographic variable and vaccination status or records returned, follow-up pairwise comparisons were conducted to evaluate column proportions (Green, Salkind, & Akey, 2000). This allowed the researcher to identify the exact vaccination or records status where the distribution was significantly associated with respondent characteristics. A Bonferroni correction also was applied within tests if the initial analysis indicated significance. This was done by utilizing the SPSS option to adjust $p$ values using the Bonferroni method when comparing column proportions.

Attention to effect size in health education research has been called for in the health education field to allow for increased clarity of research results for practitioners and the public (Cottrell & McKenzie, 2011). Results that were deemed to be statistically significant in this study were also assessed for practical significance, or magnitude of
relationship. Effect size tests commonly associated with two-way contingency table or chi-square tests, phi and Cramér’s $V$, were used. Phi ($\phi$) is the effect size test commonly used for 2x2 tables, while Cramér’s $V$ ($V$) is used for tables larger than 2x2 (Field, 2009; Howell, 2006; Pallant, 2007).
CHAPTER IV

RESULTS

Introduction

College populations are at particular risk for certain infectious diseases in part due to close quarters and sharing of food and bathroom facilities (U.S. Department of Health and Human Services, 2017a). Vaccination can reduce the risk of infectious disease spread among college students. Vaccines of particular importance for the health of college students include hepatitis B (HepB), human papillomavirus (HPV), meningitis serogroups ACWY (menACWY), measles, mumps, and rubella (MMR), and varicella. These vaccines are targeted by the American College Health Association (ACHA) in their Healthy Campus 2020 initiative (ACHA, 2018c). The Student Health Center (SHC) at the University of Wisconsin-La Crosse (UWL) requests vaccination records from incoming first-time students. This practice is consistent with Wisconsin state law, which requires that students be asked about vaccination status overall and particularly for the vaccines against HepB and menACWY (Wisconsin State Legislature, 2018). However, at the time of this study, no process was in place to assess the response rate for the vaccination records request, nor were the vaccination rates of respondents evaluated.

The purpose of this study was to assess vaccination rates of first-time students in the UWL fall 2018 cohort for HepB, HPV, menACWY, MMR, Tetanus, diphtheria, and pertussis (Tdap), and varicella. Differences in vaccination rates also were investigated.
based on sex, race/ethnicity, and home state. Assessing the response rate to the vaccination records request was additionally of primary importance, as well as comparison of response rates based on student demographics. Secondary vaccination record data retrieved from the electronic medical record (EMR) used by the SHC were utilized for this study. Descriptive statistics, including frequencies and percentages, were calculated to summarize the selected demographic characteristics of sex, race/ethnicity, and home state and to calculate vaccination rates for the vaccines studied, as well as for the status of completely vaccinated as recommended. Inferential statistical analysis consisted of Pearson’s chi-square tests within two-way contingency tables and were used to determine whether a relationship was present between demographics and vaccination status or response to records request. For significant bivariate results, post hoc tests were conducted for pairwise comparisons of columns. A Bonferroni correction was applied to any statistically significant results. Effect size statistics used were phi and Cramer’s V.

**Student Vaccination Records**

Student health records were reviewed for 2,165 individuals identified as first-time college students in the UWL fall 2018 cohort. Though the list of first-time college students provided by the UWL Office of Institutional Research, Assessment, and Planning was comprised of 2,170 student identification numbers, five subjects had no associated student health records within the EMR. It is possible that these five students initially were admitted to UWL for the fall 2018 semester but chose not to attend just before the semester commenced.

Other data entry and coding issues that arose involved conflicting records or incomplete information. Some students who returned records not only returned their
completed SHC Immunization History Form (IHF), but also included their state vaccination registry information. Most often, this occurred with Wisconsin residents returning the Wisconsin Immunization Registry (WIR) form along with their SHC IHF. In some cases, information on the SHC IHF would indicate that a student had not had vaccinations, like menACWY or HPV, when the registry record in fact did list vaccination dates. As the WIR has been found to be an accurate source of vaccination data (Koepke et al., 2015), in cases where the state registry records conflicted with information on the SHC IHFs in this manner, the state registry records superseded the handwritten document. For consistency, in cases where other types of additionally supplied records, like other state registries or hospital records, indicated receipt of a vaccine dose not recorded on the handwritten SHC IHF, the supplemental information was considered valid.

State registry records returned with SHC IHFs also were useful in determining the status of students’ Tdap vaccination. On the IHF, a single box is provided for students to write in the date of their most recent Tetanus and Diphtheria (Td) or Tdap vaccine. Instructions on the form direct students to designate for which vaccine they are providing a date. Often, the individual completing the form failed to indicate for which vaccine they were giving a dose date. In instances when additional records were returned along with the IHF, they were used to confirm whether the Td or Tdap vaccine had been administered. When additional records were not returned, a person’s age at vaccination was used to determine which vaccine was likely to have been given, with the assumption that medical providers administered vaccines as recommended. Age was established via visible data on the EMR home page for the student record. The Diphtheria, Tetanus, and
Pertussis (DTaP) vaccine is a five-dose series given between ages two months and six years; it is not recommended after age six. Tdap vaccine is recommended during adolescence, typically around 11 or 12 years of age. The Td vaccine should be given every subsequent ten years following administration of the Tdap vaccine (National Center for Immunization and Respiratory Diseases, 2018a). As Tdap was the vaccine of interest in this study, determining which tetanus vaccine formulation a student received was important (Dr. A. Deyo, personal communication, June 7, 2018). For vaccination dates recorded in the Td/Tdap box occurring at age seven or later, Tdap was assumed to be the vaccine administered. If the student was younger than age seven at the date given, it was assumed that the student had not had their Tdap vaccine.

**Student Demographics**

Demographics for first-time college students in the UWL fall 2018 cohort are given in Table 6. The majority of students in the fall 2018 cohort were female (58%, $n = 1,258$), White (90.1%, $n = 1,951$), and from Wisconsin (74.1%, $n = 1,605$). Student records without an identified racial/ethnic category were included in the ‘unknown’ category (0.3%, $n = 6$). Home state was unable to be determined for just over 10% ($n = 222$) of student records, the majority of which were non-respondents.
Table 6. Demographic Characteristics of the First-Time College Students in the UWL Fall 2018 Cohort

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>$n$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>907</td>
<td>42</td>
</tr>
<tr>
<td>Female</td>
<td>1,258</td>
<td>58</td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
<td></td>
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<tr>
<td>Black/African American</td>
<td>40</td>
<td>1.8</td>
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<tr>
<td>Asian</td>
<td>76</td>
<td>3.5</td>
</tr>
<tr>
<td>Latino/Hispanic</td>
<td>57</td>
<td>2.6</td>
</tr>
<tr>
<td>Native American/Indian</td>
<td>35</td>
<td>1.6</td>
</tr>
<tr>
<td>White</td>
<td>1,951</td>
<td>90.1</td>
</tr>
<tr>
<td>Not Identified/Unknown</td>
<td>6</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Home state</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1,605</td>
<td>74.1</td>
</tr>
<tr>
<td>Minnesota</td>
<td>276</td>
<td>12.7</td>
</tr>
<tr>
<td>Other</td>
<td>62</td>
<td>2.9</td>
</tr>
<tr>
<td>Unknown</td>
<td>222</td>
<td>10.3</td>
</tr>
</tbody>
</table>

$N = 2,165$

**Demographics of Responding Students**

Among responding students, a majority were female (58%, $n = 830$), White (91.4%, $n = 1,311$), and Wisconsin residents (82.1%, $n = 1,172$) (Table 7). State of residence could not be determined for 0.7% ($n = 10$) of respondents.
Table 7. Demographic Characteristics of Responding First-Time College Students in the UWL Fall 2018 Cohort

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>$n$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>608</td>
<td>42</td>
</tr>
<tr>
<td>Female</td>
<td>830</td>
<td>58</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1,311</td>
<td>91.4</td>
</tr>
<tr>
<td>Non-White</td>
<td>124</td>
<td>8.6</td>
</tr>
<tr>
<td>Home state</td>
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<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1,172</td>
<td>82.1</td>
</tr>
<tr>
<td>Minnesota</td>
<td>211</td>
<td>14.8</td>
</tr>
<tr>
<td>Other</td>
<td>45</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Note: Percent refers to valid percent. Missing values excluded.

