

**AN ANALYSIS OF THE KNOWLEDGE, ATTITUDES, AND PRACTICES OF
REGISTERED NURSES TOWARD CLIMATE-DRIVEN VECTOR BORNE
DISEASES**

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DEDICATION

To nurses around the globe, working in one of the most challenging, difficult, and tiring professions, but one that is also beautiful and rewarding. This was eloquently stated by Florence Nightingale, when she referred to nursing as an art which “requires an exclusive devotion as hard a preparation as any painter’s or sculptor’s work...it is one of the Fine Arts: I had almost said, the finest of Fine Arts.” (Nightingale, 1860)

ABSTRACT

Background: There is abundant evidence that climate change is contributing to increasing rates of vector-borne diseases, affecting the health of Canadians. Registered nurses are central to a highly performing health care system and play an integral role in supporting individuals and populations affected by various health challenges. **Purpose:** The purpose of this quantitative, cross-sectional research study was to investigate the knowledge, attitudes, and practices of registered nurses in Canada related to climate sensitive vector-borne diseases, namely Lyme disease and West Nile virus, using Planetary Health as the guiding theoretical framework.

Methods: A national survey was distributed via Qualtrics™ to practicing registered nurses in Canada, through contact with nursing organizations and regulatory bodies, as well as social media. **Results:** 382 survey responses were included in data analysis. Survey responses were received from nurses throughout Canada, working in a wide variety of practice areas. Research findings suggest that nurses' knowledge on climate change and vector-borne diseases was limited, especially among frontline nurses and those in Western and Northern regions of Canada. There was greater knowledge of Lyme disease compared to West Nile virus, particularly among nurses working in endemic areas and among nurses who declared Indigeneity. Participants did not often consider vector-borne diseases in practice and demonstrated a lack of confidence and preparedness in addressing vector-borne diseases in the practice setting. Barriers to discussing vector-borne diseases in practice exist, with lack of knowledge and time reported most frequently. Most study participants never received training or education on vector-borne diseases, and information on the topic in the practice setting is absent. Most participants believed they have a role in health equity and social justice, particularly for equity-denied populations.

Conclusion: A greater understanding of nurses' knowledge, attitudes, and practices of climate

driven vector-borne diseases has been achieved through the meaningful data obtained from study participants. Based on the findings, recommendations for education, practice, advocacy, and research are presented, with the goal that nurses are better educated, and subsequently more prepared to address vector-borne diseases in the practice setting and assume a greater role in leading change to advocate for a climate-resilient future.

ETHICS STATEMENT

Work described in this thesis received research ethics approval from the University of Alberta Research Ethics Board, Project Name “AN ANALYSIS OF THE KNOWLEDGE, ATTITUDES, AND PRACTICES OF REGISTERED NURSES TOWARD CLIMATE-DRIVEN VECTOR BORNE DISEASES”, No. Pro00131179, AUGUST 25, 2023.

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LIST OF ABBREVIATIONS

ANHE	Alliance of Nurses for Healthy Environments
AMMI	Association of Medical Microbiology and Infectious Disease Canada
CANE	Canadian Association of Nurses for the Environment
CASN	Canadian Association of Schools of Nursing
CDC	Centers for Disease Control and Prevention
CFNU	Canadian Federation of Nurses Unions
CMA	Canadian Medical Association
CNA	Canadian Nurses Association
CPHA	Canadian Public Health Association
HCP	Health Care Professional
ILADS	International and Associated Disease Society
ICN	International Council of Nurses
IDSA	Infectious Diseases Society of America
IPCC	Intergovernmental Panel on Climate Change
KAP	Knowledge, Attitude, and Practice
NCCIH	National Collaborating Centre for Indigenous Health
PHAC	Public Health Agency of Canada
RDS	Respondent-driven Sampling
RN	Registered Nurse
SDOH	Social Determinants of Health
VBDs	Vector-borne Diseases
WHO	World Health Organization
WNV	West Nile virus

CHAPTER ONE: INTRODUCTION

The world's climate is changing, impacting the elements needed for good human health and well-being, namely clean air, safe drinking water, nutritious food, and secure shelter. Recent estimates indicate the planet was 1.35 degrees Celsius warmer in 2023 than the pre-industrial period (Lindsey & Dahlman, 2024). According to Environment and Climate Change Canada (2019), past and future warming in Canada is double the magnitude of global warming, and in some areas, particularly Northern Canada, changes of 2.3 degrees Celsius have been observed (Bush & Lemmen, 2019; Cerny et al., 2021).

