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Vaccine Knowledge and Vaccine Attitudes of Undergraduate Nursing Students

Caitlyn Wilpstra
University of Windsor

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By

Caitlyn Wilpstra

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Vaccine Knowledge and Vaccine Attitudes of Undergraduate Nursing Students

by

Caitlyn Wilpstra

APPROVED BY:

_____

K. Lafreniere
Department of Psychology

_____

L. Patrick
Faculty of Nursing

_____

J. Ralph, Advisor
Faculty of Nursing

August 4, 2020

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ABSTRACT

Vaccine hesitancy is a growing threat to public health worldwide; however, the vaccine knowledge and attitudes of nursing students—a population of future immunizers and health promoters—are largely unknown. The purpose of this descriptive research study was to assess baccalaureate nursing students' knowledge and acceptance of vaccinations as well as leading, self-reported vaccination influences in their lives. The sample consisted of 145 fourth-year nursing students at a Southwestern Ontario university who completed an in-class, online survey in February 2020 (pre-COVID-19 restrictions) consisting of the Vaccination Knowledge Scale, the Vaccine Acceptance Instrument, and demographic and vaccination influence questions. The participants were found to have high mean vaccine knowledge scores (7.8/9, $SD \pm 1.5$) and vaccine acceptance scores (123.3/140, $SD \pm 16.1$), and the two variables were positively correlated using Pearson's correlation ($r[143] = .69$, $p < .001$). However, the vaccine acceptance results revealed varying degrees of vaccine hesitancy, and the students displayed the lowest scores in the subscale pertaining to the role of government in requiring vaccinations. Nursing school was selected as the leading vaccine influence among the participants, but healthcare providers were chosen as a primary influence by students with lower vaccine knowledge scores. Nursing educators are in a prime position to positively impact students' knowledge of and attitudes toward vaccination and should consider providing targeted education toward common vaccination misconceptions among nursing students.

DEDICATION

Dedicated to the glory of God, with much thankfulness for His good gifts of science and research. "…Test everything; hold fast what is good" (1 Thes. 5:21 ESV).

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CHAPTER 1

INTRODUCTION AND BACKGROUND

Immunization is a crucial public health intervention that has prevented many diseases and deaths both in Canada and worldwide (Government of Canada, 2016; World Health Organization [WHO], 2019a). The WHO (2019b) estimates that between 2 and 3 million deaths are averted every year from immunization alone. Immunization is unique in that it provides both individual and societal protection from vaccine-preventable diseases (Government of Canada, 2016; WHO Strategic Advisory Group of Experts on Immunization [SAGE] Working Group on Vaccine Hesitancy, 2014b). Not only is the vaccinated individual protected, but a high immunization rate also provides a degree of protection to those who cannot receive immunizations including infants and the immunocompromised—a concept known as *herd immunity* (Government of Canada, 2016). This combination of high community vaccination rates plus herd immunity has effectively restricted and even eliminated the spread of many vaccine-preventable diseases in Canada (Government of Canada, 2016). Nevertheless, as the COVID-19 global pandemic unfolds, many Canadians are now witnessing the widespread effects of an infectious disease that has no specific treatment and no vaccine (Government of Canada, 2020).

In spite of the overwhelming success of vaccinations and the concurrent worldwide impact of COVID-19 in the absence of a COVID-19 vaccine, a trend has developed that threatens to reverse the progress of widespread immunization. This attitude of apprehension and doubt surrounding the safety and efficacy of vaccinations is known as *vaccine hesitancy* (Yaqub, Castle-Clarke, Sevdalis, & Chataway, 2014).

Vaccine hesitancy is defined by the WHO as the "delay in acceptance or refusal of vaccines despite availability of vaccination services" (WHO SAGE Working Group on Vaccine Hesitancy, 2014b, p. 7). The outcomes of vaccine hesitancy range from complete acceptance of all vaccinations to total refusal of all vaccinations (WHO SAGE Working Group on Vaccine Hesitancy, 2014b). Accordingly, vaccine hesitancy is viewed as a continuum (WHO SAGE Working Group on Vaccine Hesitancy, 2014b; Yaqub et al., 2014). For the purpose of this study, the vaccine acceptance continuum is equated with the vaccine hesitancy continuum, as these two concepts have been used interchangeably in scholarly literature (Betsch et al., 2018; Sarathchandra, Navin, Largent, & McCright, 2018).

The impact of vaccine hesitancy on public health is significant. In fact, the WHO (2019c) declared vaccine hesitancy to be among the top 10 threats to global health in 2019. This was demonstrated by the resurgence of diseases such as measles in countries where measles was nearing extinction (WHO, 2019c). For example, in the USA, measles was considered to be eliminated in the year 2000 (Centers for Disease Control and Prevention [CDC], 2019). However, in 2019, the USA experienced more measles cases than any year since 1992, and the majority of affected individuals were unvaccinated (CDC, 2019). Vaccine hesitancy has also contributed to measles outbreaks in Canada (Kershaw, Suttorp, Simmonds, & St. Jean, 2014) and in Europe (Woudenberg et al., 2017), with the latter experiencing over 100 deaths from measles in an 18-month period from January 2018 to May 2019 (WHO Regional Office for Europe, 2019). Furthermore, these risks are not limited to one particular region of the world; vaccine hesitancy has

been documented in over 90% of countries worldwide (Lane, MacDonald, Marti, & Dumolard, 2018).

Although vaccine hesitancy is often associated with parents making vaccination decisions for their children, vaccine hesitancy is not limited to those caring for children (Luyten, Bruyneel, & van Hoek, 2019). Vaccine hesitancy may occur at the individual, group, community, or population level in various age groups (WHO SAGE Working Group on Vaccine Hesitancy, 2014b). Recent research has found that vaccine hesitancy also exists among healthcare professionals (Karafillakis et al., 2016; Suryadevara, Handel, Bonville, Cibula, & Domachowske, 2015; Yaqub et al., 2014). This finding is noteworthy as healthcare providers have been found to be the most positive, influential source of vaccine information for the general public (Yaqub et al., 2014). Therefore, if healthcare providers possess hesitant attitudes, their clients' receptiveness to receiving immunizations may be negatively impacted (WHO SAGE Working Group on Vaccine Hesitancy, 2014a). Many different factors affect healthcare providers' willingness to support and recommend vaccinations (WHO Regional Office for Europe, 2013). Considering the present threat of vaccine hesitancy to global health (WHO, 2019c), two factors that are frequently mentioned in current scholarly literature were examined in this study: knowledge of vaccines and attitudes toward vaccines.

Vaccine knowledge refers to one's awareness of vaccination and encompasses both level of knowledge and accuracy of knowledge surrounding vaccination (WHO SAGE Working Group on Vaccine Hesitancy, 2014b). Knowledge of vaccination consists of facts that are supported by evidence-based science (Zingg & Siegrist, 2012). Lower vaccine knowledge has been associated with increased vaccine hesitancy

(Zarobkiewicz et al., 2017; Zingg & Siegrist, 2012). Likewise, increased vaccine knowledge among nurses has been linked with higher patient vaccination rates (Desmond, Grant, Goodyear-Smith, Turner, & Petousis-Harris, 2011) and overall competence in vaccination (Nikula, Rapola, Hupli, & Leino-Kilpi, 2009).

For the purpose of this paper, vaccine attitudes refer to one's perceived thoughts and beliefs surrounding the acceptability of vaccinations. Attitudes including trust, perceived risk-benefit analysis, and beliefs surrounding health and illness all act as determinants of vaccine acceptance, or uptake (WHO Regional Office for Europe, 2013; WHO SAGE Working Group on Vaccine Hesitancy, 2014a). To clarify, the WHO's use of the term *vaccine acceptance* often refers to the act of physically receiving a vaccine. For the purpose of this study, vaccine acceptance refers to one's attitudes surrounding vaccination, as opposed to physical receipt of a vaccine, because vaccine attitudes were measured on the Vaccine Acceptance Instrument (Sarathchandra et al., 2018). The attitudes of healthcare providers surrounding immunization matter, as clients' concurrence with vaccination may be negatively impacted by the hesitant attitudes of their healthcare providers (WHO SAGE Working Group on Vaccine Hesitancy, 2014a). Negative or hesitant attitudes toward vaccination have been qualitatively associated with a reluctance of healthcare providers to immunize (Kennedy, Brunton, & Hogg, 2014) and quantitively associated with decreased population coverage rates of certain vaccinations (Weigel et al., 2014), demonstrating the significance of healthcare providers' vaccine views.

Nursing students compose a specific and unique population of healthcare providers, representing both future immunizers and health promoters. In general, nursing

students are younger than their working counterparts (Loulergue & Launay, 2014). The Pew Research Center (2019) has found that young adults between 18–29 years of age are leading users of social media websites. Many Canadian vaccination experts consider inaccurate, anti-vaccination content on websites—including social media—to be a primary source of vaccine hesitancy (Dubé et al., 2016), which may contribute to nursing students' vaccination beliefs. It is also possible that nursing students' parents play a significant role in impacting students' vaccination views. One qualitative study involving various non-nursing healthcare students in Canada found that several participants expressed an assumption that they would simply follow the vaccination attitudes and practices of their parents (McMurtry et al., 2015). Furthermore, nursing students are still developing their ability to seek out and utilize evidence-based knowledge sources (Cosme, Milner, & Wonder, 2018). With the rising threat of vaccine hesitancy to global health (WHO, 2019c), the supposition that healthcare students are adequately prepared to vaccinate and eagerly endorse immunizations must be reassessed (Yaqub et al., 2014). Specific knowledge gaps and vaccine-hesitant attitudes were found to exist in varying degrees among nursing students sampled in two small North American studies (Dybsand, Hall, & Carson, 2019; Pelly et al., 2010); however, the current state of vaccine knowledge and attitudes among nursing students is relatively unknown.

Therefore, the purpose of this study was to assess both current knowledge of vaccinations and attitudes toward vaccinations in undergraduate baccalaureate nursing students at a Southwestern Ontario university. The specific research questions consisted of the following:

1. On a test of general knowledge of vaccination, what percentage of questions are answered correctly by fourth-year nursing students?
2. On a survey of vaccine acceptance in the same sample of students, what is the average vaccine acceptance score for the overall instrument, and what is the average score for the subscales of "perceived safety of vaccines," "perceived effectiveness and necessity of vaccines," "acceptance of the selection and scheduling of vaccines," "positive values and affect toward vaccines," and "perceived legitimacy of authorities to require vaccinations"? (Sarathchandra et al., 2018, p. 1).
3. Is there a correlation between the vaccine knowledge score and the vaccine acceptance score?
4. For the groups of students who score in the lowest and highest quartiles for vaccine knowledge scores and the lowest and highest quartiles for vaccine acceptance scores, what sources of vaccine information do they consider to be most influential in their lives?

Theoretical Framework

The theoretical framework that guided this study was the WHO Regional Office for Europe's (2013) model of the factors that influence health workers' practices with regard to childhood vaccination (Figure 1). This model is part of a larger framework known as *Tailoring Immunization Programs (TIP)*, which was designed to improve vaccine uptake in Europe (WHO Regional Office for Europe, 2013). Although this model specifically addresses childhood vaccinations, for the purpose of this study, the model was applied to vaccinations in general, including childhood vaccinations. According to

the WHO Regional Office for Europe, three overarching themes encompass the determinants of vaccine practices, recommendations, and professional attitudes among healthcare providers. These themes consist of *environmental opportunity factors*, *supportive ability factors*, and *personal motivation factors* (WHO Regional Office for Europe, 2013). For the purpose of this study, the desired outcome of these factors was considered to be the practice, promotion, and facilitation of immunization by nursing students.