$n = 1,438$

**Demographics of Non-Responding Students**

A majority of students in the non-responding group were female, (58.9%, $n = 428$), White (88.4%, $n = 640$), and Wisconsin residents (84.1%, $n = 433$) (Table 8). State of residence could not be determined for 29.2% ($n = 212$) of non-respondents.
Table 8. Demographic Characteristics of Non-Responding First-Time College Students in the UWL Fall 2018 Cohort

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>299</td>
<td>41.1</td>
</tr>
<tr>
<td>Female</td>
<td>428</td>
<td>58.9</td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>640</td>
<td>88.4</td>
</tr>
<tr>
<td>Non-White</td>
<td>84</td>
<td>11.6</td>
</tr>
<tr>
<td><strong>Home state</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>433</td>
<td>84.1</td>
</tr>
<tr>
<td>Minnesota</td>
<td>65</td>
<td>12.6</td>
</tr>
<tr>
<td>Other</td>
<td>17</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Note: Percent refers to valid percent. Missing values excluded.

$n = 727$

**Research Questions and Accompanying Results**

**Research Question #1:** What was the response rate to the vaccination records request from the Student Health Center for first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort?

Of the 2,165 student health records, 1,438 were found to contain returned vaccine history records while 727 did not, resulting in a 66.3% response rate to the vaccination records request from the UWL SHC.

**Research Question #2:** What were the vaccination rates of responding first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort against HepB, HPV, menACWY, MMR, Tdap, and varicella?

Among responding students, most had a complete HepB (96.5%, $n = 1,387$), MMR (97.6%, $n = 1,403$), Tdap (95.6%, $n = 1,375$), and varicella (95.6%, $n = 1,376$)
vaccine series (Table 9). A little more than half (57.7%, \( n = 830 \)) had a complete HPV vaccine series. For the menACWY vaccine series, about three quarters (74.5%, \( n = 1,071 \)) of responding students were fully vaccinated.

Table 9. Vaccination Rates of Responding First-Time College Students in the UWL Fall 2018 Cohort

<table>
<thead>
<tr>
<th>Series Completeness</th>
<th>HepB (2%)</th>
<th>HPV (27%)</th>
<th>Men ACWY (13.1%)</th>
<th>MMR (1.6%)</th>
<th>Tdap (4.4%)</th>
<th>Varicella (2.2%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No series</td>
<td>29</td>
<td>388</td>
<td>188</td>
<td>23</td>
<td>63</td>
<td>31</td>
</tr>
<tr>
<td>Partial series</td>
<td>22 (1.5%)</td>
<td>220 (15.3%)</td>
<td>179 (12.4%)</td>
<td>12 (0.8%)</td>
<td>n/a</td>
<td>31 (2.2%)</td>
</tr>
<tr>
<td>Full series</td>
<td>1,387 (96.5%)</td>
<td>830 (57.7%)</td>
<td>1,071 (74.5%)</td>
<td>1,403 (97.6%)</td>
<td>1,375 (95.6%)</td>
<td>1,376 (95.6%)</td>
</tr>
</tbody>
</table>

\( n = 1438 \)

**Research Question #3: What percentage of responding first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort were completely vaccinated as recommended?**

Approximately 48% (\( n = 688 \)) of responding students were completely vaccinated as recommended, meaning they had evidence of a completed vaccine series for HepB, HPV, menACWY, MMR, Tdap, and varicella. Fifty-one percent (\( n = 735 \)) of students were partially vaccinated, indicating they were deficient in one or more doses of the six recommended vaccination series, while 15 students (1%) returned vaccination records with no evidence of any doses of the vaccines of study.
Research Question #4: How did vaccination rates of first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort compare based on sex, race/ethnicity, and home state?

Vaccination rates of first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort based on sex. Chi-square tests were conducted to assess whether significant relationships were present between student sex (male, female) and vaccination series status (no, partial, full). Results were as follows:

- For sex and vaccine series status for HepB, no significant relationship was present $\chi^2(2, N = 1438) = 1.841, p = .398$.
- For sex and vaccine series status for menACWY, no significant relationship was present $\chi^2(2, N = 1438) = .076, p = .963$.
- For sex and vaccine series status for MMR, no significant relationship was present $\chi^2(2, N = 1438) = .938, p = .625$.
- For sex and vaccine series status for Tdap (no series, full series), no significant relationship was present $\chi^2(1, N = 1438) = .028, p = .868$.
- For sex and vaccine series status for varicella, no significant relationship was present $\chi^2(2, N = 1438) = .697, p = .706$.
- For sex and status of completely vaccinated as recommended, a statistically significant relationship was present $\chi^2(2, N = 1438) = 7.083, p = .029, V = .070$.

However, after a Bonferroni correction was applied and the alpha level of significance was adjusted to $< .002$, the result was no longer significant.

The chi-square test conducted to assess whether a relationship was present between student sex and HPV vaccine series status revealed a statistically significant
relationship $\chi^2 (2, N = 1438) = 20.671, p = .000, V = .120$. After applying a Bonferroni correction and adjusting the alpha level of significance to < .002, the result was still significant. Post hoc pairwise comparisons were used to identify levels of vaccination status with significant differences in distribution of males versus females. When comparing column proportions, a built-in Bonferroni correction in SPSS was used to adjust the alpha level of significance to a more conservative value. Within the variable level of no HPV vaccine, the sample proportion for male students was 31.7%, while the sample proportion for female students was significantly lower at 23.5%. Conversely, within the variable level of completed HPV vaccine series, the sample proportion for male students was 50.8%, while the sample proportion for female students was significantly higher at 62.8%. For the partially complete HPV vaccine series variable level, no significant difference was noted between the male (17.4%) and female (13.7%) groups (Figure 3).

![Figure 3. Distribution of Male and Female Respondents by HPV Vaccine Status.](image)
Vaccination rates of first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort based on race/ethnicity. Chi-square or Fisher’s exact tests were conducted to assess whether significant relationships were present between student race/ethnicity (White, Non-White) and vaccination series status (no, partial, full). Results were as follows:

- For race/ethnicity and vaccine series status for HepB, the Fisher’s exact test was not significant at $p = .719$.
- For race/ethnicity and vaccine series status for HPV, no significant relationship was present $\chi^2 (2, N = 1435) = 5.105, p = .078$.
- For race/ethnicity and vaccine series status for menACWY, no significant relationship was present $\chi^2 (2, N = 1435) = 3.974, p = .137$.
- For race/ethnicity and vaccine series status for MMR, the Fisher’s exact test was not significant at $p = .159$.
- For race/ethnicity and vaccine series status for Tdap (none, full), no significant relationship was present $\chi^2 (1, N = 1435) = .065, p = .799$.
- For race/ethnicity and vaccine series status for varicella, the Fisher’s exact test was not significant at $p = .624$.
- For race/ethnicity and the status of completely vaccinated as recommended, the Fisher’s exact test was not significant at $p = .283$.

Vaccination rates of first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort based on home state. Chi-square or Fisher’s exact tests were conducted to assess whether significant relationships were present
between student home state (Wisconsin, Minnesota, Other) and vaccination series status (no, partial, full). Results were as follows:

- For home state and vaccine series status for HepB, the Fisher’s exact test was not significant at $p = .925$.
- For home state and vaccine series status for HPV, no significant relationship was present $\chi^2 (4, N = 1428) = .563$, $p = .967$.
- For home state and vaccine series status for menACWY, no significant relationship was present $\chi^2 (4, N = 1428) = 2.492$, $p = .646$.
- For home state and vaccine series status for MMR, the Fisher’s exact test was not significant at $p = .936$.
- For home state and vaccine series status for Tdap (none, full), no significant relationship was present $\chi^2 (2, N = 1428) = .563$, $p = .755$.
- For home state and vaccine series status for varicella, the Fisher’s exact test was not significant at $p = .994$.
- For home state and status of completely vaccinated as recommended, the Fisher’s exact test was not significant at $p = .953$.