Sadly, those who are least responsible for climate change will likely be disproportionately affected by its adverse outcomes – a phenomenon known as climate justice (Myers & Frumkin, 2020; Nicholas & Breakey, 2017). Experiencing existing social and structural inequities and lacking in any one or more of the social determinants of health (SDOH) compounds one's vulnerability to climate related health problems (Public Health Agency of Canada (PHAC), 2022). Social and structural inequities, such as homelessness, racism, marginalization, colonialism, and lack of access to health care, exacerbate climate-related health risks (Health Canada, 2022).

First Nations, Inuit, and Metis communities are closely connected to natural ecosystems, where the geographical location of their communities causes them to experience the effects of rapid climate change and planetary decline to a greater extent than other Canadians. Indigenous Peoples and isolated northern communities are particularly impacted by climate injustice in Canada (National Collaborating Centre for Indigenous Health (NCCIH), 2022). The increasing temperatures in Canada's North are threatening food safety, water security, the availability of

traditional medicine, and the stability of infrastructure for Indigenous Peoples, affecting their livelihoods, relationship with the land, culture, and overall well-being (NCCIH, 2022).

Climate change trends are expected to continue, affecting the health of Canadians, as well as the global population (Canadian Public Health Association (CPHA), 2021). For instance, heat waves, wildfires, floods, droughts, rising sea levels, thawing permafrost have increased in recent years in Canada. Climatic factors, including heat and increasing temperatures, have contributed to an expanding geographical distribution of vector-borne diseases (VBDs) in Canada and are becoming a significant health threat for Canadians (CPHA, 2021; PHAC, 2022). West Nile virus (WNV) and Lyme disease are believed to be the most common endemic VBDs in Canada that compromise health, and current surveillance specifies that incidence of these diseases is increasing annually (Bouchard et al., 2019; CPHA, 2021; Ludwig et al., 2019).

Climate change has been identified as a public health emergency in Canada, and health care professionals (HCPs) must take action to address climate related health challenges (CPHA, 2021). Practitioners and professionals are urged to address the complex planetary health challenges that exist, including climate change and subsequent health threats, which will provide opportunities to transform the systems that support life on our planet (Guzman & Potter, 2021). Consensus exists among researchers that nurses have a significant role to play in mitigating and addressing climate change and VBDs in practice, given their substantial presence within healthcare (Canadian Nurses Association (CNA), 2008; 2017; International Council of Nurses (ICN), 2018; Kalogirou et al., 2020; Martin & Vold, 2019). Despite the roles nurses could perform, several authors suggest that most nurses lack awareness, knowledge, and resources to adequately prevent and address climate-related health threats in practice (Kalogirou et al., 2020; Leffers et al., 2017; Martin & Vold, 2019).

Purpose of Research Study

Guzman and Potter (2021) advocate that practitioners and professionals be prepared with the necessary knowledge, skills, values, and attitudes to restore planetary health. Therefore, to better understand the current planetary health mindset among practicing nurses in Canada, the objective of this research study was to explore the knowledge, attitudes, and practices (KAP) of registered nurses (RNs) in Canada related to climate sensitive VBDs. The overall research question guiding this study was: What is the knowledge, attitudes, and practices (KAP) of RNs in Canada related to climate sensitive VBDs, namely Lyme disease and WNV. This research question emerged from current planetary health challenges, including the evolving climate change context in Canada and subsequent health effects on populations, as well as the documented lack of awareness and knowledge by nurses in published literature.

A scoping review was recently conducted to assess available literature to determine appropriateness and identify gaps (Vandenberg, Chircop, Sedgwick, & Scott, 2023). The specific objective of the scoping review was to map nurses' knowledge, perceptions, attitudes, and experiences toward climate sensitive VBDs, with a specific focus on Lyme disease and WNV, as these two diseases are the most common endemic VBDs in Canada presently. Results of the scoping review revealed that nurses lack knowledge and confidence regarding climate change and VBDs (Vandenberg et al., 2023). The literature retrieved alludes to the fact that nurses *should* be knowledgeable about VBDs but research on whether nurses *actually feel* prepared is absent. This gap in literature was not unexpected since the overall incidence of Lyme disease and WNV, although endemic to Canada, has increased only in recent years and thus is an emerging issue (Vandenberg et al., 2023). These findings demonstrated a need for further research to evaluate planetary health practice readiness among nurses.