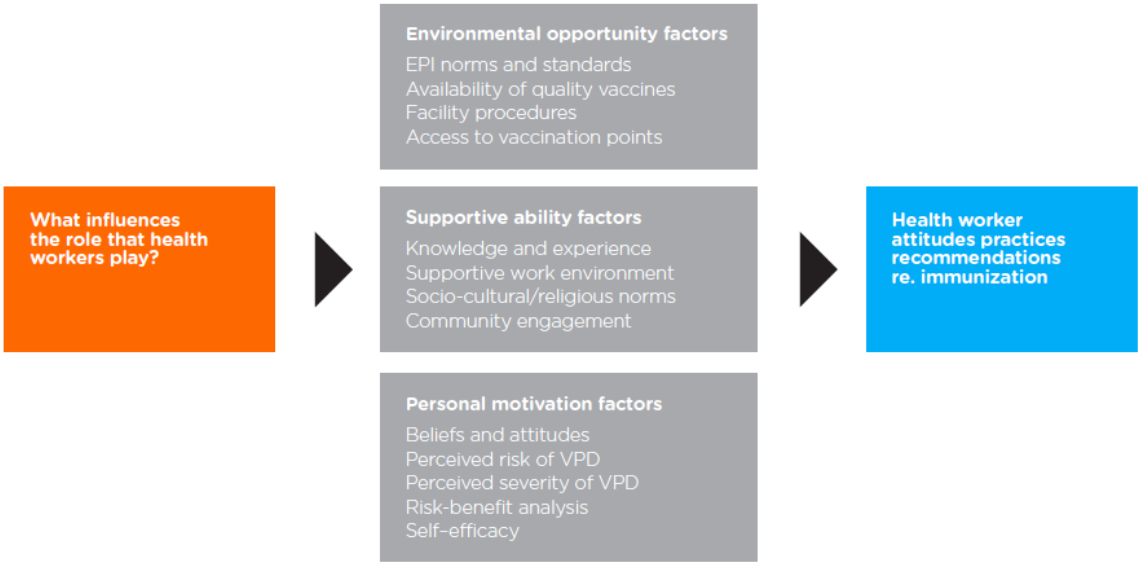

Figure 1. Factors that influence health workers' practices with regard to childhood vaccination. From "The Guide to Tailoring Immunization Programmes (TIP)" by the WHO Regional Office for Europe, 2013, http://www.euro.who.int/__data/assets/pdf_file/0003/187347/The-Guide-to-Tailoring-Immunization-Programmes-TIP.pdf. Copyright 2013 by the World Health Organization. Reprinted with permission.

Environmental opportunity factors refer to the structural and physical supports in place that facilitate healthcare workers' ability to provide immunizations (e.g. availability of vaccine supplies) (WHO Regional Office for Europe, 2013). Because nursing students are not yet independent vaccinators, these factors were not addressed in this study.

Supportive ability factors refer to "the socio-cultural, community and medical contexts" in which vaccination occurs (WHO Regional Office for Europe, 2013, p. 21). For healthcare providers, this involves factors such as religious beliefs and cultural norms, the support of one's workplace for vaccination, and professional connection to and engagement with the community (WHO Regional Office for Europe, 2013). However, the primary supportive ability factor examined in this study was knowledge of vaccinations (WHO Regional Office for Europe, 2013). The WHO Regional Office for Europe (2013) recognizes that knowledge-based concerns and doubts surrounding vaccinations may originate in healthcare training (e.g. nursing school), which makes this factor particularly relevant to nursing students.

Personal motivation factors involve "the personal and psychological context that influences the individual to vaccinate or not" (WHO Regional Office for Europe, 2013, p. 21). These factors include one's attitudes and beliefs surrounding vaccination, risk-benefit analysis, perceived risks and severity of vaccine-preventable diseases, and self-efficacy (WHO Regional Office for Europe, 2013). Although the primary factor addressed in this study was vaccine attitudes measured on a vaccine acceptance scale, it must be noted that many of the personal motivation factors are simply called *vaccine attitudes* in the literature, such as one's perceptions of the risks and severity of vaccine-preventable diseases and risk-benefit analysis (Sarathchandra et al., 2018).

The WHO Regional Office for Europe's (2013) model of the factors that influence health workers' practices with regard to childhood vaccination demonstrates and supports the role that healthcare providers' vaccine knowledge and vaccine attitudes play in their likelihood to endorse, facilitate, and recommend vaccinations. These two

factors were specifically chosen for this study because they were noted to be the most frequently discussed factors in current scholarly literature involving nursing students, medical students, and registered nurses. In the present study, which focused specifically on nursing students, the WHO Regional Office for Europe's model supports the need to assess the vaccine knowledge and vaccine attitudes of nursing students, as these two factors are expected to directly impact their future vaccination discourse and practices as registered nurses.

CHAPTER 2

REVIEW OF LITERATURE

Search Strategy

A detailed review of current scholarly literature was performed to examine the present state of vaccine knowledge and vaccine attitudes among nursing students. The terms, "vaccine," "vaccination," "immunization," "vaccine hesitancy," "nurse," "nursing student," "student," "resident," "healthcare professional," "attitude," "knowledge," "belief," "perception," "influence," and "information source" were searched in various combinations using the research databases CINAHL Complete, ProQuest Nursing and Allied Health Database, OVID, and PubMed. The ancestry and descendancy approaches were employed extensively to find additional relevant articles. A librarian from the University of Windsor was consulted to ensure that both the search terms and search strategies utilized were comprehensive for the research topic.

As vaccine hesitancy is a growing, dynamic threat to public health (WHO, 2019c), articles were limited to peer-reviewed studies published between 2009 and 2019. A paucity of research pertaining to vaccine knowledge and attitudes of nursing students prevented further limitations to the publication date range. Articles were included if they discussed vaccine attitudes, vaccine knowledge, or vaccination influences among nursing students or nurses. Research involving medical students and residents was also incorporated due to their similarity as healthcare students. Articles were excluded if they solely discussed vaccination uptake rates or if they exclusively focused on physicians, due to physicians' high levels of specialization. Furthermore, articles that centered on any one particular vaccine were excluded from the literature review, which eliminated a

number of articles about the influenza and human papillomavirus (HPV) vaccines. The author closely reviewed both general and vaccine-specific vaccination literature and noted that attitudes surrounding specific vaccines (especially the influenza and HPV vaccines) were often considerably different from overall vaccination attitudes. In total, 22 articles were included in the review of literature. The articles that met the inclusion criteria revealed the known state of vaccine knowledge and vaccine attitudes among nursing students, medical students, and registered nurses. The literature review also uncovered an association between vaccine knowledge and vaccine attitudes. Finally, the articles were evaluated for potential influences on vaccination views.

Vaccine Knowledge

According to the WHO SAGE Working Group on Vaccine Hesitancy (2014a), vaccine knowledge refers to one's awareness of vaccination and includes both the level of knowledge and accuracy of knowledge surrounding vaccination. The literature suggests that nursing students possess overall low levels of vaccination knowledge with lower knowledge scores than both medical and pharmacy students (Dybsand et al., 2019; Pelly et al., 2010) and practicing nurses (Loulergue et al., 2009; Nikula, Puukka, & Leino-Kilpi, 2012). Dybsand et al. (2019) discovered that only 24.7% of the baccalaureate nursing students in their study were able to correctly answer either 4 or 5 out of 5 basic vaccine knowledge questions compared to 73.4% of medical students. Students in one nursing program in Nova Scotia were noted to have the lowest mean vaccine knowledge scores among various healthcare students at 11.1/21 or 52.9% (Pelly et al., 2010). Nikula et al. (2012) identified that public health nursing students nearing graduation possessed lower vaccine knowledge than their working counterparts, scoring

on average 7% lower on a general vaccine knowledge test. Likewise, Loulergue et al. (2009) found that nursing students demonstrated lower knowledge of occupational vaccinations than registered nurses, with the exception of influenza vaccine awareness.

One article was identified that exclusively assessed nursing students' vaccine knowledge (Hadaye, Shastri, & Lavangare, 2018). This study, which took place in India, found that most of the students could not correctly identify the price, dosage, or availability of routine adult vaccines (Hadaye et al., 2018). The lack of articles specific to general vaccine knowledge among nursing students demonstrates a need for additional research to assess current students' learning needs. Additionally, the existing studies all used different instruments to assess vaccine knowledge, and many of the authors did not comprehensively report on the reliability or validity analyses of their instruments. Therefore, directly comparing knowledge test results between these studies was not possible, highlighting the need for research into nursing students' vaccine knowledge using standardized measurements.

Although few studies have examined vaccine knowledge in nursing students, multiple studies of vaccine knowledge among medical students and residents have produced varying results. A study of final-year medical students in France demonstrated rather low mean vaccine knowledge scores of only 57.8% (Kernéis et al., 2017). However, when compared to students in non-medical programs, several researchers found that medical students obtained relatively high scores on general vaccine knowledge tests (Cvjetkovic, Jeremic, & Tiosavljevic, 2017; Zarobkiewicz et al., 2017). Multiple studies highlighted that significant gaps remain in medical students and residents' knowledge of vaccinations (Betsch & Wicker, 2012; Cvjetkovic et al., 2017; Dybsand et

al., 2019; Kernéis et al., 2017; Pelly et al., 2010; Zarobkiewicz et al., 2017). For instance, studies of American medical residents found that between 20.6–59% of participants reported no training on vaccine safety or communication during their schooling (Sarnquist et al., 2013; Williams & Swan, 2014). Furthermore, Betsch and Wicker (2012) discovered that nearly half of the medical students in their study were either unsure or incorrectly stated that vaccine additives are dangerous to recipients. While Betsch and Wicker described using an instrument that is known to have satisfactory psychometric properties (Zingg & Siegrist, 2012), many of the aforementioned studies did not report on the validity or reliability analyses of their instruments. However, it must be noted that medical students have been found to have higher vaccine knowledge scores than nursing students (Dybsand et al., 2019; Pelly et al., 2010), demonstrating the critical need for additional research into vaccine knowledge among nursing students.

Similar to studies of medical students, studies involving practicing nurses have identified significant gaps in nurses' knowledge of immunizations (Desmond et al., 2011; Loulergue et al., 2009; Picchio, Carrasco, Sagué-Vilavella, & Rius, 2019; Scatigna et al., 2017; Shibli, Rishpon, Cohen-Dar, & Kandlik, 2019). Nurses were found to possess insufficient awareness of vaccination schedules (Halcomb & Hickman, 2016) and contraindications to vaccination (Desmond et al., 2011). Research pertaining to nurses' knowledge of vaccination was difficult to compare and contrast as the studies involved nurses with varying educational backgrounds working in different countries and diverse practice settings. For instance, Nikula et al. (2012) found relatively high levels of vaccine knowledge among the Finnish public health nurses in their study, but the authors acknowledged that nurses who administer vaccinations in Finland must first undergo

specialized education. On the other hand, nearly two thirds of the paediatric healthcare providers included in an Israeli study were unable to correctly answer all six questions testing their knowledge of childhood vaccines (Shibli et al., 2019). Although physicians and nurses were assessed together in this study, the authors mentioned that their differences in knowledge scores were insignificant (Shibli et al., 2019). As with research involving nursing and medical students, none of the studies on nurses' vaccine knowledge levels comprehensively reported on the reliability or validity of their instruments. The wide range of vaccine knowledge and specific knowledge gaps identified in the literature suggest that the initial vaccine education of nurses during their undergraduate schooling deserves specific regional assessments.