Research Question #5: How did response to the vaccination records request for first-time college students in the University of Wisconsin-La Crosse fall 2018 cohort compare based on sex, race/ethnicity, and home state?

Chi-square tests were conducted to assess whether significant relationships were present between sex, race/ethnicity, or home state and response to vaccination records request (yes, no). Results were as follows:
• For sex and response to the vaccination records request, no significant relationship was present $\chi^2 (1, N = 2165) = .264, p = .608$.

• For home state and response to the vaccination records request, no significant relationship was present $\chi^2 (2, N = 1943) = 1.448, p = .485$.

• For race/ethnicity and response to the vaccination records request, a statistically significant relationship was present $\chi^2 (1, N = 2159) = 4.846, p = .028, \phi = -.047$. However, after a Bonferroni correction was applied and the alpha level of significant was adjusted to < .002, the result was no longer significant.

**Summary**

About two thirds of first-time college students in the UWL fall 2018 cohort responded to the vaccination records request. Complete series vaccination rates were above 95% for the HepB, MMR, Tdap, and varicella vaccines. About three quarters of respondents were fully vaccinated against menACWY, and over half had completed the vaccination series for HPV. Nearly half of respondents were completely vaccinated as recommended. Pearson’s chi-square tests and Fisher’s exact tests were used to analyze whether relationships were present between student demographics and vaccination status, as well as response to the vaccination records request. Results indicated a significant relationship between HPV vaccination status and student sex. Male students were represented at a significantly higher proportion among those completely lacking HPV vaccination, while female students were represented at a significantly higher proportion among those with a completed HPV vaccine series. Sex was not related to vaccination series status for the other five vaccines of study. Results indicated no relationship between vaccine series status and student race/ethnicity or home state for any of the six
vaccines of study. Student sex, race/ethnicity, and home state were not significantly associated with whether students were completely vaccinated as recommended. Sex, race/ethnicity, and home state were also not significantly associated with whether students responded to the vaccine records request.
CHAPTER V

DISCUSSION AND RECOMMENDATIONS

Introduction

College populations are at particular risk for certain infectious diseases in part due to close quarters and sharing of food and bathroom facilities (U.S. Department of Health and Human Services, 2017a). Vaccination can reduce the risk of infectious disease spread among college students. Vaccines of particular importance for the health of college students include hepatitis B (HepB), human papillomavirus (HPV), meningitis serogroups ACWY (menACWY), measles, mumps, and rubella (MMR), and varicella. These vaccines have been targeted by the American College Health Association (ACHA) in their Healthy Campus 2020 initiative (ACHA, 2018c). Without regular assessment of vaccination status, it is difficult to understand the vaccine-preventable disease risk of a given population, or where to direct resources to improve vaccination rates. The Student Health Center (SHC) at the University of Wisconsin-La Crosse (UWL) requests vaccination records from incoming first-time students. This practice is consistent with Wisconsin state law, which requires that students be asked about vaccination status overall, and particularly for the vaccines against HepB and menACWY (Wisconsin State Legislature, 2018). However, at the time of this study, no process was in place to assess the response rate for the vaccination records request, nor were the vaccination rates of respondents evaluated.
The purpose of this study was to assess vaccination rates of first-time students in the UWL fall 2018 cohort for HepB, HPV, menACWY, MMR, tetanus, diphtheria, and pertussis (Tdap), and varicella. Differences in vaccination rates also were investigated based on sex, race/ethnicity, and home state. Assessing the response rate to the vaccination records request was additionally of primary importance, as well as comparison of response rates based on student demographics. Secondary vaccination record data retrieved from the electronic medical record (EMR) used by the SHC were utilized for this study.

Results from this study indicated that approximately 66% of students in the UWL fall 2018 cohort responded to the vaccination records request. Among responding students, vaccination rates were above 95% for HepB, MMR, Tdap, and varicella. Approximately 75% of respondents were fully vaccinated against menACWY, while only about 58% had completed the HPV vaccine series. After applying a Bonferroni correction, the only statistically significant relationship present was between HPV vaccination status and sex. Male students were represented at a significantly higher proportion among those completely lacking HPV vaccination, while female students were represented at a significantly higher proportion among those with a completed HPV vaccine series.

Conclusions and Discussion

Response Rate

Approximately two-thirds of first-time college students in the UWL fall 2018 cohort responded to the vaccination records request from the SHC. While a 66% response rate may be considered good for surveys administered in the health education and health
promotion field, for a process with a supposedly required response, this rate should be much higher. It is possible that some students did not respond due to a lack of consequence associated with failure to respond or due to a lack of understanding of the importance of returning vaccination records as requested. When individuals fail to respond to an information request, the impact of nonresponse error needs to be considered. Nonresponse error is a threat to survey validity as it is rarely random (Adams & Lawrence, 2015; Stratton, 2015). There may be important unknown differences between the groups of non-respondents and respondents, which prevent the generalization of findings to the entire study population. Actions can be taken to reduce nonresponse bias, including issuing reminders and providing incentives. Additionally, if possible, demographics of the entire population should be assessed to identify whether respondent characteristics closely resemble those of non-respondents. In this study, the demographics of the responding and non-responding groups were compared through a visual inspection of the descriptive data in an attempt to understand the effect of nonresponse bias on study findings. Comparison of the two groups showed that Non-White students were more strongly represented in the group that failed to respond to the records request than in the group that did respond to the request. This finding indicates that distinct differences were present between the responding and non-responding groups. Thus, study findings cannot be generalized to the study population.

Vaccination Rates

For responding first-time college students in the UWL fall 2018 cohort, vaccination rates generally were high. Over 95% had records indicating completed vaccine series for HepB, MMR, Tdap, and varicella. Approximately 75% of responding
students had a complete menACWY vaccine series and 58% were fully vaccinated against HPV. When comparing vaccination rates to the ACHA Healthy Campus 2020 target rates (ACHA, 2018c), responding UWL first-time college students exceeded all National College Health Assessment (NCHA) - II target rates. Respondent vaccination rates also exceeded the National Immunization Survey (NIS) -Teen target rates for menACWY, MMR, and varicella, though not for HepB or HPV (Table 10). No target rate was available for Tdap as it was not included as a vaccine of focus in Healthy Campus 2020 objectives.

Table 10. Vaccination Rates of Responding First-Time College Students in the UWL Fall 2018 Cohort Compared to Healthy Campus 2020 Target Rates

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>UWL respondent vaccination rates</th>
<th>Healthy Campus 2020 target vaccination rates NIS-Teen/NCHA II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hep B</td>
<td>96.5</td>
<td>97.5/80.3</td>
</tr>
<tr>
<td>HPV</td>
<td>57.7</td>
<td>58.4/36.5</td>
</tr>
<tr>
<td>MMR</td>
<td>97.6</td>
<td>97.5/78.0</td>
</tr>
<tr>
<td>MenACWY</td>
<td>74.5</td>
<td>62.8/60.2</td>
</tr>
<tr>
<td>Varicella</td>
<td>95.6</td>
<td>87.0/47.7</td>
</tr>
<tr>
<td>Tdap</td>
<td>96</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Additionally, respondent rates exceed those from the state of Wisconsin and La Crosse County in 2017 for the recommended adolescent vaccines of HPV, menACWY, and Tdap (Wisconsin Department of Health Services [WDHS], 2018a) (Table 11).
Table 11. Vaccination Rates of Responding First-Time College Students in the UWL Fall 2018 Cohort Compared to Wisconsin and La Crosse County Data

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Vaccination rates of responding UWL first-time college students, fall 2018</th>
<th>Percent vaccinated in Wisconsin, 2017</th>
<th>Percent vaccinated in La Crosse County, 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPV complete</td>
<td>57.7</td>
<td>39</td>
<td>50.4</td>
</tr>
<tr>
<td>MenACWY</td>
<td>74.5</td>
<td>43.9</td>
<td>49.7</td>
</tr>
<tr>
<td>Tdap</td>
<td>96</td>
<td>78.8</td>
<td>80.27</td>
</tr>
</tbody>
</table>

While study results indicated that vaccination rates for responding first-time students in the UWL fall 2018 cohort exceeded three of the five target rates set by the ACHA and the 2017 vaccination rates for Wisconsin and La Crosse County, it is important to remember that approximately a third of the cohort did not respond to the records request. There may be significant unknown differences between the groups of non-respondents and respondents, which prevent the generalization of vaccination rates to the entire UWL fall 2018 cohort of first-time college students. The lack of vaccination data for one third of this cohort makes accurately understanding the infectious disease risk of the student body more difficult and may negatively impact the planning, resources, and capacities of the SHC.