To address research gaps, revealed by the scoping review findings above, the KAP of Canadian RNs toward climate driven VBD were examined in this research study. The research questions that guided this study included the following:

- 1) What is the overall knowledge of climate sensitive VBD of RNs in Canada?
- 2) What are the overall attitudes of RNs in Canada toward climate sensitive VBD?
- 3) What are the practices and experiences of RNs in Canada addressing climate sensitive VBD in the practice setting?
- 4) Does knowledge of climate sensitive VBD vary:
 - a. by position
 - b. by education
 - c. by practice area
 - d. by age
 - e. by years of practice
 - f. by province/territory
 - g. by urban/rural setting
 - h. by Indigeneity
- 5) Do attitudes toward climate sensitive VBD vary:
 - a. by position
 - b. by education
 - c. by practice area
 - d. by age
 - e. by years of practice
 - f. by province/territory

- g. by urban/rural setting
 - h. by Indigeneity
- 6) Do practices and experiences in addressing climate sensitive VBD vary:
- a. by position
 - b. by education
 - c. by practice area
 - d. by age
 - e. by years of practice
 - f. by province/territory
 - g. by urban/rural setting
 - h. by Indigeneity

Goals of the Research Study

The purpose of research is to contribute to scientific knowledge. According to Cameron (2017), nurses are responsible for identifying nursing issues that require investigation through research. At the doctoral level, nurses must develop scientific methods of inquiry and use various research designs to extend existing knowledge, which is relevant to nursing and other areas of healthcare (Cameron, 2017). These perceptions are supported by the Canadian Association of Schools of Nursing (CASN) (2022), where nurses enrolled in doctoral programs must create new nursing knowledge, evaluate existing knowledge, and become thought leaders in practice. Additionally, at a doctoral level, nurses must “engage in critical, independent, and creative thinking to expand existing knowledge to address global and planetary health issues” (CASN, 2022, p. 10). This research on the KAP of nurses toward climate driven VBDs fulfills the

learning outcome listed above of CASN's (2022) *National Nursing Education Framework* and makes a significant and unique contribution to existing research, as summarized below.

Firstly, the topic of study is a novel area of research, particularly within nursing literature. To my knowledge, there is no published literature on nurses' preparedness to address VBDs, and an evaluation or baseline data of their practice readiness is absent in the literature (Vandenberg et al., 2023). Additionally, a lack of original research exists on this topic, and absence of a nursing perspective is apparent in the grey literature (Vandenberg et al., 2023). Government websites and advocacy organizations address the role of HCPs in addressing VBDs; however, a specific focus on nurses was missing (Can Lyme, 2024; CPHA, 2021; Government of Canada, 2015; 2023). Given the lack of literature which exists on this topic, this research study contributes significantly to the current body of knowledge. This study provides an in-depth analysis of the knowledge, attitudes, perceptions, and practices of RNs, filling a void in the existing literature.

Secondly, this research study provides baseline survey data on knowledge, attitudes, and practices of RNs toward climate driven VBDs. These data are effective to determine if interventions or programs are needed to enhance knowledge on the research topic (Andrade et al., 2020). For instance, learning modules, instructive resources, or education programs are warranted for nurses to improve patient care and in understanding preparedness toward planetary health and climate change mitigation and advocacy roles. These baseline data also demonstrated a need for further research to evaluate RN workforce and practice readiness in meeting the challenges of planetary health and VBD, promoting improved practice competence.

Thirdly, the study findings have generated recommendations for nursing education, practice, advocacy, and research (discussed in detail in Chapter Five) to position nurses as

leaders within planetary health and the healthcare environment. CPHA (2021) urges governments, health organizations, and HCPs to take action to combat climate-related health challenges of Canadians. Nurses have an opportunity to provide global leadership in addressing planetary health, climate change, and subsequent health implications, such as VBDs (Nicholas & Breakey, 2017); however, Law, Kalogirou, and Dahlke (2021) assert that nurses' ambiguity about their role in climate change has contributed to a delayed response to action.