While objective measures of immunization knowledge are difficult to assess and compare in studies of nursing students, medical students, and nurses, the literature suggests that all three groups subjectively feel underprepared in their knowledge of vaccination and desire additional training in vaccination awareness and/or communication (Arora et al., 2019; Dybsand et al., 2019; Kernéis et al., 2017; McMurtry et al., 2015; Nikula et al., 2009; Nikula et al., 2012; Pelly et al., 2010; Picchio et al., 2019; Sarnquist et al., 2013; Shibli et al., 2019; Williams & Swan, 2014). A mere 21% of healthcare students surveyed at two Nova Scotia universities believed they received sufficient undergraduate training in immunizations; specific values were not supplied for nursing students (Pelly et al., 2010). Notably, students who felt they received sufficient vaccination training obtained higher vaccine knowledge scores than those who felt inadequately prepared (Pelly et al., 2010). Similarly, only 55.9–66% of medical students and residents in the literature reported receiving sufficient general vaccination education

(Arora et al., 2019; Kernéis et al., 2017). However, when broken down by topic, satisfaction with vaccine education was found to vary widely in a sample of American nursing and medical students (Dybsand et al., 2019). For example, while only 56.6% of nursing students and 65.3% of medical students were satisfied with their education concerning the vaccine development and safety testing process, satisfaction rose to 90.5% for nursing students and 97.3% for medical students regarding education about vaccine-preventable diseases (Dybsand et al., 2019). Both medical students and practicing nurses were found to lack and/or desire more education on vaccine safety concerns (Picchio et al., 2019; Sarnquist et al., 2013; Williams & Swan, 2014). The general dissatisfaction surrounding vaccine education among participants in current scholarly research suggests that additional research into current nursing students' vaccine knowledge levels is required.

Vaccine Attitudes

Vaccine attitudes refer to one's perceived thoughts and beliefs surrounding the acceptability of vaccinations. The attitudes of contemporary nursing students toward vaccination are largely unknown. Dybsand et al. (2019) found that nursing students had somewhat more hesitant attitudes toward vaccination than did medical students or pharmacy students. For example, 92.8% of nursing students were found to believe in the safety of childhood vaccinations compared to 97.3% of medical students (Dybsand et al., 2019). However, the authors used only four survey items to assess for vaccine-hesitant attitudes in their participants (Dybsand et al., 2019). Pelly et al. (2010) stated that attitudes surrounding vaccination among healthcare students (including nursing students) at two Nova Scotia universities were "worrisome" (p. 6), but they did not deconstruct the

results of their attitudinal survey, except to correlate specific attitudinal statements with mean vaccine knowledge scores. Neither article reported complete validity or reliability measures for their instruments, and no other research was identified assessing general vaccine attitudes of nursing students.

Medical students and residents' attitudes toward vaccination have been better studied than those of nursing students. Kernéis et al. (2017) asked medical students to self-rate their attitudes toward vaccination and discovered that 99% of the participants reported favourable attitudes. Similarly, 97.3% of the medical students and 100% of the paediatric residents in Dybsand et al.'s (2019) and Arora et al.'s (2019) studies, respectively, believed in a positive risk-benefit analysis of vaccination. Likewise, in qualitative research involving Ontario medical students, participants were found to possess overall positive attitudes toward immunization at the start of their medical education, and they developed awareness of existing immunization controversies while in school (McMurtry et al., 2015). Multiple studies suggest that medical students have more positive attitudes toward immunization than their peers in non-medical university programs (Cvjetkovic et al., 2017; Zarobkiewicz et al., 2017) and the general public (Latella, McAuley, & Rabinowitz, 2018).

However, when specific survey questions were asked about the medical students and residents' vaccination beliefs, vaccine-hesitant attitudes became apparent. For example, while Arora et al. (2019) described 100% of the residents in their study possessing attitudes supportive of vaccination, 7% of participants maintained that an excessive number of vaccinations are given to children on the same day. Between 47.3–59.3% of the medical students and residents in several studies accepted alternative

vaccine schedules as a method of reducing parental vaccine anxieties (Arora et al., 2019; Dybsand et al., 2019). Although medical students and residents' attitudes toward vaccination have been better studied than those of nursing students, the discrepancies between overall vaccine attitudes and specific indicators of vaccine hesitancy suggest that additional research is required to examine vaccine-hesitant attitudes among both medical and nursing students.

As with nursing students, practicing nurses' attitudes toward vaccination in general have been minimally studied. Similar to medical students, research suggests that nurses possess overall accepting attitudes toward immunization but that specific and substantial vaccine-hesitant attitudes exist. For example, Halcomb and Hickman (2016) found that 98% of the nurses in their study affirmed the safety and efficacy of vaccines; however, apprehension regarding the risks of vaccine additives was conveyed by 10.7% of participants. Qualitative research involving Scottish nurses found that the nurses had ongoing doubts surrounding the safety of the measles, mumps, and rubella (MMR) vaccine (Kennedy et al., 2014).

Three studies combined nurses and physicians in their assessments of vaccine attitudes without fully specifying results by profession, precluding generalization of findings to nurses alone (Picchio et al., 2019; Shibli et al., 2019; Suryadevara et al., 2015). One quarter of the healthcare providers in Picchio et al.'s (2019) research expressed doubts surrounding one or more routine childhood vaccinations, and nurses were found to possess more hesitant attitudes toward specific vaccinations than physicians. Similarly, 13% of the healthcare providers in Suryadevara et al.'s (2015) study conveyed hesitant attitudes regarding vaccine safety, and 31% expressed doubts

about vaccine effectiveness, with physicians having more apprehension about efficacy than nurses. On the other hand, Shibli et al. (2019) found that both nurses and physicians possessed generally positive vaccination attitudes. Interestingly, the definition of the score that indicated a positive attitude toward vaccines was not provided, and 7% of the participants expressed serious concerns about vaccine side effects (Shibli et al., 2019). Further, 24% of participants believed in giving fewer vaccines at a single appointment (Shibli et al., 2019). Conversely, Scatigna et al. (2017) found that nurses possessed less positive attitudes toward vaccinations than physicians. These mixed findings of vaccine-hesitant attitudes among nurses support the need for additional studies into the attitudes of nursing students while they are receiving their initial vaccination education.

Among studies of vaccine attitudes, it must be noted that only Cvjetkovic et al. (2017) fully reported the psychometric properties of their instrument. Various methods were used in the literature to quantify vaccine attitudes. For example, Loulergue et al.'s (2009) only assessment of vaccine attitudes was receipt of the influenza vaccine. This limitation in current literature suggests that research into vaccine attitudes is needed using reliable, validated instruments; the WHO SAGE Working Group on Vaccine Hesitancy (2014b) acknowledges that a lack of these instruments is an ongoing difficulty in vaccine hesitancy research.

Association Between Vaccine Knowledge and Vaccine Attitudes

The literature demonstrates an association between vaccine knowledge and vaccine attitudes; higher vaccine knowledge has been consistently associated with more accepting vaccination attitudes or less hesitant attitudes among healthcare students and providers (Cvjetkovic et al., 2017; Kernéis et al., 2017; Pelly et al., 2010; Zarobkiewicz

et al., 2017). While two studies stated that a correlation exists between increased vaccine knowledge and positive vaccine attitudes in medical students, neither study reported correlation coefficients in their results (Cvjetkovic et al., 2017; Kernéis et al., 2017). However, Cvjetkovic et al. (2017) did find a statistically significant positive association between vaccine knowledge and attitudes in their multivariate model explaining variance in vaccine attitudes. The link between attitudes and knowledge has scarcely been studied in nursing students; only one study by Pelly et al. (2010) assessed for a correlation of these two factors in a sample including nursing students. While Pelly et al. did find an association between specific positive vaccine attitudes and knowledge of vaccinations in healthcare students, attitudinal scores were not provided by program, and correlation coefficients were not reported. Furthermore, the data were collected from only two universities in one province nearly a decade ago (Pelly et al., 2010). Therefore, although current research suggests that a correlation may exist between vaccine knowledge and vaccine attitudes, studies providing true correlation coefficients were noted to be lacking.

Sources of Vaccination Information

Scholarly literature suggests that people's vaccination attitudes and beliefs are influenced by many different sources (Yaqub et al., 2014); however, data specific to nursing students were found to be scarce. Dybsand et al. (2019) expressly highlighted a need for research on nursing students' vaccination influences. Although both Desmond et al. (2011) and Nikula et al. (2012) discussed preferred vaccine information resources among nurse immunizers, neither study addressed vaccine influences outside of a clinical context. Qualitative research involving various non-nursing healthcare students (including medical students) identified that parents may strongly impact students' vaccine

assumptions and practices (McMurtry et al., 2015). McMurtry et al. (2015) also discovered that formal healthcare education programs meaningfully influenced students' vaccination views. Likewise, Arora et al. (2019) quantitatively found that medical students reported strong educational influences on vaccination beliefs, whereas Betsch and Wicker (2012) noted that the medical students in their sample considered healthcare providers and textbooks to be leading health information sources. Although research in medical students suggests that parents and undergraduate education may be important vaccination influences (Arora et al., 2019; Betsch & Wicker, 2012; McMurtry et al., 2015), it is largely unknown what factors most significantly impact nursing students' vaccine views. Overall, many questions remain surrounding current Canadian nursing students' knowledge of and attitudes toward vaccination, in an era where vaccine hesitancy is considered a top threat to global health (WHO, 2019c). Assessing these gaps, along with influential sources of vaccine information, may assist nurse educators in tailoring the curriculum of nursing schools to account for any knowledge gaps or attitudinal barriers toward vaccinations.

CHAPTER 3

METHODOLOGY

Design

The research questions predominately utilized a descriptive research design. Correlational methodology was also used to assess for a correlation between students' vaccine knowledge and vaccine acceptance levels. Descriptive research methods are appropriate to assess, quantify, and determine the extent of relatively new phenomena (Sutherland, 2017), such as vaccine hesitancy in nursing students. Furthermore, as two separate variables (vaccine knowledge and vaccine attitudes) were examined, simple correlational research methods were used to assess and define the relationship between these two variables (Sutherland, 2017).

Questionnaire Selection

In order to answer the research question, "On a test of general knowledge of vaccination, what percentage of questions are answered correctly by fourth-year nursing students?" the one-dimensional Vaccination Knowledge Scale (Zingg & Siegrist, 2012) was utilized. This instrument uses nine questions to assess general vaccine knowledge of factors that may play a role in one's decision to be vaccinated. The Vaccination Knowledge Scale was developed using a Mokken scale analysis. Although formal validity testing was not reported, the authors developed the instrument based on public health documents and other research on the most frequently encountered vaccine misconceptions. Furthermore, the unidimensionality of the scale supports the content validity of the instrument (van der Heijden, van Buuren, Fekkes, Radder, & Verrips, 2003). The instrument measures one concept—general vaccine knowledge—and contains

no subscales. The Vaccination Knowledge Scale was found to have a Loevinger's scalability coefficient of $H = .45–.48$ (Zingg & Siegrist, 2012). Scalability refers to the accuracy with which the scale ranks or sequences participants, and it is calculated by testing the response patterns of participants against a theoretically perfect Guttman scale (van der Heijden et al., 2003). A scalability coefficient of $.4 \leq H < .5$ demonstrates a satisfactory scale with average scalability (Mokken, 1971). The scale is considered to be highly reliable with $p = .79–.80$ and a test-retest reliability of $r = .70$ (Zingg & Siegrist, 2012).

The Vaccine Acceptance Instrument was used to answer the research question, "On a survey of vaccine acceptance, what is the average vaccine acceptance score for the overall instrument, and what is the average score for the subscales of 'perceived safety of vaccines,' 'perceived effectiveness and necessity of vaccines,' 'acceptance of the selection and scheduling of vaccines,' 'positive values and affect toward vaccines,' and 'perceived legitimacy of authorities to require vaccinations?" (Sarathchandra et al., 2018, p. 1). In other words, this instrument addresses the attitudinal components of vaccine acceptance, as it expressly deals with one's perceptions of and affect toward vaccinations. The Vaccine Acceptance Instrument is considered to be valid and reliable. The authors of the instrument performed extensive pilot testing in order to ensure construct validity. Furthermore, the reliability of both the full instrument and the five subscales is considered to be high (Grove, 2017) with a Cronbach's α of .96 for the full instrument and .81–.91 for the subscales (Sarathchandra et al., 2018).