Additionally, while it is encouraging that most respondent vaccination rates were found to be above target, these findings do not absolve the campus community of continued efforts at improvement. Certainly, some members of the UWL student body may be unable to be vaccinated due to health risks or may object to vaccination on religious grounds or personal beliefs. However, it is possible that many students with
gaps in vaccine doses can be caught up. The most commonly noted gaps were for the menACWY and HPV vaccines. For some students, series were started but not finished. For others, there was no evidence of HPV or menACWY series initiation, but the same student records did show receipt of other immunizations. Results from previous studies of a relationship between prior and future receipt of vaccines were mixed. Historical influenza vaccine receipt has been shown to have a positive relationship to future influenza vaccination (Nichol & Hauge, 1997). However, Hirth and colleagues (2012) noted declining completion rates among younger female cohorts compared to older female cohorts for the HPV vaccine, though initiation rates of the HPV vaccine series did increase over time. Nevertheless, it is possible that students with missing vaccinations are able and willing to receive the necessary doses, and would do so if informed about the gap, reminded of the importance, and presented with the opportunity to be vaccinated.

Just under half of all responding students were completely vaccinated as recommended, meaning they had evidence of complete vaccine series for all the vaccines of study. Fifty-one percent of students were partially vaccinated as recommended, meaning they were missing one or more doses of the recommended vaccines. Just one percent of responding first-time students in the UWL fall 2018 cohort were not vaccinated at all. As shown in Table 10, vaccination rates with significant opportunity for improvement were the HPV and menACWY vaccines. This could be due to the fact that these vaccines are commonly given in adolescence when healthcare visits may be less frequent than in childhood. Parents may also be less aware of the importance of these vaccines for the health of their child, particularly if healthcare providers are presenting these vaccines as optional.
**Vaccination Rates by Demographics**

Comparisons of vaccination rates based on sex, race/ethnicity, and home state revealed no significant relationships between vaccine series status and race/ethnicity or home state. Additionally, no significant relationships between the status of completely vaccinated as recommended and sex, race/ethnicity, or home state were found. A significant relationship was present between HPV vaccination status and sex. Among responding first-time students in the fall 2018 UWL cohort, females were more strongly represented in the group of students who had completed the HPV vaccine series while male students were more strongly represented in the group of students who had not initiated HPV vaccine series. This finding is consistent with previous research (Faherty, French, & Fiks, 2016; Farmar et al., 2016; National Center for Immunization and Respiratory Diseases, 2017; Thompson et al., 2017).

As the HPV vaccine was initially recommended and marketed only for females, it stands to reason that males may yet be behind in receipt of this vaccine. The HPV vaccine has been widely available and recommended for females since 2006 (Walling et al., 2016). Though licensed for males in October 2009 (CDC, 2010), the vaccine was not generally recommended for males until 2011 (Walling et al., 2016). However, prior research has shown it is possible to improve the HPV vaccination rate among males through educational efforts, provider interventions, and targeted reminders (Farmar et al., 2016; Walling et al., 2016).

It is necessary to consider effect size when discussing the impact of statistically significant findings. The effect size, or the magnitude of the relationship between HPV vaccination status and sex was small $V = .120$ (Green, Salkind, & Akey, 2000). This
indicates that the association between the variables, though statistically significant, was weak. The small effect size associated with the findings might suggest that raising awareness and education about vaccination for the entire student population may be just as beneficial as focusing on a particular demographic group. Though efforts should be made to tailor interventions to the groups most in need, should this not be possible due to limited time, staff, and resources, a population approach to intervention would be preferable to none at all.

**Response by Demographics**

At the conclusion of this study, no significant relationship was present between response to the vaccine records request and sex, race/ethnicity, or home state. However, a significant relationship was initially present between response to the vaccine records request and race/ethnicity, though the magnitude of the relationship was small at \( \phi = -.047 \) (Green, Salkind, & Akey, 2000). While the statistical analysis comparing response to records request and student race/ethnicity did not generate significant results following a Bonferroni correction, the very conservative nature of this statistical application should be recognized. Therefore, it still may be important to consider this possible relationship. In a comparison of representation in each response category, Non-White students in this cohort were represented in a higher proportion in the group of students who failed to respond to the vaccination records request compared to their representation in the group of students who did respond.

UWL’s attention and commitment to diversity, inclusion, and equity should extend to the health care and health education services offered at UWL as well (UWL Office of Diversity and Inclusion, 2019). All opportunities to improve access and
inclusion for students of color should be utilized if possible. This should include efforts to ensure vaccination records responses are received and can be assessed for this group. As the body of research does not clearly indicate whether individuals of color are more or less likely to be vaccinated in general (Myers, Spracklen, Ryckman, & Murray, 2015; Thompson et al., 2017; Walker, Smith, & Kolasa, 2014; Willis, Wortley, Wang, Jacques-Carroll, & Zhang, 2010; Wooten, Janssen, Smith, & Pickering, 2009), assumptions cannot be made about the vaccination statuses of students who identify with racial/ethnic categories other than White. Maximizing records request response overall, and especially for minority students, will allow the SHC to understand the specific vaccination needs of students of color at UWL and pinpoint any additional outreach or intervention as necessary. Interventions, such as additional reminders or assistance with obtaining vaccination records, should be undertaken to encourage acquisition of vaccination records from all incoming students, and especially students of color.

**Recommendations for Public Health Practice**

**Improving Response to Records Request**

A finding from this research of high importance to the SHC was the response rate to the vaccination records request. Over a third of first-time students in the UWL fall 2018 cohort did not respond to the records request, despite being informed that response was required. Improving the response rate should be a primary goal both to fulfill the obligation of the University to Wisconsin state law (Wisconsin State Legislature, 2018), and to ensure all possible measures can be taken to safeguard the health of the campus population. This might be achieved by offering the option to complete the form online, thereby making it more accessible and, hopefully, easier for students to be compliant with
the request. Additionally, reminders should be issued by mail, email, or text message. Additional outreach to students of color should be considered due to the study finding that in the UWL fall 2018 cohort, Non-White students were more strongly represented in the non-responding group. Other UWL organizations may be able to assist in outreach to students of color. The SHC could partner with the Office of Multicultural Student Services or request the assistance of campus student organizations focused on minority students, such as the Black Student Unity Organization, the Asian, Latina, African, and Native American Womxn Organization, and the International Student Organization.

All first-time students are required to attend a summer session of Student Advising, Registration, and Transition (START), where students and families get to know the UWL campus and receive important campus and academic information (S. Jocelyn, personal communication, February 20, 2019). This may be a good time for SHC representatives to issue reminders or even offer to show students or parents in person how to send records. Some state registries, like Wisconsin Immunization Registry (WIR) and the Iowa Immunization Registry Information System (IRIS), can be accessed via smartphone and records could be downloaded and emailed, or posted to the SHC’s online Immunization History Form (IHF) in a matter of minutes. Unfortunately, this option is not available for all state registries. However, SHC representatives could still assist students and parents in requesting the desired information, as some state registries, like the Minnesota Immunization Information Connection (MIIC), have webforms where requests for personal registry information can be completed.

Incentivizing response to the records request could be considered as a way to improve response rates. This is commonly done when conducting research as a way to
reduce nonresponse error (Adams & Lawrence, 2015; Stratton, 2015). However, care should be taken to avoid creating expectations among students that they will be incentivized for any and all requests from the university (S. Jocelyn, personal communication, April 2, 2019). While some requests, like participation in the ACHA NCHA – II assessment, are optional, provision of vaccination records is technically required. Setting a precedent of incentivizing all requests could result in future logistical, financial, and administrative difficulties. Further, there are more than 2,000 new students at UWL each year; applying even the most affordable incentives could result in a financial burden to the institution.