Fourthly, study findings and recommendations, presented in Chapters Four and Five, can be used to strengthen nurses' preparedness to address planetary health challenges, such as climate change and VBDs in practice, elevating nurses as leaders in enhancing interdisciplinary and multi-sectoral collaboration, where the silo approach that exists between policy and practice is challenged (Butterfield, Leffers, & Vasquez, 2021). Nurses can encourage researchers, policy developers, and other HCPs to take a multi-disciplinary and multi-sectoral perspective to develop climate-sensitive policies, given the challenges with the complexities of climate change and VBDs (Adrian, 2020; Bardosh et al., 2017; Butterfield et al., 2021).

Finally, based on the research findings, presented in Chapter Four, recommendations for future research on this emerging topic are discussed in Chapter Five. While the KAP survey in this study provides baseline data on this issue, additional research is recommended on this emerging topic of study, particularly within nursing. According to Bardosh et al. (2017), further research is necessary to alleviate the evident disparities which exist related to climate change and subsequent health challenges. Priority of climate driven VBDs prevention may improve within healthcare systems, leading to enhanced patient outcomes.

Definition of Terms

To assist in clarifying several commonly used terms in the research questions and context of the research study, the following terms have been defined:

- **Attitude:** feelings toward a topic/subject, as well as any preconceived ideas that one has toward a topic/subject; what is believed (Andrade et al., 2020; Kaliyaperumal, 2004).
- **Climate change:** “long-term shifts in temperatures and weather patterns” (United Nations, 2024, para 1).
- **Knowledge:** understanding of any given topic; what is known (Andrade, 2020; Kaliyaperumal, 2004).
- **Planetary Health:** “Planetary Health is a solutions-oriented, transdisciplinary field and social movement focused on analyzing and addressing the impacts of human disruptions to Earth’s natural systems on human health and all life on Earth” (Planetary Health Alliance, 2024, para 1).
- **Practice:** the ways in which one demonstrates their knowledge and attitude through their actions; what is done in the context of the topic of interest (Andrade, 2020; Kaliyaperumal, 2004).
- **Registered nurse (RN):** Registered nurses “are self-regulated health-care professionals who work autonomously and in collaboration with others to enable individuals, families, groups, communities, and populations to achieve their optimal levels of health. At all stages of life, in situations of health, illness, injury and disability, RNs deliver direct health-care services, coordinate care and support clients in managing their own health. RNs contribute to the health-care system

through their leadership across a wide range of settings in practice, education, administration, research, and policy” (Canadian Nurses Association, 2015, p. 5).

- **Vector-borne diseases (VBDs):** VBDs are transmitted among their human or animal hosts by arthropods, usually insects. A broader definition of VBDs recognizes that other animals can serve as the infectious disease vector by harboring pathogens that cause disease only in susceptible populations (Hierlihy, 2017).

Format of Thesis

Chapter One of this thesis introduces the research study. Chapter Two includes a discussion of recent literature on the chosen research topic. Chapter Three describes the research design used in this study, including the research questions, theoretical framework, methodology, sampling, data collection method, data analysis, and ethical considerations. The research findings are presented in Chapter Four. Chapter Five offers a discussion of the research findings related to the research questions and current literature, as well as recommendations, research dissemination, proposed program of research, personal reflections, and a conclusion to the research study. Additional documents related to this research study are included as appendices.

CHAPTER TWO: LITERATURE REVIEW

This chapter offers a review of relevant literature, which was used to inform the research topic. A literature review is the foundation of a research study and is considered a critical appraisal of the pertinent literature on a topic (Fulton, Krainovich-Miller, & Cameron, 2017). Literature pertaining to the research topic will be presented in the following sections, beginning with an overview of planetary health.

Planetary Health

The term *planetary health* emerged from a combination of preventative medicine, health promotion, and environmental health movements (Prescott, Logan, and Katz, 2019). From 1970 to 2010, the concept of *planetary health* was used by researchers, authors, clinicians, academics, and advocates who believed in holistic health though the term was not used within mainstream health settings during this time (Prescott & Logan, 2019).

Hancock (1997) believed that planetary health was the most significant health determinant. However, it was not until 2015 that the term would become more widely known and used, following the Rockefeller-Lancet Commission on Planetary Health (Whitmee et al., 2015). According to Whitmee et al. (2015), planetary health is grounded in the knowledge that human health and civilization depend on thriving natural systems and the prudent stewardship of these systems. It is further defined as the attainment of elevated health, wellbeing, and equity globally by protecting environmental limits within which humanity can flourish (Myers & Frumkin, 2020; Whitmee et al., 2015).