The third research question, "Is there a correlation between the vaccine knowledge score and the vaccine acceptance score?" was answered by using the results

obtained from the Vaccination Knowledge Scale and the Vaccine Acceptance Instrument. Therefore, no additional instruments were required to answer this research question. Based upon the review of current scholarly literature, it was hypothesized that a positive correlation would exist between students' vaccine knowledge scores and vaccine acceptance scores.

The final research question, "For the groups of students who score in the lowest and highest quartiles for vaccine knowledge scores and the lowest and highest quartiles for vaccine acceptance scores, what sources of vaccine information do they consider to be most influential in their lives?" was answered by using a single descriptive question composed by the author based on common vaccine information sources referred to in the literature. The participants were asked to choose one source of vaccine information that they consider to be most influential to them.

Additionally, several demographic questions were asked of the participants in congruence with other studies of nursing students' vaccine knowledge and attitudes. In this study, demographic questions included participants' age, gender, and parental status. See Appendix A for an example of the survey questions and instruments used in this study.

Sample and Setting

The target population for this study was fourth-year baccalaureate nursing students at a university in Southwestern Ontario. To control for knowledge differences related to time spent in nursing school, only a single year of students was included in the sample. Fourth-year nursing students were chosen as they have completed all the courses that teach immunization at the university, and the survey results reflected students'

knowledge and attitudes toward vaccination at the end of their undergraduate nursing education. The sample consisted of students enrolled in one of the required fourth-year courses. The required sample size for this study was 82 participants, which was calculated using G*Power Version 3.1.9.4. The sample size was determined for Pearson's correlation with a moderate effect size of .3, an alpha of .05, and 80% power. Apart from being enrolled in a required fourth-year nursing course, the only other inclusion criterion was that the participants were present on the day that the survey was administered.

The study took place on site at a university in Southwestern Ontario. Recruitment for the study occurred through an online announcement on the course's learning management system one week in advance (see Appendix B) and in person on the day of the survey (see Appendix C). The author explained the research study and process of obtaining informed consent to the participants (see Appendix D); however, the author, her thesis advisors, and the course professors were not present during data collection to ensure that no undue influence or coercion existed for the students to participate.

Ethics Considerations

Ethics approval was obtained from the University of Windsor's Research Ethics Board. There were minimal expected risks for the participants, as the data collected were deidentified and the topic of the study was not overtly sensitive. Participation in the survey did not impact the students' grades in any way, and this was clearly communicated to the students.

Data Collection Procedure

The data were collected in February 2020 prior to the widespread impact and restrictions of COVID-19 in Southwestern Ontario. The data collection occurred during a

required fourth-year nursing class. A QR code and online link to the Qualtrics survey were released to the participants (See Appendix E). A secretary from the university provided the survey password and was available to answer questions regarding access to the survey. The students were given approximately 10 minutes to complete the survey, and the data were automatically collected by the Qualtrics software once the surveys were submitted by the students. Participants who completed the survey were offered a small monetary credit on their student cards in appreciation for their participation.

Data Analysis

Data analysis was planned and occurred using Statistical Package for the Social Sciences (SPSS) version 26, Microsoft Excel, and the statistical techniques described below. The demographic data were analyzed using descriptive statistics. The first research question, "On a test of general knowledge of vaccination, what percentage of questions are answered correctly by fourth-year nursing students?" was also answered with simple descriptive statistics, by testing the data for normal distribution and calculating the mean and median. Descriptive statistics are useful for answering questions about the "incidence, prevalence, or frequency of a phenomenon of interest and its characteristics" (Sutherland, 2017, p. 200). In this case, the phenomenon of interest was vaccine knowledge.

The second research question, "On a survey of vaccine acceptance, what is the average vaccine acceptance score for the overall instrument, and what is the average score for each of the five subscales?" was likewise answered using simple descriptive statistics (again, calculating the mean and median and testing for normal distribution), but the data were analyzed separately for the whole instrument and for each of the subscales.

Descriptive statistics allowed for detailed analyses of students' attitudes toward vaccination.

The third research question, "Is there a correlation between the vaccine knowledge score and the vaccine acceptance score?" was answered using correlation analysis. Correlation and regression analyses are useful to assess the strength and direction of relationships between study variables (Knapp, 2017). The specific tests chosen were dependent on the results of the first two study questions, which determined whether the data met the criteria for parametric or non-parametric tests (Knapp, 2017).

Due to the limitations of nominal data, the final research question, "For the groups of students who score in the lowest and highest quartiles for vaccine knowledge scores and the lowest and highest quartiles for vaccine acceptance scores, what sources of vaccine information do they consider to be most influential in their lives?" was answered by calculating the frequency of each response. These responses were then compared between high-scoring participants and low-scoring participants on both the Vaccination Knowledge Scale and the Vaccine Acceptance Instrument. In this way, all four research questions were addressed with suitable statistical analyses.

CHAPTER 4

RESULTS

Data Handling

Data analysis began by screening for missing data. As only 0.3% of values were found to be missing, the percentage of missing data was considered to be very low and consequently suitable for single imputation data handling techniques (Schafer, 1999). Furthermore, as no individual item in the survey demonstrated more than two missing values, the omitted data appeared to be missing at random (Penny & Atkinson, 2011).

In both the Vaccination Knowledge Scale (Zingg & Siegrist, 2012) and the Vaccine Acceptance Instrument (Sarathchandra et al., 2018), a number of items were intentionally worded negatively or as incorrect statements; these items were then reverse coded in order to calculate overall scores on both instruments. The total score for the Vaccination Knowledge Scale was determined by ascribing 1 point for each correct answer and 0 points for each incorrect answer or the selection of "do not know," resulting in a potential score of 0–9. The Vaccine Acceptance Instrument utilizes a Likert scale; therefore, scores for individual questions ranged from 1 for "least accepting" answers to 7 for "most accepting" answers. This generated a possible score of 20–140 for the overall instrument. The sums of each of the five subscales were also individually calculated, with potential scores of 4–28. Consequently, in both the Vaccination Knowledge Scale and Vaccine Acceptance Instrument, higher scores are indicative of higher vaccine knowledge and higher vaccine acceptance, respectively.

The overall scores of both instruments were then screened for normal distribution of data in order to determine the correlation test to be utilized. The results of both

instruments demonstrated negatively skewed data; however, in consultation with a statistics expert at the University of Windsor, Pearson's correlation was deemed the most suitable test for the data due to its versatility and frequent usage with non-normally distributed psychometric data (K. Lafreniere, personal communication, March 3, 2020). Furthermore, Pearson's correlation has been found to be "relatively robust to nonnormality" (Bishara & Hittner, 2012, p. 411), particularly when the sample size is large and the data distribution pattern is not excessively non-normal.

Finally, the results of the Vaccination Knowledge Scale and the Vaccine Acceptance Instrument were checked for internal reliability. The Vaccination Knowledge Scale demonstrated a Cronbach's alpha of .66, which is marginally acceptable (Grove, 2017) but not unexpected for a knowledge instrument (K. Lafreniere, personal communication, March 3, 2020). Internal reliability of the Vaccine Acceptance Instrument results was noted to be strong (Grove, 2017), $\alpha = .90$. Examination of individual items in both instruments found that all items positively contributed to the overall reliability of the instruments.

Sample Characteristics

Of the 239 students registered in a mandatory fourth-year baccalaureate nursing course, 145 participated in the research study, resulting in a 60.7% response rate. Females comprised 91.7% of the sample ($n = 133$), and the average age of participants was 23.8 years ($SD \pm 5.3$, range 20–51 years). A small portion of the sample indicated that they are parents (8.3%, $n = 12$). Select demographic information was also obtained from the registrar's office for all students enrolled in the fourth-year nursing course. Among this population of nursing students, 85.8% were female, and the average age was 24.6 years

(*SD* ± 6.2 years). While parental status was not available for the population, the similarities in gender composition and mean age between the two groups suggest that the sample is representative. See Table 1 for a detailed description of the sample and population demographic information.

Table 1

Demographic information of fourth-year nursing student sample and population

Variable	**Sample Total** ***n*** **(%)**	**Population Total** ***N*** **(%)**
Gender		
Female	133 (91.7)	205 (85.8)
Male	12 (8.3)	32 (13.4)
Unknown	0 (0)	2 (0.8)
Age (years)		
20–24	118 (81.4)	182 (76.2)
25–29	12 (8.3)	28 (11.7)
30–34	6 (4.1)	11 (4.6)
35–39	3 (2.1)	5 (2.1)
≥ 40	6 (4.1)	13 (5.4)
Parental Status		
Parent	12 (8.3)	Unknown
Not a parent	133 (91.7)	Unknown

Research Question 1

On a test of general knowledge of vaccination, what percentage of questions are answered correctly by fourth-year nursing students?

The mean score obtained on the Vaccination Knowledge Scale was 7.8 or 86.7% (range 0–9, *SD* ± 1.5). The median score was 8. Table 2 demonstrates results from the Vaccination Knowledge Scale.

Table 2

Vaccination Knowledge Scale results

Item	Correct Answer *n* (%)	Incorrect Answer *n* (%)	Do Not Know *n* (%)
1. Vaccines are superfluous, as diseases can be treated (e.g. with antibiotics). (False)	111 (76.6)	13 (9.0)	21 (14.5)
2. Without broadly applied vaccine programs, smallpox would still exist. (True)	136 (93.8)	5 (3.4)	4 (2.8)
3. The efficacy of vaccines has been proven. (True)	142 (97.9)	3 (2.1)	0 (0.0)
4. Children would be more resistant if they were not always vaccinated against all diseases. (False)	126 (86.9)	10 (6.9)	9 (6.2)
5. Diseases like autism, multiple sclerosis, and diabetes might be triggered through vaccinations. (False)	138 (95.2)	1 (0.7)	6 (4.1)
6. The immune system of children is not overloaded through many vaccinations. (True)	115 (79.3)	17 (11.7)	13 (9.0)
7. Many vaccinations are administered too early, so that the body's own immune system has no possibility to develop. (False)	129 (89.0)	7 (4.8)	9 (6.2)
8. The doses of the chemicals used in vaccines are not dangerous for humans. (True)	124 (85.5)	11 (7.6)	10 (6.9)
9. Vaccinations increase the occurrence of allergies. (False)	110 (75.9)	5 (3.4)	30 (20.7)

Note: Items in column 1 are from "Measuring people's knowledge about vaccination: Developing a one-dimensional scale" by A. Zingg and M. Siegrist, 2012, *Vaccine, 30*, p. 3773. Copyright 2012 by Elsevier Ltd. Reproduced with permission.

Research Question 2

On a survey of vaccine acceptance in the same sample of students, what is the average vaccine acceptance score for the overall instrument, and what is the average score for the subscales of "perceived safety of vaccines," (items 1–4) "perceived effectiveness and necessity of vaccines," (items 5–8) "acceptance of the selection and scheduling of vaccines," (items 9–12) "positive values and affect toward vaccines," (items 13–16) and

"perceived legitimacy of authorities to require vaccinations" (items 17–20)? (Sarathchandra et al., 2018, p. 1).

Table 3 demonstrates the findings of the Vaccine Acceptance Instrument. The mean score on the Vaccine Acceptance Instrument was 123.3 (range 49–140, *SD* ± 16.1), and the median score was 127.