Creating a consequence for non-responders may be a less burdensome measure for the university to institute to ensure compliance with the request, though this would require collaboration with other campus offices. Schaffner and colleagues (2005) emphasized that penalties for students who fail to comply with vaccination requirements were fairly easy to enforce. A financial penalty could be considered but is not recommended, as this may disproportionately affect students of low socioeconomic status. However, applying a hold on students’ ability to register for classes until they return their vaccination records may be a feasible penalty which would not result in a financial burden to students. There is already precedent for this type of penalty within the UWL Student Life Office, as it can be applied to students who fail to complete their alcohol sanctions in a timely fashion (K. Ebert, personal communication, October 29, 2018).

An action of primary importance will be to improve communication between the SHC and the UWL Admissions Office to ensure that contact information for all students
in each incoming cohort is shared with the SHC, so that providers can be aware of the identities of non-responders. Without this step, it will be difficult for the SHC to act to improve the response rate to the records request. The SHC Medical Director has already taken steps to establish a communication channel with the Admissions Office.

Communication should also take place with the Office of Records and Registration (ORR). As discussed previously, this office oversees student contact information.

Typically, a student’s home address is on file, but can be changed by the student to reflect their local campus address instead. This can create issues for the SHC when trying to get in contact with students. The SHC and ORR should work together to ensure that both student home address and local address can be displayed simultaneously to avoid communication issues with students.

Improved communication may also be required with other campus offices should student account holds be considered as a motivator to improve vaccine records response. The university could consider forming a Vaccination Workgroup with representation from the SHC, Admissions, Student Life, Multicultural Student Services, and any other identified stakeholders, such as the Wellness and Health Advocacy Office and Student Senate. The workgroup would be tasked with improving the response to the records request, ensuring that capacity is available to continue tracking vaccination rates among each cohort, and supporting vaccine education and outreach efforts.

Another communication effort which could assist the SHC in improving vaccination rates among incoming students is to reach out to other SHCs at UW System institutions for insight into how they are currently handing this issue and what type of response rates they are achieving. This may produce a solution which could be replicated
at UWL or may expose the lack of attention to this process at other UW institutions. Should it be discovered that other UW institutions are experiencing similar issues, it may provide an opportunity for UW System administration to become involved in oversight of this important health concern.

Currently, it appears that the SHC is the only party responsible for ensuring compliance with the requirement that students be asked about vaccination records and respond to the request. While this may be appropriate, limited time, resources, and staff may inhibit detailed and continuous attention to the matter. UWL administrators should consider the potential legal and health implications of failing to attend to this requirement. Allocating additional personnel or funds to the SHC for this express purpose could be considered to guarantee capacity for ensuring this requirement is met. The Vaccine Workgroup may be of assistance in this manner as well.

**Changes to Vaccine Record Request**

Another way to improve the assessment of the vaccination status of students may be to change the IHF sent out by the SHC. Many students returned state registry records along with the IHF. The WIR, which was the state registry most commonly returned by students, has been found to be an accurate source of immunization records (Koepke et al., 2015). When both the IHF and state registry forms were returned, the IHF often was missing information which was present in the registry. The researcher observed that HPV and menACWY doses were the most commonly missed. Even as a medical professional, interpreting some of the vaccination records took extra attention to detail, depending on formatting of the record and how the vaccines were named. For example, HPV might be listed as HPV, 4vHPV, 9vHPV, HPV9, or Gardasil. The menACWY vaccine may be
called meningococcal, meningitis, meningo, or MPSV4. It is not difficult to discern why mistakes might have been made by parents or students trying to read vaccination records and fill in the IHF.

Unfortunately, many individuals only returned the IHF, so errors may have occurred in data collection and entry. Inconsistencies in health records represent a threat to both the validity and reliability of SHC vaccination records. Validity, whether an instrument measures what it is supposed to measure (Sullivan, 2011), was in question partly due to the finding that immunizations which did occur at times failed to be recorded on the IHF. Reliability, or the overall consistency of the instrument (Sullivan, 2011), was also called into question. Some individuals were able to correctly fill out the IHF, while others were unable to do so.

Avoiding the need to have lay individuals fill out the IHF likely would improve the accuracy of vaccination records submitted to the SHC. This would best be accomplished by requesting medical or state registry records only, and not even offering a form to be completed. The IHF may still include educational information, tuberculosis (TB) test information, and information about vaccines recommended for the college population, but request that only official vaccination records be returned. A direct link between state vaccination registries and the SHC electronic medical record (EMR) would be beneficial in avoiding the need to have lay individuals interpret vaccination records. If the state registries could interface with the EMR, the SHC could eliminate the need for the vaccination records request portion of the IHF. Currently, work is in progress with the administrators of the SHC EMR to see if this is possible, though only Wisconsin, Minnesota, and Iowa state registries are being considered. While this would cover the
majority of students at UWL, records for students not residing in these states would still need to be collected through the IHF response.

**Improving HPV Vaccination Rates**

Though the HPV vaccine series completion rate for responding first-time college students in the UWL fall 2018 cohort was higher than the 2017 rates for Wisconsin and La Crosse County, it fell below the Healthy Campus 2020 target. With over 40% of students missing one or more doses of the HPV vaccine, there still is much room for improvement. When considering educational and outreach efforts, the importance of the HPV vaccine in cancer prevention for males and females should be highlighted for the student population (Bendik, Mayo, & Parker, 2011; CDC, 2018a), as well as prevention of genital warts (CDC, 2010; CDC, 2016b). Students with increased perceptions of severity and susceptibility to HPV and HPV-associated cancers were more likely to receive the HPV vaccine (Bendik, Mayo, & Parker, 2011; Jones & Cook, 2008).

Educational efforts should be designed to increase students’ perceived susceptibility and severity towards HPV, and to reduce perceived barriers to vaccination. The Health Belief Model may be a useful when creating education and outreach interventions.

UWL Peer Health Advocates (PHAs) may be of assistance in the educational processes. Peer to peer education has been found to be effective in educating college students on health topics (Thompson et al., 2017). The UWL PHAs work within the UWL Wellness and Health Advocacy Office and are undergraduate students who “collaborate to create training workshops, presentations, and programs focused on health-related decision making, increasing knowledge and awareness of common health problems affecting college students, and encouraging students to advocate for their health
needs” (UWL Wellness and Health Advocacy Office, 2019, para. 1). Two of the PHAs act as liaisons to the SHC and assist in programming and outreach. Enlisting the SHC’s PHA liaisons to focus on HPV education can bring awareness of the importance of the HPV vaccine to the student population, which may result in vaccine-seeking behaviors. Though students may choose to receive the vaccine through their primary care provider, educational outreach could include the fact that the HPV vaccine is available at the SHC, increasing accessibility for interested students. As another risk reduction method, PHAs might encourage students to have conversations with their sexual partners about their HPV vaccination status, as is recommended when conducting education about sexual health and sexually transmitted infection prevention (Haskins, 2018).

SHC PHA liaisons should also be utilized to create educational materials for student consumption aimed at increasing awareness of the benefits of the HPV vaccine and where and how to get it. The HPV vaccine series is recommended up to age 26 (CDC, 2016b) and still is relevant to the health of most UWL students. The full group of PHAs could additionally assist the SHC PHA liaisons in conducting HPV education and raising student awareness. Education and outreach also could be delivered on the general topic of vaccination, addressing myths and facts about vaccination benefits and safety. Students may be unvaccinated or partially vaccinated due to parental choices or inaction. Promoting awareness of importance and opportunity to act could prompt students to take more direct charge of their own health by reviewing needs and addressing vaccination gaps themselves.