Prescott, Logan, and Katz (2019) defined planetary health as the intricate connection of human health to the vitality of natural systems of the Earth's biosphere, while the Planetary Health Alliance (2024) defined planetary health as a solutions-focused topic of research and

social movement which addresses the effects of human disruptions to natural systems on human and planetary health (para 1). The interdependence of humans and the environment is central to planetary health (Kurth, 2017; Whitmee et al., 2015). LeClair and Potter (2022) similarly stated that planetary health is an evolving science and an expanding movement for change.

Myers (2017) asserted that planetary health is a new field of research, where evidence suggests that human disruption of the earth's natural systems is causing increased global burden of disease. Myers (2017) further stated that human activities are driving biophysical changes at unprecedented rates within six factors: 1) disruption of the global climate, 2) widespread air, water, and soil pollution, 3) swift biodiversity damage, 4) reconfiguration of carbon, nitrogen, and phosphorus cycles, 5) prevalent changes to land use and cover, and 6) fresh water and arable land resource scarcity. Subsequent health impacts of anthropogenic changes include malnutrition, infectious diseases, non-communicable diseases, displacement and conflict, and mental health (Myers, 2017). Furthermore, Guzman and Potter (2021) depict planetary health as a distinct domain of practice and recognize the valuable contributions by Indigenous knowledge systems. At the core of planetary health is an awareness of the health impacts of global environmental disruptions and solution development that will allow humans and the ecosystem to flourish (Myers & Frumkin, 2020).

Environmental and health impacts of our changing planet are not equally distributed across populations. Human disruption of natural systems affects some populations more than others, leading to increased vulnerabilities within certain populations (Myers & Frumkin, 2020). According to Myers and Frumkin (2020), the disconnect between those who reap the benefits and those who suffer the consequences is inequitable. It is a known fact that the high and upper-middle-income countries around the world are responsible for most carbon emissions (Guzman

& Potter, 2021). The burning or combustion of fossil fuels emits climate-altering pollutants, including carbon dioxide and methane, which are considered carbon emissions (Myers & Frumkin, 2002). Sadly, the burdens of climate change are disproportionately felt by equity-denied populations, including low-income countries, and Indigenous Peoples (Guzman & Potter, 2021).

Indigenous Perspectives on Planetary Health

According to LeClair and Potter (2022) and Prescott and Logan (2019), despite recent developments in Western planetary health action, the concept of planetary health is informed by Indigenous perspectives and has been rooted in Indigenous culture for centuries. Indigenous Peoples understand the links between human and planetary health, resulting from a strong relationship with the natural environment and successful generational knowledge transfer (Prescott & Logan, 2019). Indigenous Peoples have developed paradigms based on their explicit understanding of the interconnection with nature, which are reflected in their values, customs, traditions, and stewardship of natural systems (Guzman & Potter, 2021).

Redvers (2020) and Redvers and colleagues (2022) believe that Indigenous Peoples' ontology and epistemology are intricately linked with natural ecosystems. Indigenous worldviews view planetary health as a philosophy for life and a collective responsibility to safeguard the natural environment, passed down through generations of Indigenous Peoples, which will enable future generations to thrive (Ratima, 2019). However, according to Brand and colleagues (2023) and Redvers (2021), Western knowledge has silenced the experiential knowledge that Indigenous Peoples bring to understanding planetary health. Several authors believe that Indigenous knowledge has been overlooked in climate and planetary health

discourse, and in recent global action, such as the Intergovernmental Panel on Climate Change and the United Nations Sustainable Development Goals (Deluca, 2017; Redvers et al., 2022).

According to the Planetary Health Alliance (2024), there is a shared recognition that Indigenous knowledge is necessary for preserving and repairing Earth's natural systems. Nalau and colleagues (2018) found that an enhanced appreciation of Indigenous knowledge in planetary health and climate action is apparent; however, it is often symbolic and merged with Western scientific knowledge, which is not always appropriate. Globally, the United Nations Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change recognize the importance of traditional Indigenous knowledge to climate adaptation (Nalau et al., 2018).