Table 3

Vaccine Acceptance Instrument results

Item	Strongly Disagree *n* (%)	Moderately Disagree *n* (%)	Slightly Disagree *n* (%)	I'm Not Sure *n* (%)	Slightly Agree *n* (%)	Moderately Agree *n* (%)	Strongly Agree *n* (%)
1. Vaccines are safe.	3 (2.1)	1 (0.7)	2 (1.4)	1 (0.7)	2 (1.4)	32 (22.1)	104 (71.7)
2. Vaccines contain mercury in dangerous amounts.	65 (44.8)	23 (15.9)	4 (2.8)	46 (31.7)	3 (2.1)	3 (2.1)	1 (0.7)
3. Vaccines contain dangerous ingredients.	70 (48.3)	24 (16.6)	11 (7.6)	26 (17.9)	10 (6.9)	3 (2.1)	1 (0.7)
4. Vaccines cause autism.	123 (84.8)	10 (6.9)	4 (2.8)	5 (3.4)	0 (0)	2 (1.4)	1 (0.7)
5. Some vaccines are unnecessary since they target relatively harmless diseases.	99 (68.3)	15 (10.3)	15 (10.3)	4 (2.8)	4 (2.8)	3 (2.1)	5 (3.4)
6. Diseases provide better immunity than vaccines do.	77 (53.1)	27 (18.6)	12 (8.3)	16 (11.0)	7 (4.8)	5 (3.4)	1 (0.7)
7. Vaccines are effective at preventing diseases.	4 (2.8)	2 (1.4)	2 (1.4)	1 (0.7)	8 (5.5)	39 (26.9)	89 (61.4)
8. Many of the illnesses that vaccines prevent are severe.	2 (1.4)	3 (2.1)	3 (2.1)	1 (0.7)	7 (4.8)	24 (16.6)	105 (72.4)
9. We give children the right number of vaccines.	0 (0)	2 (1.4)	4 (2.8)	12 (8.3)	11 (7.6)	47 (32.4)	69 (47.6)
10. The timing of the current vaccination schedule is appropriate.	0 (0)	0 (0)	4 (2.8)	21 (14.5)	9 (6.2)	35 (24.1)	76 (52.4)

11. We give vaccines to children when they are too young.	73 (50.3)	35 (24.1)	15 (10.3)	10 (6.9)	5 (3.4)	3 (2.1)	4 (2.8)
12. We give children too many vaccines.	81 (55.9)	33 (22.8)	12 (8.3)	6 (4.1)	6 (4.1)	4 (2.8)	3 (2.1)
13. I'm morally opposed to vaccinating my child.	130 (89.7)	7 (4.8)	2 (1.4)	3 (2.1)	1 (0.7)	1 (0.7)	1 (0.7)
14. Vaccines conflict with my belief that children should use natural products and avoid toxins.	118 (81.4)	10 (6.9)	6 (4.1)	5 (3.4)	4 (2.8)	1 (0.7)	1 (0.7)
15. Vaccines are a major advancement for humanity.	7 (4.8)	1 (0.7)	1 (0.7)	1 (0.7)	6 (4.1)	17 (11.7)	112 (77.2)
16. Vaccines are disgusting to me.	128 (88.3)	10 (6.9)	2 (1.4)	4 (2.8)	1 (0.7)	0 (0)	0 (0)
17. The government should not force children to get vaccinated to attend school.	99 (68.3)	21 (14.5)	6 (4.1)	3 (2.1)	5 (3.4)	5 (3.4)	6 (4.1)
18. My right to consent to medical treatment means that vaccinations should always be voluntary.	53 (36.6)	28 (19.3)	17 (11.7)	9 (6.2)	12 (8.3)	16 (11.0)	10 (6.9)
19. To protect public health, we should follow government guidelines about vaccines.	9 (6.2)	3 (2.1)	2 (1.4)	2 (1.4)	12 (8.3)	27 (18.6)	90 (62.1)
20. It is legitimate for government to mandate vaccinations.	9 (6.2)	4 (2.8)	4 (2.8)	5 (3.4)	11 (7.6)	26 (17.9)	86 (59.3)

Note: Items in column 1 are from "A survey instrument for measuring vaccine acceptance" by D. Sarathchandra, M. C. Navin, M. A. Largent, and A. M. McCright, 2018, *Preventive Medicine, 109,* p. 3. Copyright 2018 by Elsevier Inc. Reproduced with permission.

When the results of the Vaccine Acceptance Instrument were divided by subscale, the category of "positive values and affect toward vaccines" (Sarathchandra et al., 2018, p. 1) had the highest mean score at 26.5 (range 13–28, *SD* ± 2.9), while "perceived legitimacy of authorities to require vaccinations" (p. 1) demonstrated the lowest mean score at 23.3 (range 4–28, *SD* ± 5.0). Table 4 displays the Vaccine Acceptance Instrument subscale results.

Table 4

Vaccine Acceptance Instrument results by subscale

Subscale	Mean *(SD)*	Median	Range
"Perceived safety of vaccines"[a]	24.5 (± 3.9)	25	10–28
"Perceived effectiveness and necessity of vaccines"[b]	24.9 (± 3.6)	26	9–28
"Acceptance of the selection and scheduling of vaccines"[c]	24.2 (± 4.4)	25	7–28
"Positive values and affect toward vaccines"[d]	26.5 (± 2.9)	28	13–28
"Perceived legitimacy of authorities to require vaccinations"[e]	23.3 (± 5.0)	25	4–28

[a,b,c,d,e]Sarathchandra et al., 2018, p. 1.

Research Question 3

Is there a correlation between the vaccine knowledge score and the vaccine acceptance score?

The mean Vaccination Knowledge Scale scores and the mean Vaccine Acceptance Instrument scores were found to have a strong positive correlation (Cohen; Grove & Cipher as cited in Cipher, 2017), $r(143) = .69$, $p < .001$. Correlation was measured using Pearson's correlation coefficient. Figure 2 displays the correlation

between the Vaccination Knowledge Scale scores and the Vaccine Acceptance Instrument scores as a scatterplot with the regression line.

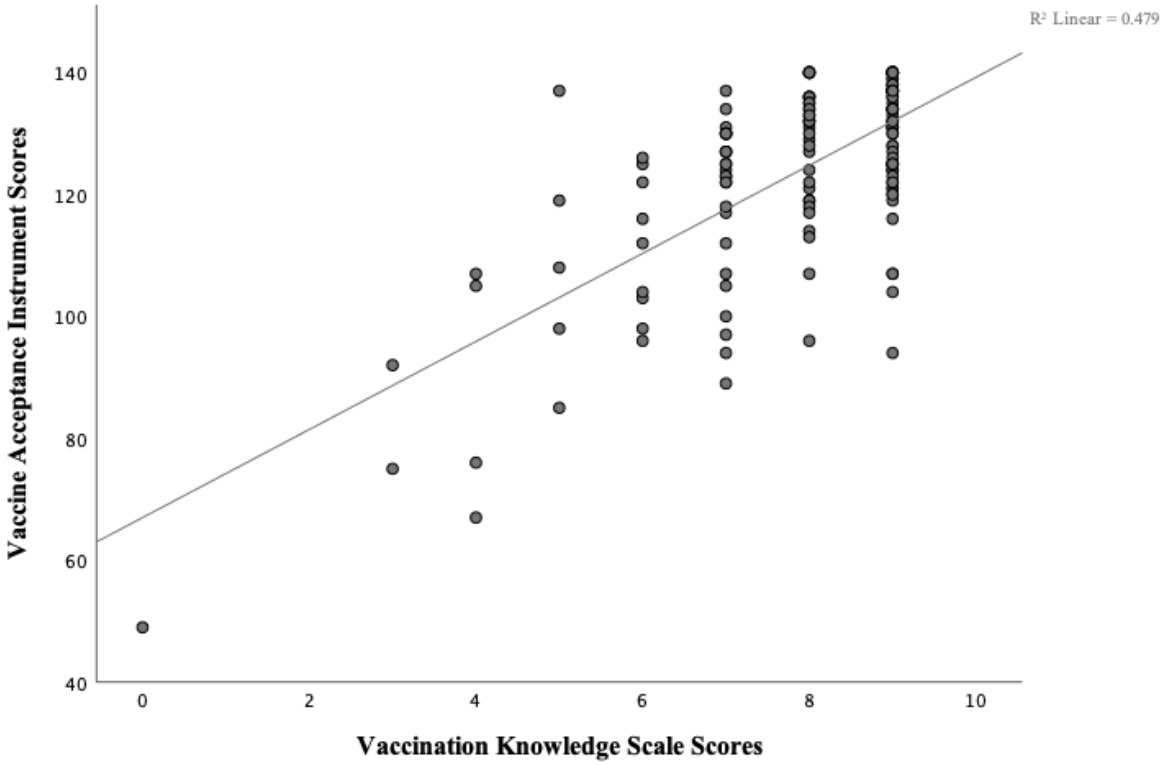

Figure 2. Scatterplot with regression line for Vaccination Knowledge Scale scores and Vaccine Acceptance Instrument scores

Research Question 4

For the groups of students who score in the lowest and highest quartiles for vaccine knowledge scores and the lowest and highest quartiles for vaccine acceptance scores, what sources of vaccine information do they consider to be most influential in their lives?

Nearly half of the participants (46.2%, $n = 67$) considered "nursing school" to be the leading vaccination influence in their lives. "Healthcare providers" (29.7%, $n = 43$) and "government/official websites" (15.9%, $n = 23$) were also reported as important vaccine information sources. See Figure 3 for a detailed visual depiction of leading vaccination influences among the participants.

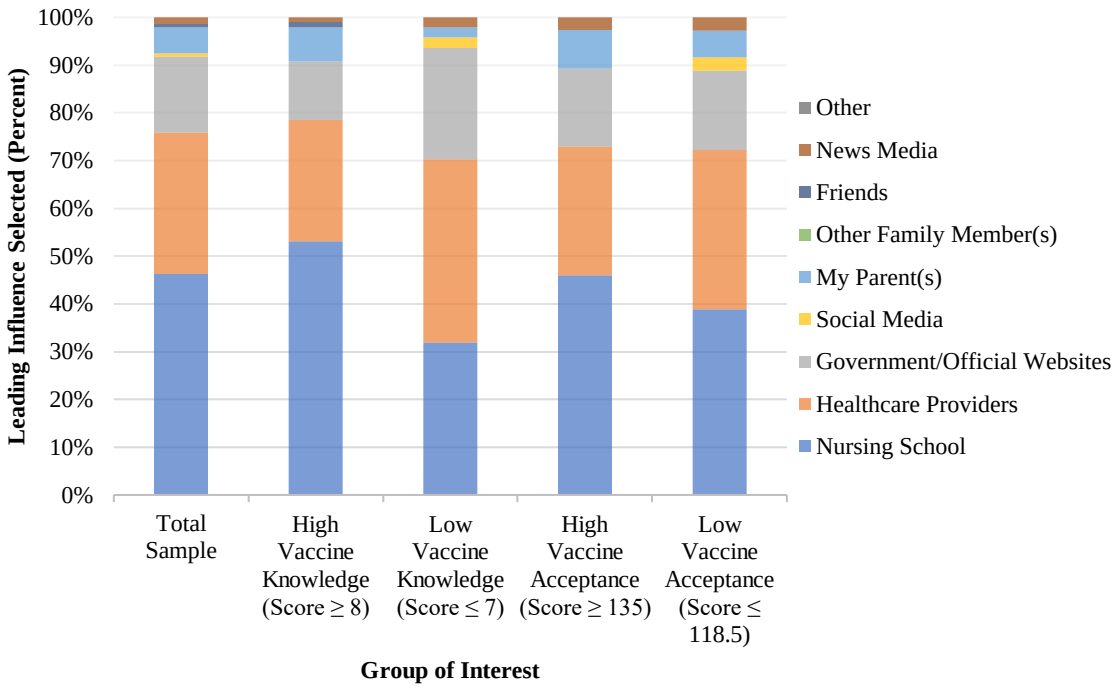

Figure 3. Stacked bar graph of leading vaccination influences broken down by vaccine knowledge and vaccine acceptance scores

When the Vaccination Knowledge Scale results were divided into quartiles, the top 25% of participants obtained 9/9 correct answers, and the bottom 25% of participants obtained ≤ 7/9 correct answers. The data were noted to be quite negatively skewed, with the majority of the participants obtaining scores of 8/9 or 9/9. Furthermore, participants reported difficulties understanding the meaning of the word "superfluous" in the first item, "Vaccines are superfluous, as diseases can be treated (e.g. with antibiotics)" (Zingg & Siegrist, 2012, p. 3773). Therefore, the decision was made to divide participants into two groups: those with higher vaccine knowledge scores (≥ 8) (n = 98) and those with lower vaccine knowledge scores (≤ 7) (n = 47). A small majority of participants with higher vaccine knowledge selected "nursing school" as their leading vaccination influence (53.1%, n = 52). On the other hand, the most frequently selected vaccine

influence among those with lower vaccine knowledge scores was “healthcare providers” (38.3%, n = 18) (Figure 3).