Reducing barriers should be considered when planning outreach efforts. One such effort could be a special event like a vaccination clinic. Vaccination clinics are already
conducted by the SHC at sites around campus for the influenza vaccine. Increasing the accessibility of the vaccine by holding HPV vaccination clinics where students tend to congregate, such as the student union or recreational center, may encourage students to take advantage of the vaccination opportunity. Events could also be coordinated with other relevant campus activities or national health observances. Though cost could be an issue for some students, the SHC offers the vaccine at the reduced rate of $195 per dose and can provide receipts which students may submit to their health insurance providers for reimbursement. Further, the SHC could refer students unable to afford the cost of the vaccine to their primary care provider or other local health care providers who may participate in the Vaccines for Children Program, a federal program which offers free vaccines to children up to age 19 who are on Medicaid, are Native American or Alaska Natives, or are without health insurance (Schaffner, Brooks, Jenson, Juszczak, & Word, 2005). Unfortunately, the HPV vaccine is not offered at either of the local community clinics (Essential Health Clinic representative, personal communication, April 17, 2019; Neighborhood Family Clinics, 2019).

The SHC also should consider following the CDC (2018a) guidelines, *Top 10 Tips for HPV Vaccination Success*. While not every step will apply to the SHC, many of the tips may still be relevant for students who, perhaps for the first time, have the opportunity to make decisions about their own health care. Interventions like standing vaccination orders for use by nursing staff, addressing vaccination at each clinic visit, strongly recommending vaccination to patients, encouraging attention to vaccination among health center staff, and being aware of the vaccination rates of the population served are all CDC recommendations relevant to the SHC. Physicians could consider
creating standing orders, as is done with urinary tract infection and strep throat testing and treatment at the SHC. The standing orders would be used by nursing staff when checking patients in for visits, particularly as many student visits to the SHC are for acute or preventive care appointments. While time and resources would be required to write and approve, no additional staff time or effort would be required at the time of student contact. Nursing staff would be able to use the protocol to assess whether a patient was deficient in any vaccines, address any deficiencies with the student right away, and administer the vaccine if the student consented. Streamlining the process of receiving the vaccine and placing the burden on the healthcare provider rather than the student may make busy college students more receptive to the HPV vaccine.

**Improving MenACWY Vaccination Rates**

The vaccination rate for menACWY among responding first-time college students in the UWL fall 2018 cohort was approximately 75%. While this is above the ACHA Healthy Campus 2020 target rate, it also indicates that 25% of students are unprotected against meningitis. Vaccination against meningitis, which can be a fatal illness, is recommended for individuals living in residence halls (CDC, 2016c). As 97% of first-time college students at UWL live in the residence halls (UWL, 2018), attention to improving the vaccination rate among first-time college students is timely and critical.

Interventions to improve vaccination rates for menACWY could closely mirror those recommended for HPV. An education and marketing campaign could be created by the SHC PHA liaisons focused on the susceptibility to, and severity of, contracting meningitis. Students should also be made aware that they can receive the meningitis vaccine at the SHC. While there is an upfront cost associated with obtaining the vaccine
at the SHC, the cost is actually lower than if they obtained the vaccine from one local community clinic (Neighborhood Family Clinics, 2019), while the other focuses on reproductive and sexual health specifically and does not offer immunizations at this time (Essential Health Clinic Representative, personal communication, April 17, 2019). Additionally, students can request a receipt to submit to their insurance for reimbursement or could use their insurance to obtain the vaccine at one of the local hospital systems. For students who are without health insurance and age 19 or younger, the VFC program may be able to assist as well. The CDC’s (2018) Top 10 Tips for HPV Vaccination Success also could be used to increase meningitis vaccination rates. The document from which it was reportedly adapted, The 10 Immunization Success Factors: Practical Strategies for Providers (Khatib, 2015), focused on measures to improve overall immunization rates. It is likely that some of the tips effective for the HPV vaccine, like provider recommendation, writing standing orders for nursing staff to use to administer the vaccine, and addressing vaccination status at each clinic visit would apply to meningitis vaccination as well.

**Recommendations to Improve this Research**

**Student Survey**

One significant way to improve upon this research would have been to ask all first-time college students in the UWL fall 2018 cohort to participate in a demographic survey. This process could have provided information about additional demographic characteristics previously shown to be associated with vaccination status such as maternal insurance status, socioeconomic status, and maternal marriage status (Luman, McCauley, Shefer, & Chu, 2003; Myers, Spracklen, Ryckman, & Murray, 2015; Willis, Wortley,
Wang, Jacques-Carroll, & Zhang, 2010). These types of grouping variables would allow for additional research questions about relationships between vaccination status and demographics, which could allow the SHC to direct vaccination outreach efforts with greater specificity. Adding questions about the knowledge, attitudes, perceptions, and barriers of students towards HPV and the HPV vaccine would provide additional opportunities for the SHC to act to reduce barriers and promote vaccine uptake (Bendik, Mayo, & Parker, 2011; Jones & Cook, 2008). Nonresponse error would need to be considered in this type of research as well. Incentives could be offered to encourage survey participation. Additionally, communication with other UWL offices might have provided access to other demographic information not available from the IHF or EMR.

**Definition of Complete HPV Series**

An important point to note for this research was the difference in operational definitions of completed HPV vaccine series found within the literature. While the Wisconsin Department of Health Services (WDHS) (2018a) and the SHC (2019) classified a completed HPV vaccine series as one in which three vaccines were given, a source from the CDC (2016b) defined it more specifically as a series of two vaccines if the series was started between ages nine and 14, but a series of three doses if the series was initiated after age 15. In this study, 220 individuals were classified as having a partially completed HPV vaccine series based on the WDHS and SHC criteria. Choosing to use an operational definition consistent with how the CDC defined a completed HPV series may have resulted in more individuals classified as having a completed HPV vaccine series. This may also have impacted whether relationships between demographics and vaccination rates or response rates were found to be statistically or
practically significant. Moving forward, the WDHS (2018a) will define a completed HPV series as two doses for those starting the series as of 2018, consistent with the CDC definition (2016b). While this should reduce inconsistencies in future research, it will be important for future researchers to be aware of the change in definition of completed series for the HPV vaccine.

**Student Health Center Intervention**

Returned fall 2018 vaccination records were reviewed by SHC staff and students with gaps were notified of the recommended vaccinations they were missing. This created the need for more attention to detail in collecting data for this study to ensure that data was not collected from vaccination records which may have been influenced by the SHC intervention. As 2018 was the first time the SHC had engaged in this type of outreach, this risk would not have been a factor if a cohort from a different academic year had been chosen. Data from cohorts prior to 2018 could be assessed and compared with results from the fall 2018 cohort. Further, as the SHC plans to continue this type of intervention, vaccination data in future assessments should be recorded in an Excel spreadsheet as records are received to reduce the risk of using records influenced by SHC outreach. There was a positive impact of the intervention by the SHC in that it ameliorated the ethical obligation of the researcher, in their dual role as researcher and health care provider at the SHC, to act on knowledge to improve patient health.

**Assessing Error Rate**

The issue of errors present in vaccination records arose during data collection. Many student records contained both the IHF and medical provider or state registry records. This allowed the researcher to discover that many IHFs contained inaccuracies,
most often failing to indicate a vaccine dose that a student had received according to state registry or healthcare provider records. Had the researcher additionally included a research question regarding the frequency of errors noted on the IHF, a more formal summary of concerns related to the validity and reliability of the IHF could have been brought to light. While relaying the researcher’s impressions of errors and inaccuracies noted in the IHF still is beneficial, the ability to provide actual data would have been valuable in providing support for changes recommended to the document and process of records collection.

**Recommendations for Future Research**

**Additional Immunization History Form Data**

Acknowledging the limitations of the secondary data available from the IHF, data from this source could be used to study other health topics pertinent to the college population. Future research should include an assessment of receipt of the influenza vaccine in college populations. While influenza was not a vaccine of study in this research, it is a vaccine identified by the ACHA as important for the health of college students (ACHA, 2018c). As an annual vaccine, historical receipt does not confer immunity in subsequent years. However, as historical influenza vaccine receipt has been suggestive of future influenza vaccination (Nichol & Hauge, 1997), it may be valuable to explore whether a relationship exists between historical receipt and future receipt of the vaccine among UWL students, or between receipt of other recommended vaccines and the influenza vaccine. Further, understanding barriers to influenza vaccination among UWL students could be of use. This type of research may assist the SHC in outreach efforts to groups more likely to be unprotected. This also is the most commonly given
vaccine at the SHC, so study of the influenza vaccination habits of the study body would be particularly pertinent.