Diver (2017) established that integrating Indigenous knowledge within scientific knowledge fails to challenge the status quo of Western ideas and climate adaptation solutions, and power imbalances between the schools of thought are not addressed. Similarly, Redvers and colleagues (2020) believed that the current understandings of planetary health are based on a predominantly Western construct, embedded within traditional Indigenous knowledge systems, with no clear distinction between the health of the planet and the health of self or the ecosystem. Traditional Indigenous ways of knowing are holistic, community-based, and intrinsically interrelated with people and their land and environment (Redvers, 2018).

Indigenous perspectives contrast with the Western worldviews on health and well-being. While the SDOH have become important in public health and nursing discourse, given the focus on advocacy, social justice, and health equity, they lack emphasis on Indigenous perspectives (Redvers et al., 2022). Additionally, the SDOH focus on human health, rather than planetary health as the central focus. Nursing practice and health promotion that focuses entirely on the

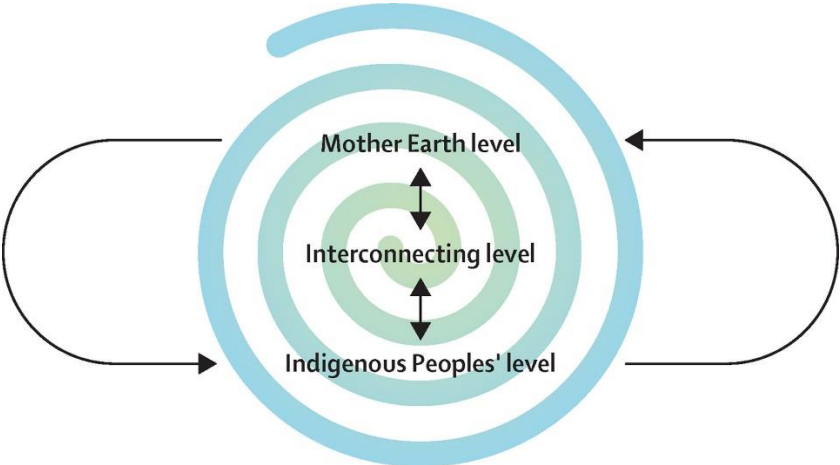
social aspects of health is not appropriate, and a focus on ecological determinants of health is necessary to promote health for both current and future generations (Tu’itahi et al., 2021).

Determinants of Planetary Health

Around the world, Indigenous peoples have faced colonization, exploitation, and marginalization. As discussed above, Indigenous knowledge has often been overlooked in favor of Western perspectives in planetary health discourse. To address this imbalance, a group of Indigenous scholars, Elders, knowledge-holders, and practitioners conceptualized the determinants of planetary health from an Indigenous perspective, which include ten primary determinants in three interconnected levels, depicted in Figure 2.1 below. An examination of the three levels, which include Mother Earth-level Determinants, Interconnecting Determinants, and Indigenous Peoples’ level Determinants, and the ten primary determinants within these levels, is presented below in Table 2.1 (Redvers et al., 2022).

Figure 2.1

The Interconnectedness of the Determinants of Planetary Health



(Redvers et al., 2022)

Table 2.1*Determinants of Planetary Health*

Determinants of Planetary Health	
Mother Earth-level Determinants	
Respect of the feminine	Indigenous women are important to uphold cultural identity and are considered caretakers of the natural environment.
Ancestral legal personhood designation	Indigenous Peoples have the sacred mandate to give voice to Nature, through the United Nations Declaration on the rights of Indigenous Peoples (UNDRIP).
Interconnecting Determinants	
Human interconnectedness with Nature	There is an increasing loss of awareness of the interconnectedness between humans and the natural ecosystem or Nature. Repairing the relationship with Nature is a vital feature of planetary health.
Self and community relationships	Community and interdependence with others and Land and Country promotes health and wellbeing, which is an important focus of Indigenous Peoples.
The modern scientific paradigm	Western paradigms are limited in their ability to explain complex relationships over time, and are reductionistic in nature, where Indigenous scientific methods are contextual, systems-oriented, ecologically based, and relational, which are well-aligned with the complexities of planetary health.
Governance and Law	Governance and law are transformed into norms and acceptance on worldviews, many of which harm the health of the planet, such as overconsumption and waste.
Indigenous Peoples' Level Determinants	
Indigenous land tenure rights	Indigenous lands have been forcefully removed and are under constant threat from governments and other global cooperations, which threatens their ability to ensure a healthy planet for all.
Indigenous languages	Indigenous Peoples comprise 5% of the global population, speaking more than 4000 languages, however, estimates suggest that one Indigenous language is lost every two weeks due to colonization.
Indigenous peoples' health	Greater well-being is associated with Land, culture, and sovereignty which demonstrates the need for holistic acknowledgement of Indigenous Peoples' health to promote planetary health.
Indigenous elders and children	Indigenous Elders are sacred knowledge keepers of culture and tradition, which includes their knowledge of living in harmony with Mother Earth. The Elders guide children on traditions, ideology, and social values, which will assist them in nourishing the relationship with Mother Earth.