Finally, the Vaccine Acceptance Instrument scores were divided into quartiles, with high vaccine acceptance scores counted as ≥ 135 (n = 37) and low vaccine acceptance scores considered to be ≤ 118.5 (n = 36). “Nursing school” was the most frequently selected vaccination influence among those with both high vaccine acceptance scores (45.9%, n = 17) and low vaccine acceptance scores (38.9%, n = 14) (Figure 3).

CHAPTER 5

DISCUSSION

Vaccine Knowledge

The results of the Vaccination Knowledge Scale suggest that the baccalaureate nursing students in this study possessed high levels of vaccination knowledge near the end of their undergraduate nursing education. Their mean vaccination knowledge score of 86.7% was higher than results obtained on comparable vaccination knowledge tests among similar populations of nursing students. For example, final year baccalaureate nursing students in one nursing school in Nova Scotia had a mean vaccination knowledge score of 52.9% (Pelly et al., 2010), while graduating public health nursing students in Finland scored an average of 76% on a test of immunization knowledge (Nikula et al., 2012). Dybsand et al. (2019) found that only 24.7% of their baccalaureate nursing students answered at least 4 questions correctly on a 5-item general vaccine knowledge test, whereas 85.5% of the students in the present study obtained a comparable score of at least 7 out of 9 correct answers on the Vaccination Knowledge Scale. Compared to the students in this study, Dybsand et al.'s participants were notably heterogenous, with students' years of study not specified and multiple program streams included in the sample. Furthermore, the knowledge questions included in Nikula et al.'s (2012) survey were highly specific to safe vaccine administration. Despite these differences, the overall high mean knowledge score obtained in the present study suggests that the students possessed satisfactory and above-average general vaccination knowledge as they commenced independent nursing practice.

Although several studies in the literature found that medical students possessed greater vaccine knowledge than nursing students (Dybsand et al., 2019; Pelly et al., 2010), the nursing students in the present study were noted to have higher vaccination knowledge scores than all samples of medical students and residents found in the literature. Mean vaccination knowledge scores ranged from 43.7–78.1% among medical students and residents, as measured on various knowledge scales and instruments (Betsch & Wicker, 2012; Cvjetkovic et al., 2017; Kernéis et al., 2017; Pelly et al., 2010; Zarobkiewicz et al., 2017). Betsch and Wicker's (2012) study also utilized the Vaccination Knowledge Scale with second-year medical students. The mean score of 86.7% obtained in the present study was considerably higher than the mean score of 67.6% in Betsch and Wicker's study. Notably, the Cronbach's alpha of .69 reported by Betsch and Wicker was highly similar to that calculated in the present study (.66), which reinforces the reliability of the Vaccination Knowledge Scale. Both groups of students obtained the lowest scores on item #9, which states, "Vaccinations increase the occurrence of allergies" (Zingg & Siegrist, 2012, p. 3773). However, the medical students in Betsch and Wicker's study obtained a much higher score on one particular question: "Vaccines are superfluous, as diseases can be treated (e.g. with antibiotics)" (Zingg & Siegrist, 2012, p. 3773) (92.6% correct vs. 76.6% correct). Students in the present study may have struggled to understand the meaning of the word "superfluous," as their overall knowledge scores were markedly higher in spite of the lower scores obtained on this one question.

One notable distinction between the baccalaureate nursing students in this study and the medical students in the literature is the differing years of study among

participants. Only two of the research studies explicitly specified that final year students were sampled (Kernéis et al., 2017; Pelly et al., 2010), and the two lowest vaccination knowledge scores identified in medical students in the literature were found among mixed-year samples (Cvjetkovic et al., 2017; Zarobkiewicz et al., 2017), with Cvjetkovic et al. specifically noting a large proportion of first-year medical students in their study. It is possible that the high knowledge scores obtained in the present study may be related to the length of time spent in nursing school, as the participants had already completed all courses covering vaccinations in the four-year program.

The knowledge scores of study participants and practicing nurses in the literature were found to be quite similar, with comparable mean knowledge scores of 83–84% on various instruments (Nikula et al., 2012; Shibli et al., 2019). Some differences were noted between the participants in the present study and the nurses in the literature. The nurses in both Nikula et al.'s (2012) and Shibli et al.'s (2019) research were public health and paediatric specialists, respectively, and they were tested on specific rather than general vaccine knowledge. However, the high knowledge scores among both the current study participants and practicing nurses suggest that the completion of one's nursing education has a positive impact on vaccination knowledge, although further research is required to assess the direct impact of nursing school on vaccine knowledge scores.

Among samples of nursing students, medical students, and registered nurses, one specific question demonstrated consistently low knowledge scores. Three studies asked a question regarding the safety of vaccination during mild illness (Cvjetkovic et al., 2017; Desmond et al., 2011; Dybsand et al., 2019); this item revealed a distinct knowledge gap in all three studies but was not asked in the current study. This suggests that while the

students in the present study obtained high knowledge scores, the Vaccination Knowledge Scale may have gaps in what is considered general vaccination knowledge in other studies in the literature.

Vaccine Attitudes

As with vaccination knowledge, the participants in the current study demonstrated generally positive vaccination attitudes as measured on the Vaccine Acceptance Instrument. Dybsand et al. (2019) also assessed baccalaureate nursing students' vaccination attitudes with items comparable in content to the Vaccine Acceptance Instrument. Similar to Dybsand et al.'s (2019) findings, the participants' vaccine attitudes in the present study were largely accepting, with the majority of students in both studies agreeing that vaccines are safe and efficacious. However, Dybsand et al. highlighted that approximately one third of the nursing students in their sample possessed concerns about vaccination schedules. Students in the present study reported little hesitation in this area, with very few students selecting answers indicating outright disagreement with vaccination timing and schedules. Nevertheless, the overall vaccination attitudes of both samples appear to be positive. This stands in contrast to Pelly et al.'s (2010) finding of "worrisome" (p. 6) vaccination attitudes among nursing students. However, Pelly et al. combined results from students in three unique healthcare programs, and the content of most of their attitudinal assessment questions largely differed from the Vaccine Acceptance Instrument making results difficult to compare.

Medical students were likewise noted to possess generally positive vaccination attitudes (Arora et al., 2019; Cvjetkovic et al., 2017; Dybsand et al., 2019). Cvjetkovic et al. (2017) used a valid and reliable instrument to measure vaccination attitudes among

Serbian medical students. The medical students' mean score on the Attitudes Toward Vaccination Scale was 59.52/70—a score that is considered to reflect positive vaccination attitudes (Cvjetkovic et al., 2017). However, the participants in Cvjetkovic et al.'s research were observed to be quite hesitant about the government's role in mandating vaccinations, with only 35.5% strongly agreeing with mandated vaccinations. Likewise, in the present study, the subscale, "perceived legitimacy of authorities to require vaccinations" (Sarathchandra et al., 2018, p. 1) demonstrated the lowest mean score of all the subscales in the Vaccine Acceptance Instrument; however, the participants' acceptance of the government's role in requiring vaccinations was still relatively high overall. Conversely, the majority (90.7%) of the American medical residents in Arora et al.'s (2019) research supported prohibiting personal vaccination exemptions. The discrepancy between the three studies' findings (Arora et al., 2019; Cvjetkovic et al., 2017) aligns with the WHO's assertion that vaccine hesitancy is "context, time, place, program and vaccine specific" (WHO SAGE Working Group on Vaccine Hesitancy, 2014b, p. 14). Where one lives and one's attitudes toward government and authorities likely have a significant impact on one's level of acceptance of the government's role in vaccination. Despite the detailed results of the Vaccine Acceptance Instrument, the nursing students' rationales behind their less-accepting responses to the questions concerning the government's role in vaccination remain unclear. For example, are the participants who selected hesitant responses lacking trust in authorities, or are they wary of losing individual decision-making freedoms pertaining to vaccination? In light of the current COVID-19 pandemic, understanding the hesitancy surrounding trust in authorities and their "perceived legitimacy…to require vaccinations" (Sarathchandra et al., 2018, p.

3) will be paramount for promoting confidence in and acceptance of a future COVID-19 vaccine.

As with vaccine knowledge, the nursing students in the current study seem to possess vaccine attitudes similar to nurses studied in scholarly literature. Both groups expressed overall positive attitudes toward vaccination, although the nursing students demonstrated more accepting attitudes pertaining to specific vaccination topics. For example, Shibli et al. (2019) found that paediatric nurses possessed generally positive vaccination attitudes, with a mean score of 43.68/56 on their attitudinal scale. Similar to the present study, Halcomb and Hickman (2016) found that their sample of registered nurses was highly accepting of vaccine efficacy and the safety of vaccine ingredients, but the students in the present study were generally more accepting of overall vaccine safety and numbers of vaccinations given.

Nurses in the literature frequently demonstrated hesitant attitudes pertaining to numbers of vaccinations given in a single visit (Shibli et al., 2019; Suryadevara et al., 2015) and the childhood vaccination schedule in general (Halcomb & Hickman, 2016; Picchio et al., 2019; Shibli et al., 2019). Students in the present study appeared to be more accepting of vaccination schedules than nurses in the literature; however, a relatively large percentage of students (14.5%) also responded, “I’m not sure,” when asked about the appropriateness of the childhood vaccination schedule. It is possible that nursing students have had less exposure to vaccination schedules as they are a relatively younger population than working nurses and only 8.3% of them reported being a parent. However, it is also possible that the Vaccine Acceptance Instrument did not adequately capture one of the primary concerns expressed by nurses in the literature about numbers

of vaccinations given at a single appointment. Asking this question may have exposed additional hesitant beliefs in the study participants.

Conversely, the Vaccination Acceptance Instrument captured a particular area of uncertainty among the nursing students that has been infrequently studied among other healthcare providers in the literature. Nearly one third (31.7%) of the students were unsure if vaccines contain dangerous amounts of mercury. Picchio et al. (2019) described a similar proportion (29.8%) of their mixed nursing and physician sample expressing uncertainty of the risks of thimerosal in vaccines. Notably, Picchio et al.'s participants were all paediatric healthcare providers involved in vaccine administration, which demonstrates that this is a pervasive area of uncertainty and an opportunity for nursing educators to provide targeted teaching regarding the safety of particular vaccine ingredients.

Correlation Between Vaccine Knowledge and Vaccine Attitudes

As hypothesized, the nursing students' vaccination knowledge scores were found to have a strong positive correlation with their vaccine acceptance scores. Other studies of nursing and medical students also stated that a correlation or association exists between vaccination knowledge and attitudes (Cvjetkovic et al., 2017; Kernéis et al., 2017; Pelly et al., 2010; Zarobkiewicz et al., 2017). However, correlation coefficients were not reported in these studies, although Cvjetkovic et al. (2017) found a statistically significant positive association between vaccine knowledge and vaccine attitudes when these factors were included in a multivariate model explaining variance in vaccine attitudes. Overall, the general agreement in previous literature (Cvjetkovic et al., 2017; Kernéis et al., 2017; Pelly et al., 2010; Zarobkiewicz et al., 2017) supports the current

findings of a correlation between the students' vaccination knowledge scores and vaccine acceptance scores.