Meningitis B (menB) also should be a vaccine of study in future research. Vaccination against menB was much less common than for the meningitis ACWY serotypes, however recent outbreaks on college campuses have brought menB into the spotlight. According to Nolana, O’Ryan, Wassil, Abitbol, and Dull (2015), after outbreaks at the University of California at Santa Barbara and Princeton University in 2013 resulted in 13 cases and one death, 14,538 students were vaccinated against menB between the two universities. The authors noted that the menB vaccine was not yet approved for use in the U.S. when the outbreaks occurred. Most recently, an outbreak occurred at the University of Wisconsin-Madison (UW-Madison) campus in which three students became ill, with one case resulting in death. Following this outbreak, 21,000 students received the menB vaccine (Johnson, 2016). The recent U.S. approval of this vaccine may explain the lack of robust vaccination data. National receipt of the menB vaccine was estimated for the first time in a report from the CDC (Walker et al., 2018). Results indicated that 14.5% of adolescents aged 13 to 17 had received the vaccine. Given the close proximity of UWL to the UW-Madison campus, an assessment of UWL student vaccination rates for menB may be pertinent.

While this study focused on assessing one entire cohort of first-time students due to a lack of established response rate to the vaccination records request, future studies should attempt to obtain a more representative picture of the vaccination status of first-time college student cohorts at UWL for the HepB, HPV, menACWY, MMR, Tdap, and varicella vaccines. A retrospective study could assess cohorts of first-time college
students at UWL from different academic years to establish vaccination and records request response rates. For future first-time college student cohorts, vaccination rates and vaccination records request response rates should continue to be assessed to provide a more complete picture of the vaccination status and infectious disease risks of first-time college students at UWL.

Data about another type of infectious disease risk is also available from the IHF. The form includes a section intended to assess a student’s risk factors for tuberculosis (TB) exposure and provide guidelines and recommendations for TB testing (TST). Compliance with this portion of the assessment should be studied. Further, future studies should assess whether students for whom testing was recommended were actually tested. Results would provide valuable insight into the TB infection risk on campus. Though a cohort study similar to this research would likely not be generalizable to the entire UWL population, it only takes one student infected with TB to pose a risk to the entire campus population. Obtaining insight into the fidelity of the UWL TB risk assessment and testing process should be of high importance to the SHC and the campus community.

Validity and Reliability of Instrument

An area of value for future research is the validity and reliability of the IHF. Should the SHC choose to continue using it in its current form, understanding whether the form accurately and consistently captures student vaccination rates will be important. As noted, discrepancies existed between state registry or medical record data and the handwritten information on the IHF. Understanding the frequency of this occurrence will be valuable in considering whether to continue use of the form in its current state, make and pilot test changes within the form, or discontinue use of the form altogether.
Secondary data could be reviewed for errors and inaccuracies, though this only would be discoverable in student health records which contain both the IHF and state registry or healthcare provider records. Another option might be to review a sample of student health records which contain the IHF, and for those which do not additionally contain state registry or healthcare provider records, researchers could seek confirmatory vaccination records directly from state registries or from students themselves.

**Attitudes, Perceptions, and Barriers**

A previously mentioned method of improving this research also could be applied to future studies. Aside from assessing additional demographic characteristics, students’ attitudes, perceptions, and barriers towards receiving vaccinations should be studied. While acknowledging the difficulty in generating a high response rate and representative survey participation, a strong attempt should still be made to attain this insight. Offering incentives for participation could be one option for increasing response to such a survey. Additionally, offering information and opportunities to take the survey at multiple points throughout the survey window may help. PHAs could table in the student union with information and assistance in accessing the survey. Information about the survey, along with a link to the survey, could be posted in the SHC waiting room and exam rooms. Focus groups with students could also be used to produce qualitative information about attitudes, perceptions, and barriers surrounding vaccination to supplement the quantitative data generated by the survey. Offering incentives for participation may be useful here as well. As the Health Belief Model has previously been used to assess knowledge, attitudes, perceptions, and barriers of health behaviors of college students, and specifically the constructs of perceived susceptibility, perceived severity, and
perceived barriers (Bendik, Mayo, & Parker, 2011; Jones & Cook, 2008), it should be considered as a framework of future vaccination studies. Also, since health care providers have been found to be key influencers in vaccination receipt (Bendik, Mayo, & Parker; CDC, 2018a; Jones & Cook), access to this additional insight could allow the SHC to use their influence as health professionals to target education and outreach efforts.

**Multivariate Analysis**

Finally, future studies should consider the use of multivariate analyses in assessing student characteristics associated with vaccination status. The intersectionality of demographic characteristics is unavoidable and the influence of each identity on the other and on the outcome of interest should be considered. Using bivariate analyses when studying independent variables which may be related to each other increases the risk of incorrectly identifying multiple demographic characteristics associated with vaccination or response rates. Using a multivariate testing approach helps to identify independent variables which are associated with each other as well as the unique contribution of an independent variable to the dependent variable (Adams & Lawrence, 2015). Though only one demographic factor was found to have a statistically significant relationship to vaccination status in this study, future studies analyzing additional demographic factors such as maternal race and socioeconomic status should consider using multivariate testing.
REFERENCES


APPENDIX A

Student Health Center Immunization History Form
Dear Students and Parents,

On behalf of the UW La Crosse Student Health Center staff, I would like to welcome you to the University and wish you a productive and healthy college career. We are looking forward to meeting you and helping you through your college years.

Attached you will find health information forms. The Health Center uses these forms to verify a student’s immunization record, and to provide the Student Health Center staff with information about specific health concerns, emergency notification contacts, and family health insurance. Please note that all incoming UWL students MUST submit an up-to-date immunization history, including vaccination dates. You might be able to obtain this information from your high school or from your family physician’s office.

The UWL Student Health Center recommends all students attending UWL receive an annual flu vaccine and students living in resident housing receive the meningitis vaccine. Both vaccines are offered at the Health Center at a reduced cost (2016 prices: $15.00/520.00-flu injection, and $95.00 - $155.00 for meningitis).

A physical examination is not required for general admission to the University. However, please inform the Student Health Center of any ongoing medical problems. You may do this by indicating the problem on the enclosed form or by having your personal physician send us a summary letter. The health center is happy to work with your own medical provider to ensure continued care for any ongoing medical condition.

Participation in intercollegiate sports requires a medical statement from your personal physician. This exam can be done at the University Student Health Center. A scheduled appointment for this exam can be made following the start of the semester. Please obtain the correct form from the ATHLETIC OFFICE (Room 128, Mitchell Hall).

Please complete the attached health information forms as soon as possible and fax, mail or bring them to the Student Health Center. Our goal is to maintain your health. If you become ill, injured or need to be seen for any reason call 608-785-8558 for a same day appointment. Scheduled appointments and an urgent care clinic are also available. The Student Health Center is located in the Health Science Center at 1300 Badger Street. Our hours are Monday, Wednesday and Friday: 8 a.m.-4 p.m., Tuesday 9 a.m.-4 p.m. and Thursday 8 a.m.-4 p.m. with limited appointment times until 7 p.m. Hours and services vary during break and interim times.

Visit our website at www.uwlax.edu/studenthealth/ for additional information. Once classes begin you may access the OpenCommunicator portal at https://myhealth.uwlax.edu for secure online services.