These determinants of planetary health offer a holistic compass to assist the global community move forward to integrate planetary health in positive ways to ensure sustainable health for both humans and our planet (Redvers et al., 2022). They can also be implemented and practically applied to larger networks of communities, in addition to Indigenous-led and focused research (Redvers et al., 2022). Additionally, nurses can take action in restoring relationships with Indigenous communities, returning Indigenous lands for self-determination, and privileging Indigenous knowledge in planetary health efforts (Jones et al., 2022). Therefore, according to Redvers et al. (2020), formal recognition of Indigenous knowledge, as a critical foundation of planetary health, is needed.

Two-Eyed Seeing

Planetary health is complex and broad, and epistemological pluralism may be appropriate in research contexts, where several valuable ways of knowing are present, and accepting this plurality can lead to greater success (Miller et al., 2008). An *Etuaptmumk* or “Two-Eyed Seeing” approach was developed by Mi’Kmaq Elders Albert and Murdena Marshall, and is a valuable method within epistemological pluralism, which involves learning to appreciate the strengths of Indigenous knowledge through one eye, while recognizing the strengths of Western knowledge and ways of knowing from the other eye, and to use both eyes simultaneously (Bartlett, Marshall, & Marshall, 2007; Martin, 2012; Sinclair et al., 2021).

Two-Eyed Seeing is an important theoretical approach which ensures that one worldview does not dominate or undermine other worldviews, and balanced consideration of different worldviews can strengthen understanding and respect for diversity of perspectives (Martin, 2012). This approach may be valuable within planetary health, where the strengths of Indigenous perspectives and Western science are simultaneously considered to promote sustainable solutions

for our planet (Guzman & Potter, 2021; Heuckmann & Zeyer, 2022). A Two-Eyed Seeing approach seeks to create a healthier planet for children and children's children, for Seven Generations (Martin, 2012; Sinclair et al., 2021).

Planetary Health in Nursing

Given that the metaparadigm of nursing includes the environment, the theoretical basis of the profession supports planetary health (Kalogirou et al., 2020). Despite this fact, nurses often conceptualize the environment as directly relating to the patient, rather than viewing the environment more broadly (Kalogirou et al., 2020; Portela Dos Santos et al., 2023). Within these conceptualizations of the environment, the focus is on the individual, rather than society more broadly (Thorne et al., 1998). Similarly, Hanley and Jakubec (2019) maintained that the concept of environmental health in nursing is often marginalized, where nurses struggle to move beyond the motto to realistic applications in practice. In the mid 1990s, the global perspective on the environment in public health nursing became apparent (Thompson & Schwartz Barcott, 2017). Kleffel (1996) believed that nurses should shift their human-centered focus to an ecosystem approach, given the interconnectedness of humans and the environment.

McLean and colleagues (2022) established that nursing has been active in recent planetary health discourse. Nursing involvement in planetary health began with Kurth's (2017) calls to action for planetary health nursing and followed by Potter's (2019) advocacy for planetary health nursing education. More recently, Astle and colleagues (2020), Cook (2023), and Kurth and Potter (2022) call on nurses to prioritize planetary health in nursing practice and become advocates for planetary health action both within immediate practice settings as well as globally. Prioritization of planetary health can include advocating for sustainable policies and

procedures in healthcare delivery, preparing for public health emergencies, and decreasing our collective ecological footprint (Glauber et al., 2023).