Nevertheless, while the students' overall vaccine knowledge and vaccine acceptance scores were positively correlated, incongruous findings emerged when specific vaccination knowledge responses were compared to similarly worded vaccine acceptance responses. For example, on the Vaccination Knowledge Scale, a notable 97.9% of participants correctly indicated that "the efficacy of vaccines has been proven" (Zingg & Siegrist, 2012, p. 3773). However, when asked about their acceptance of the statement, "Vaccines are effective at preventing diseases" (Sarathchandra et al., 2018, p. 3), only 61.4% of the students selected "strongly agree." Likewise, while 89% of the students correctly identified that the statement, "Many vaccinations are administered too early, so that the body's own immune system has no possibility to develop" (Zingg & Siegrist, 2012, p. 3773) is false, only 50.3% strongly disagreed with the equivalent item on the Vaccine Acceptance Instrument, "We give vaccines to children when they are too young" (Sarathchandra et al., 2018, p. 3). These findings suggest that while vaccination knowledge and attitudes are generally correlated, possessing high levels of vaccine knowledge alone does not guarantee completely accepting attitudes toward vaccinations, and varying degrees of hesitancy can exist even when vaccine knowledge is accurate.

Influences on Vaccination Views

With regard to vaccination influences, nursing school was selected as the leading vaccine information source among the entire sample, those with high vaccine knowledge scores, and those with both high and low vaccine acceptance scores. These findings suggest that nursing students consider their undergraduate nursing education important in

shaping their views and opinions surrounding vaccination. The results are congruent with Arora et al.'s (2019) and McMurtry et al.'s (2015) research, which found that undergraduate education is an influential source of vaccine information among medical students and residents.

However, a large number of students who had lower vaccination knowledge scores (scores of ≤ 7) selected healthcare providers as their primary vaccination influence. Interestingly, the medical students in Betsch and Wicker's (2012) research were found to have a lower mean score on the Vaccination Knowledge Scale than the nursing students in the present study (67.6% vs. 86.7%), and their participants also selected healthcare providers as a leading vaccination information source. In the present study, the mean knowledge score among those scoring ≤ 7 was 6.02, or 66.9%—a value within 1 percentage point of the students' average score in Betsch and Wicker's study. The selection of the same leading vaccination influence among two groups of healthcare students with lower vaccination knowledge scores is a topic that deserves greater research. In particular, it remains unclear which healthcare providers these students obtained their vaccination information from. For example, did these students turn to nurses, physicians, allied health professionals, or perhaps complementary/alternative healthcare providers? Further, did these students seek out healthcare providers who validated their pre-existing views surrounding vaccination, or did the healthcare workers provide outdated, incomplete, or inaccurate vaccination information? Because the majority of the participants in the present study were young adults, it is possible that they have had fewer routine interactions with their healthcare providers than other age groups, such as children or the elderly. Therefore, they may have acquired vaccine

misinformation from childhood vaccination experiences or during specific, episodic interactions with their healthcare providers (e.g. obtaining antibody titre levels or vaccinations for medical clearance to attend clinical placements). Understanding these factors could potentially help nursing educators understand where prevalent vaccination misconceptions are emerging from in nursing students in order to effectively address these misconceptions.

Surprisingly, social media and students' parents were selected as vaccination influences less frequently than expected based on the findings of other research studies (Dubé et al., 2016; McMurtry et al., 2015). These unexpectedly low numbers may have resulted from the phrasing of the question itself, which asked participants to select a single leading vaccination influence. It is possible that parents and social media impact students' vaccination views somewhat subconsciously and therefore were not selected as primary vaccination influences. As the students' average age was only 23.8 years, their parents have likely made or influenced the majority of their vaccination decisions thus far, whether or not they realize it. Likewise, young adults have been found to be leading users of social media (Pew Research Center, 2019), which is a known source of vaccine-hesitant viewpoints (Dubé et al., 2016). Therefore, it is probable that the nursing students are regularly exposed to information promoting vaccine hesitancy on social media, but it remains unknown if this exposure has a significant influence on their vaccine knowledge and attitudes.

Implications

Implications for nursing education. The results of this study suggest that graduating baccalaureate nursing students possess relatively high levels of general

vaccine knowledge; however, nursing educators should not assume that all of their students readily or fully endorse vaccinations (Yaqub et al., 2014). Furthermore, nursing educators should consider that possessing accurate vaccine knowledge alone does not guarantee students' total acceptance of all aspects of vaccination. Students may be fully accepting of some aspects of vaccination but hesitant or misinformed about other aspects. Specific uncertain or hesitant beliefs may require targeted vaccination education, particularly regarding the safety of vaccine ingredients, such as mercury, and the timing of the childhood vaccination schedule. Fortunately, the study results also found that undergraduate nursing educators play an important role in shaping vaccination views and opinions, as nearly half of the students selected "nursing school" as the leading vaccination influence in their lives. Furthermore, because the vaccination knowledge and acceptance scores were positively correlated, providing thorough and factual vaccine education can improve students' acceptance of vaccines. Therefore, nursing educators have a prime opportunity to positively influence vaccine knowledge and attitudes throughout the four years of students' undergraduate nursing education. Consequently, as nursing students' vaccine knowledge and acceptance increase, the WHO Regional Office for Europe's (2013) model of the factors that influence health workers' practices with regard to childhood vaccination suggests that the students will then be more likely to endorse, facilitate, and recommend vaccinations themselves.

Implications for nursing practice. As the study involved fourth-year nursing students approaching graduation, the study implications will extend into the students' clinical practice as registered nurses. The results demonstrate that the students are beginning their nursing careers with high general vaccine knowledge and high but

varying degrees of vaccine acceptance, which could directly impact their future clients. For example, if a student indicated that they "slightly agree" that vaccines are safe, what messages about vaccine safety will they convey to clients, families, and communities? In light of the COVID-19 pandemic, this study reinforces that vaccine hesitancy occurs on a continuum (WHO SAGE Working Group on Vaccine Hesitancy, 2014b; Yaqub et al., 2014), even among well-educated healthcare providers, and this reality may have significant consequences when a novel vaccine is introduced that will likely exacerbate pre-existing hesitant attitudes. In fact, the WHO SAGE Working Group on Vaccine Hesitancy (2014b) considers the "introduction of a new vaccine" (p. 12) to be a specific factor that contributes toward vaccine hesitancy. The positive correlation between vaccine knowledge and attitudes suggests that providing continuing education regarding both a future COVID-19 vaccine and vaccines in general will positively influence nurses' attitudes toward these vaccines. However, this study only assessed general/childhood vaccine knowledge and attitudes, and a major reason why specific vaccinations (e.g. the influenza and HPV vaccines) were omitted from the literature review and research focus was because these vaccines were noted to produce distinct controversies and specific hesitant attitudes. Therefore, areas of nursing practice that encounter these particular vaccines, including a future COVID-19 vaccine, may benefit from additional research into vaccine-specific hesitant attitudes and perhaps additional continuing education.

Implications for research. The results of the present study demonstrate a number of opportunities for future research. This study examined fourth-year nursing students who had already completed all courses covering vaccinations, and their baseline vaccine knowledge and acceptance levels remain unknown. Future research should quantitatively

investigate the impact that nursing school itself has upon vaccine knowledge and attitudes by measuring knowledge and acceptance levels at baseline and throughout the four-year university program. Likewise, the impact of targeted education programs for some of the common vaccine misconceptions found in this study should be researched as a potential method to improve vaccine knowledge and, therefore, acceptance.

A major finding of this study was the range of responses on the Vaccine Acceptance Instrument. Although the majority of responses were on the more-accepting end of the spectrum, many items also revealed high numbers of partially accepting responses (e.g. “slightly agree” or “moderately agree”). However, the meaning of these different acceptance levels and the impact of mild vaccine hesitancy on clinical practice is unknown, and these areas may be better explored using qualitative or mixed methods research strategies. Finally, the research question pertaining to vaccination influences revealed multiple opportunities for future research. In particular, the impact that parents and social media have on nursing students’ vaccination attitudes should be further examined. Exploring students’ perceptions of who or what influences their vaccination views and attitudes using qualitative approaches may help to explain the range of vaccine acceptance noted in the present study and assist nursing educators in targeting their vaccine education approaches.

Limitations

Several limitations were noted in the process of designing and implementing this research study. The study utilized a convenience sample and took place at a single school of nursing where specific vaccinations are required to attend clinical placements. Therefore, regardless of whether the students possessed hesitant attitudes or not, they

would have already received all the vaccines required to complete four years of clinical placements. In general, the research participants possessed high levels of vaccine knowledge and acceptance, with very few students demonstrating truly low knowledge or acceptance scores. Consequently, the results may preclude insight into nursing students with lower levels of vaccine knowledge and acceptance. In particular, the very low numbers of students who selected the "least accepting" response on each item in the Vaccine Acceptance Instrument make these responses difficult to generalize to other populations of nursing students. However, the demographic similarities between the research sample and the population of fourth-year nursing students at the university suggest that the sample is representative of the school itself, and it is possible that, in general, there are few nursing students who outright reject all vaccinations.

Secondly, a particular limitation may have occurred in the process of assessing leading vaccination influences. Potentially, students may have selected "nursing school" as their leading vaccination influence because this influence was foremost in their minds as they completed the survey during class time. It is also possible that "nursing school" was viewed as the most socially desirable answer to this particular question. Therefore, the setting of the data collection should be considered when interpreting the results. However, the similarities in vaccination influences reported among medical students (Arora et al., 2019; Betsch & Wicker, 2012) suggest that the data collection setting did not strongly affect the results.

Finally, a number of limitations were noted with the instruments selected for use in this study. The Vaccination Knowledge Scale measures general vaccine knowledge rather than specific vaccine knowledge (Zingg & Siegrist, 2012), and obtaining high

knowledge scores on this instrument does not guarantee vaccination proficiency in clinical practice. Other studies in the literature found significant knowledge gaps in topics that exceed the scope of the Vaccination Knowledge Scale but are important for nurses to know, such as the safety of administering immunizations during mild illnesses (Cvjetkovic et al., 2017; Desmond et al., 2011; Dybsand et al., 2019). On the other hand, the Vaccine Acceptance Instrument specifically measures attitudes surrounding childhood vaccinations (Sarathchandra et al., 2018), and this may have had an impact on participants' responses to certain questions, especially as the majority of participants were not parents themselves. The Vaccine Acceptance Instrument was also noted to be the only 7-point Likert scale used to measure vaccine attitudes in the literature, and this presented challenges comparing results to the 5-point Likert scales more commonly used in other studies. However, there are a paucity of valid and reliable instruments available for research use that measure general vaccine knowledge and attitudes. Therefore, despite the limitations of the instruments used, a major strength of this study is that it utilized valid and reliable instruments for both measures.

Conclusion

Vaccine hesitancy is a growing threat to public health worldwide (WHO, 2019c), and healthcare workers are not immune from hesitant beliefs (Yaqub et al., 2014). Healthcare workers' likelihood to support and recommend vaccines is impacted by their knowledge of and attitudes toward immunizations (WHO Regional Office for Europe, 2013). This study examined nursing students' vaccine knowledge and acceptance at the end of their four-year baccalaureate nursing education. The participants were found to have high vaccine knowledge and acceptance scores, and the two scores were positively

correlated. However, the results also demonstrated a range of attitudes toward various aspects of immunization, and the impact of varying degrees of vaccine acceptance is a topic for future researchers to investigate. Nursing educators have the opportunity to positively impact students' vaccination knowledge and attitudes, as nursing school was considered to be the leading vaccination influence in many of the students' lives. By promoting high-quality, accurate vaccination education, nursing educators can potentially shape the future clinical practice of their students as they care for clients, families, and communities and contribute to an accurate and positive discourse surrounding vaccination.