Sincerely,

Kristin E. Swanson, M.D.
Interim Director of Student Health Center
## Student Health Center
1300 Badger Street
La Crosse, WI 54601
Telephone: (608) 785-8558  Fax: (608) 785-8746
www.uwlax.edu/studenthealth

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**Immunization Record**

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<th>Booster dose is recommended every 10 years. One of these should include pertussis.</th>
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<td>MMR</td>
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<td>Two doses recommended. Indicate monthly for all doses after age 12 months. Not needed if student born before 1957.</td>
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<td>Varicella (Chicken Pox)</td>
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<td>Recommended for all students who have not had the disease in childhood. Two doses needed.</td>
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<td>Hepatitis A</td>
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<td>Two dose series recommended for persons at increased risk and for international travel.</td>
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<td>Hepatitis B</td>
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<td>Recommended for all students. Required for students in education and health care fields. Three doses needed.</td>
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<td>Meningitis (Menveo or Menactra)</td>
<td>Date dose given</td>
<td>Recommended for entering freshman, dorm residents or immunocompromised.</td>
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<td>Meningitis B (Baxero or Trumebna)</td>
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<td>TB Test</td>
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<td>Results: 1 Poc (chest x-ray required) 2 Neg</td>
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<td>Influenza (Flu Shot)</td>
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<td>Recommended annually for all students. Available at Student Health Center.</td>
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Can attach a recent copy of your state's Immunization Registration
Emergency Notification

Specify parent(s) / guardian(s) to be notified in case of emergency

Name _____________________________ Relationship _____________________________

Telephone (home): __________________________  (work): __________________________

OR

Name _____________________________ Relationship _____________________________

Telephone (home): __________________________  (work): __________________________

Health Information

Allergies: O Yes  O No  Please List:

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Medications: O Yes  O No  Please List:

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Chronic Illnesses (Asthma, Diabetes, etc.)  Please List:

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Health Insurance

Company _____________________________ Telephone: _____________________________

Name of Policy Holder _____________________________ Policy Number: _____________________________

CONSENT FOR TREATMENT:

I hereby authorize any University of Wisconsin-La Crosse Student Health Center staff to render any emergency treatment, medical or surgical care deemed necessary to maintain health and well-being even if treatment requires hospitalization at an accredited local hospital:

___/___/____

Date

Signature of Student

___/___/____

Date

Signature of parent of guardian if student is under legal age of 18
**Tuberculosis (TB) Screening Questionnaire** (to be completed by incoming students and returned to the University of Wisconsin-La Crosse Student Health Center, 1300 Badger St, Suite 1030, La Crosse, WI 54601)

Please answer the following questions:

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<tr>
<td>Zimbabwe</td>
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</tbody>
</table>


Have you had frequent or prolonged visits* to one or more of the countries listed above with a high prevalence of TB disease? (If yes, CHECK the countries, above)  

Yes  No

Have you been a resident and/or employee of high-risk congregate settings; (e.g., correctional facilities, long-term care facilities, and homeless shelters)?  

Yes  No

Have you been a volunteer or health-care worker who served clients who are at increased risk for active TB disease?  

Yes  No

Have you ever been a member of any of the following groups that may have an increased incidence of latent *M. tuberculosis* infection or active TB disease – medically underserved, low-income, or abusing drugs or alcohol?  

Yes  No

If the answer is YES to any of the above questions, the University of Wisconsin-La Crosse requires that you receive TB testing as soon as possible but at least prior to the start of the subsequent semester.  

If the answer to all of the above questions is NO, no further testing or further action is required.

*The significance of the travel exposure should be discussed with a health care provider and evaluated.*

University of Wisconsin-La Crosse Student Health Center  
Phone: 608-785-8558  
Fax: 608-785-8746
In accordance with AB 344 signed by Governor Jim Doyle, effective January 1, 2004, all residence hall students must be provided information regarding the risks associated with meningococcal disease and hepatitis B and the availability and effectiveness of vaccines against disease.

Meningitis
Meningococcal disease is quite rare, but can be fatal. The bacterium, Neisseria meningitidis, causes both meningitis (infection around the brain) and sepsisemia (blood poisoning). The reported incidence of meningitis illness in college students is about 1.5 per 100,000 students annually. The incidence increases to 3.24 per 100,000 annually for students living in residential housing. Social behaviors, such as excessive alcohol consumption, bar patronage, and exposure to cigarette smoke also increase risk for the disease. Good personal hygiene habits, e.g. frequent hand washing, and not sharing eating utensils or drinks, reduce the risk of disease.

Meningitis Vaccine Effectiveness
The UWL Student Health Center recommends that all students living in residence halls receive the vaccine. The meningococcal vaccine, Menveo, provides protection against 70%-80% of meningococcal disease and the vaccine offers protection for 5-10 years. The vaccine is quite safe and the most common side effects are local tenderness at the injection site, mild body aches or low-grade fever.

UWL students can call 608-785-8558 to make an appointment to receive the immunization at the Student Health Center. The cost is $95.00 - $155.00 (subject to change) and will be billed to their student account. The immunization is usually available through your local MD. Check our website for information about the new meningitis B vaccine. Please contact the Student Health Center if you have additional questions.

Hepatitis B Risk
Hepatitis B is a serious viral illness that can strike silently and cause long-term illness that may lead to liver damage, liver cancer or death. Hepatitis B enters the blood stream invading the liver, and causing disruption of normal function. In 2001, 70,000 people were infected with the Hepatitis virus. Thirty percent had no symptoms but went on to infect others.

Symptoms of the Disease
In the mildest case you may never know you had an infection. Symptoms during the acute phase may include loss of appetite, tiredness, diarrhea and vomiting, yellowing of the skin or eyes (jaundice) or pain in the muscles, joints, and stomach. Recovery may take weeks or months. In the most serious cases, the disease scars the liver and may lead to liver cancer.

Transmission
You can get Hepatitis B by direct contact with the blood or body fluids of an infected person. Contact with blood through cuts, open sores or mucous membranes (mouth or vagina) of an infected person can transmit the virus. Transmission is possible by sharing needles as with steroid injections, ear or body piercing, intravenous street drugs or getting a tattoo. Hepatitis B can be transmitted through semen, vaginal secretions or saliva. Individuals who engage in unprotected vaginal, oral or anal sexual intercourse are at risk of acquiring Hepatitis B.

Hepatitis B Vaccine Effectiveness
There is no cure, but Hepatitis B can be prevented. The Hepatitis B vaccine is extremely safe and provides greater than 96% protection against Hepatitis B infection. You cannot get the disease from the vaccine. Vaccination requires a series of three shots over a six-month period. Students can receive the vaccine at the UWL Student Health Center. Each injection costs $36.00 (subject to change) and will be billed to the student's account. Please contact the Student Health Center if you have additional questions.

Other Forms of Prevention
In addition to vaccination, students can modify their behavior by using condoms during sex and avoiding tattooing and body piercing with non-sterile instruments or techniques. They can also avoid sharing needles, pierced earrings, razors or toothbrushes.
APPENDIX B

Example of Wisconsin Immunization Registry Record
### Client Information

**Client Name (First - MI - Last):**

**Mother's Maiden Name (First Last):**

**DOB:**

**Gender:**

**Race:**

**Ethnicity:**

**Comments:** 05/01/1991 - History of Chicken Pox/Varicella

### History

<table>
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<tr>
<th>Vaccine Group</th>
<th>Vaccine</th>
<th>Date Administered</th>
<th>Series</th>
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### Current Age: [Redacted]

### Vaccines Recommended

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<td>Complete</td>
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APPENDIX C

Protecting Human Research Participants Certificate of Completion
Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Alexandra Larsen successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 10/11/2017.

Certification Number: 2527795.
APPENDIX D

Institutional Review Board Approval Letter
To: Alexandra Larsen

From: Bart Van Voorhis, Coordinator
Institutional Review Board (IRB) for the
Protection of Human Subjects
bvanvoorhis@uwf axle edu
5-6892

Date: November 21, 2018

Re: RESEARCH PROTOCOL SUBMITTED TO IRB

The IRB Committee has reviewed your proposed research project: “Assessing the Vaccination Status of First-year College Students at the University of Wisconsin – La Crosse.”

Because your research protocol will place human subjects at minimal risk, it has been approved under the expedited review category in accordance with 45 CFR 46, 46.116(a)(1)(i). Also, a waiver of signed consent has been granted in accordance with 46.117(c)(1)(i).2.

Since you are not seeking federal funding for this research, the review process is complete and you may proceed with your project. Remember to provide participants a copy of the consent form and to keep a copy for your records. Consent documentation and IRB records should be retained for at least 3 years after completion of the project.

Please note that this approval is for a one year period only, from the date of this letter. If the project continues for more than 12 months, an IRB renewal must be requested using Attachment C on the IRB website. Please submit Attachment C one month prior to the date on this letter. Continued data collection beyond this date will place your project in non-compliance. The IRB is required to report instances of noncompliance to the Federal Office of Human Research Protections.

Good luck with your project!

cc: IRB File