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APPENDICES

Appendix A

Survey Questions

1. How old are you? _____

2. What is your gender? _____

3. Are you a parent?
   ☐ Yes
   ☐ No

Please select the correct response for each of the following statements:

1. Vaccines are superfluous, as diseases can be treated (e.g. with antibiotics).
   ☐ Correct
   ☐ Incorrect
   ☐ Do not know

2. Without broadly applied vaccine programs, smallpox would still exist.
   ☐ Correct
   ☐ Incorrect
   ☐ Do not know

3. The efficacy of vaccines has been proven.
   ☐ Correct
   ☐ Incorrect
   ☐ Do not know

4. Children would be more resistant if they were not always vaccinated against all diseases.
   ☐ Correct
   ☐ Incorrect
   ☐ Do not know

5. Diseases like autism, multiple sclerosis, and diabetes might be triggered through vaccinations.
   ☐ Correct
   ☐ Incorrect
   ☐ Do not know

6. The immune system of children is not overloaded through many vaccinations.
   ☐ Correct
   ☐ Incorrect
   ☐ Do not know

7. Many vaccinations are administered too early, so that the body's own immune system has no possibility to develop.
   - ☐ Correct
   - ☐ Incorrect
   - ☐ Do not know

8. The doses of the chemicals used in vaccines are not dangerous for humans.
   - ☐ Correct
   - ☐ Incorrect
   - ☐ Do not know

9. Vaccinations increase the occurrence of allergies.
   - ☐ Correct
   - ☐ Incorrect
   - ☐ Do not know

Note: Items 1–9 are from "Measuring people's knowledge about vaccination: Developing a one-dimensional scale" by A. Zingg and M. Siegrist, 2012, *Vaccine, 30,* p. 3773.

Please indicate whether you disagree or agree with each of the following statements about childhood vaccines.

	Strongly disagree	Moderately disagree	Slightly disagree	I'm not sure	Slightly agree	Moderately agree	Strongly agree
1. Vaccines are safe.	1	2	3	4	5	6	7
2. Vaccines contain mercury in dangerous amounts.	1	2	3	4	5	6	7
3. Vaccines contain dangerous ingredients.	1	2	3	4	5	6	7
4. Vaccines cause autism.	1	2	3	4	5	6	7
5. Some vaccines are unnecessary since they target relatively harmless diseases.	1	2	3	4	5	6	7
6. Diseases provide better immunity than vaccines do.	1	2	3	4	5	6	7
7. Vaccines are effective at preventing diseases.	1	2	3	4	5	6	7
8. Many of the illnesses that vaccines prevent are severe.	1	2	3	4	5	6	7
9. We give children the right number of vaccines.	1	2	3	4	5	6	7
10. The timing of the current vaccination schedule is appropriate.	1	2	3	4	5	6	7
11. We give vaccines to children when they are too young.	1	2	3	4	5	6	7
12. We give children too many vaccines.	1	2	3	4	5	6	7
13. I'm morally opposed to vaccinating my child.	1	2	3	4	5	6	7
14. Vaccines conflict with my belief that children should use natural products and avoid toxins.	1	2	3	4	5	6	7
15. Vaccines are a major advancement for humanity.	1	2	3	4	5	6	7
16. Vaccines are disgusting to me.	1	2	3	4	5	6	7

17. The government should not force children to get vaccinated to attend school.	1	2	3	4	5	6	7
18. My right to consent to medical treatment means that vaccinations should always be voluntary.	1	2	3	4	5	6	7
19. To protect public health, we should follow government guidelines about vaccines.	1	2	3	4	5	6	7
20. It is legitimate for government to mandate vaccinations.	1	2	3	4	5	6	7

Note: Items 1–20 are from "A survey instrument for measuring vaccine acceptance" by D. Sarathchandra, M. C. Navin, M. A. Largent, and A. M. McCright, 2018, *Preventive Medicine, 109*, p. 3. Copyright 2018 by Elsevier Inc. Reproduced with permission.

Vaccination Information Sources:

Which of the following vaccine information sources do you consider to be the most influential in your life? (Please select **one** of the following):

☐ Healthcare providers

☐ Nursing school

☐ Government/official websites

☐ Social media

☐ My parent(s)

☐ Other family member(s)

☐ Friends

☐ News media

☐ Other (please specify)_____

Appendix B

Learning Management System Recruitment Announcement

To all fourth-year students in [redacted]

You are invited to participate in a research study and share your knowledge and attitudes surrounding vaccination. The study is titled, "Vaccine Knowledge and Vaccine Attitudes of Undergraduate Nursing Students" and is being conducted by Caitlyn Wilpstra (MScN student) under the supervision of Dr. Jody Ralph from the Faculty of Nursing.

On February 7, 2020, you will be provided the opportunity to complete a brief online survey at the beginning of your [redacted] class. The survey will take approximately 10 minutes to complete. Please bring with an electronic device, such as a computer, tablet, or smart phone, if you wish to participate.

All students who complete the survey will be offered a small token of appreciation for their time.

This study has been reviewed and cleared by the University of Windsor's Research Ethics Board. Survey participation is completely voluntary, and participation will not affect your grades in any way. Your name will not be linked to your survey data. You can choose to provide your name and student number if you want to receive the small token of appreciation. Your personal data will be kept confidential. You may choose to skip any questions you do not wish to answer and still receive the token of appreciation.

Thank you in advance for your participation!
If you have any questions or want to know more about this study, please review the attached letter of information or feel free to contact Caitlyn Wilpstra at [redacted]

Appendix C

In-Class Recruitment Announcement

Hello, my name is Caitlyn Wilpstra. I am a second-year Master of Science in Nursing student at the University of Windsor. Currently, I am working on completing my thesis, under the supervision of Dr. Jody Ralph from the Faculty of Nursing. My thesis is called, "Vaccine Knowledge and Vaccine Attitudes of Undergraduate Nursing Students." This research will hopefully lead to a better understanding of how knowledgeable fourth-year nursing students are about vaccinations, as well as what their beliefs and attitudes are towards immunization. Your class is almost ready to graduate, and some of you might be future vaccinators. We are also looking for potential areas of improvement in the undergraduate nursing curriculum regarding vaccination education.

If you volunteer to participate in this study, we will ask you to complete a brief, online survey. You will be given 10 minutes to complete the survey, and you will need an electronic device. You will be asked to carefully review the consent page at the start of the survey prior to agreeing to complete the survey, and then you may begin the survey. If there are any questions that you don't want to answer, you may skip that question and still be included in the research. If you decide you don't want to be in the survey at some point, just close your browser window, and your data will not be included. However, once you click "submit" at the end of the survey, we can no longer retrieve your data, **because we won't know who completed which survey.**

At the end of the survey, you will have the option to submit your name and student number in order to receive a $3 credit on your [redacted] student card, which can be used in the stores and restaurants around the university campus.

I would like to assure you that this study has been cleared by the University of Windsor's Research Ethics Board. **However, it is completely up to you whether or not you participate**. You should also know participating or not participating will not affect your grades in any way, and both myself, Dr. Ralph, and your professors will leave the room while the survey is being completed. The link to the survey will be released shortly through a Blackboard course announcement and email. It will also be provided as a scannable QR code. The nursing secretary, [redacted], will be available to help you access the survey.

Thank you for your time, and thank you in advance for your participation and contribution to nursing research! Do you have any questions for me?

Appendix D

Consent to Participate in Research Form

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: **Vaccine Knowledge and Vaccine Attitudes of Undergraduate Nursing Students**

You are asked to participate in a research study conducted by Caitlyn Wilpstra under the supervision of Dr. Jody Ralph from the Faculty of Nursing at the University of Windsor. The results of this study will contribute to a Master of Science in Nursing thesis investigating vaccine knowledge and vaccine attitudes in undergraduate nursing students. If you have any questions or concerns about the research, please feel to contact Caitlyn Wilpstra at [redacted] or Dr. Jody Ralph at [redacted] or [redacted] ext. [redacted].

PURPOSE OF THE STUDY

The purpose of this study is to assess both the current knowledge of vaccinations and attitudes towards vaccinations in undergraduate nursing students at [redacted].

PROCEDURES

If you volunteer to participate in this study, you will be asked to complete an online survey. The survey will include questions about you, your knowledge of vaccinations, your attitudes/beliefs surrounding vaccination, and what sources of vaccination information influence you. The survey takes approximately 5-10 minutes to complete and will be completed in one sitting during class time.

POTENTIAL RISKS AND DISCOMFORTS

The psychological, emotional, social, and data security risks associated with participating in the study are low. Participants may feel discomfort answering certain questions. The survey results may reflect on the vaccine education provided by the [redacted] nursing program. To reduce these risks, you may choose not to answer any questions that you don't feel comfortable answering. If you feel upset as a result of the survey, the [redacted] Nursing Clinical Therapist, [redacted], is available to speak with you. Appointments can be made at [redacted], ext. [redacted] or by email at [redacted]. In addition, to protect your privacy and the university's privacy, the name of the university will not appear in the data when the results of the research are published.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

There are no direct benefits expected as a result of participating in this study. The indirect benefits you may gain from participating in this study include insights into your class's knowledge of vaccines as future registered nurses, as you will be able to review the class's combined results when the data are released and compare these results to the correct answers to the knowledge questions. The survey may also help you clarify your own beliefs towards and acceptance of vaccination. Other indirect benefits of participating in this research include contributing to nursing research and contributing towards the future vaccine education of nursing students at the [redacted].

COMPENSATION FOR PARTICIPATION

Participants who provide their name and student number at the end of the survey will receive a $3 credit on their [redacted], which can be used towards purchases at the [redacted] food and retail outlets in appreciation for contributing to the study. Your name and student number will not be linked to the answers you provide in the survey.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission.

No personal, identifying information will be collected in the survey itself. Participants have the opportunity to provide their name/student number at the end of the survey in order to receive a $3 credit on the student's [redacted]. The [redacted] Office will have access to your name and student number in order to upload the $3 credit on your student card.

The survey data will be stored on a password-protected website (Qualtrics) and computer, only accessible to the researcher, her thesis committee, and a statistician. The data will be stored until the research is accepted for publication or according to the date set by journal policy, at which point the data will be deleted. In order to ensure you receive the $3 credit, your name and student number will be stored on a password-protected computer. Your personal identifiers will only be shared with the [redacted] office to upload your $3 [redacted] credit. The list of participants will be deleted on April 7, 2020.

PARTICIPATION AND WITHDRAWAL

You may decide whether or not you would like to participate in this study. If you choose to participate in the study, you may withdraw from the survey at any point by closing your browser window. Any data entered up to that point will be deleted after one week and will not be included in the data analysis. Once you submit the online survey, there is no way to retrieve your survey, as the survey is completely anonymous. There are no consequences to withdrawing from the survey. You may also choose not to answer any questions that you wish and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

A short summary of the research findings will be made available to participants via a class Blackboard announcement prior to the end of the semester. A summary of the findings will also be made available on the University of Windsor's Research Ethics Board website.

Web address: https://scholar.uwindsor.ca/research-result-summaries/
Date when results are available: September 2020

SUBSEQUENT USE OF DATA

These data may be used in subsequent studies, in publications, and in presentations.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: [redacted], ext. [redacted]; e-mail: [redacted]

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____
Signature of Investigator Date

Please select one of the following options:

☐ I understand the information provided for the study “Vaccine Knowledge and Vaccine Attitudes of Undergraduate Nursing Students” as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study.

☐ I do not agree to participate in this study.

Appendix E

QR Code Link to Survey

QR Code Link to Survey:

Survey Password:

vaccine

VITA AUCTORIS

NAME:	Caitlyn Wilpstra
PLACE OF BIRTH:	Sarnia, ON
YEAR OF BIRTH:	1992
EDUCATION:	Lambton Central Collegiate & Vocational Institute, Petrolia, ON, 2009
	University of Windsor, B.Sc. (Nursing), Windsor, ON, 2013
	University of Windsor, M.Sc. (Nursing), Windsor, ON, 2020