Potter (2021) stated that every nurse must be knowledgeable in planetary health. Nurses have a professional responsibility to ensure that the health of global citizens does not take priority over our planet (Astle et al., 2020). In a recently released position statement on planetary health, the CNA (2024) calls on nurses to “recognize that human health and the health of our natural world are one and the same, and to promote human health, we must also promote the health of our planet” (p. 3). Additionally, nurses must provide nursing care in a manner that supports planetary health by addressing the triple threat, namely, climate change, biodiversity loss, and pollution (CNA, 2024).

Nurses can address the planetary health calls to action by applying an equity-centered framework that supports strategies and policy implementation on a global level (Astle et al., 2020). As leaders and advocates for social justice and health equity, nurses can ensure planetary health is a priority within the profession and extend their advocacy efforts to include broader environmental issues such as climate justice and planetary health (Catton, 2023; CNA, 2024; Kurth, 2017; Martin & Kaminski, 2021; Rosa, 2017). According to LeClair et al. (2022), “climate justice in nursing addresses the social, racial, economic, environmental, and multispecies justice issues of the climate crisis through centering the experiences and ways of knowing in frontline and fenceline communities and safeguarding the rights of Nature to achieve planetary health” (p. s257)

Nurses, as trusted HCPs, will be sought out for guidance and support in mitigating climate-driven threats, as their expertise in climate-related health outcomes is desirable (CNA, 2024; Leffers et al., 2017; Liu, Potter, & Zahmer, 2020). Nurses influence health at all levels of

the socio-ecological model, from individuals and families to communities and populations.

Population and global health are evolving, which can provide opportunities to shift from a focus on human health to planetary health and sustainability (Rosa & Upvall, 2019).

Therefore, nurses can take planetary action using a more inclusive approach to embrace the interdependence of humans, animals, and the environment (Rosa & Upvall, 2019), as well as critically explore disruptions to the earth by humans (Astle, 2021). Planetary health incorporates issues which were beyond the traditional scope of nursing practice, including climate change, biodiversity loss, energy production and consumption, and changing ecosystems, including increases in VBDs and epidemics (CNA, 2024; Kurth, 2017; Kurth & Potter, 2022; Rosa & Upvall, 2019).

Currently, the term *global nursing* is widely used within the profession and focuses on the role of nurses within constructs such as SDOH, human dignity, and cultural diversity. According to Rosa and Upvall (2019), a shift from “global nursing”, which involves nurses’ role in global health efforts with a focus on SDOH, respect for human dignity, and cultural diversity, to “planetary nursing” is needed, that includes broader possibilities for engagement and advocacy in planetary health initiatives. This shift to planetary nursing would situate nurses as global leaders within current global health initiatives, such as the United Nations 2030 Agenda for Sustainable Development (Astle, 2021; Rosa & Upvall, 2019).

The United Nations 2030 Agenda for Sustainable Development offers opportunities for nurses to engage in planetary health in practice, through a concentrated focus on the 17 sustainable development goals (SDGs), which range from ending poverty to combatting climate change (Rosa & Upvall, 2019). There are opportunities for nurses within the SDGs framework to address the mitigation, adaptation, and resilience to climate change (Lilienfeld, Nicholas,

Breakey, & Corless, 2018), which will promote health outcomes on a global level. SDG 3 – Good Health and Well-being is of particular importance, as it focuses on ensuring healthy lives and promoting well-being across the lifespan (Ebi et al., 2020). Sadly, despite advances in global health, significant health burdens associated with environmental factors exist (Ebi et al., 2020).

Planetary Health in Nursing Education

To ensure future nurses are prepared for the changing reality of our planet and their expanded role of supporting and advancing planetary health, Canadian nursing programs have begun to incorporate planetary health and climate change concepts (Martin & Kaminski, 2021); however, at this point, a planetary perspective has not been widely integrated into nursing education curricula. It may not be viewed as an important topic and curricula focus is often directed to illness treatment rather than promotion of human and planetary health (Walpole, Barna, Richardson, & Rother, 2019). Preparing and motivating students for planetary health advocacy can be challenging for nurse educators, who are tasked with integrating new concepts into already full curricula. However, according to Cook (2023), nursing students are requesting content on environmental health, which has positively impacted curriculum shifts to including a planetary health approach within nursing education.

To advance nurses' preparedness for practice, planetary health should be incorporated as the theoretical basis for nursing education (Kalogirou et al., 2020). Integrating a planetary health approach into nursing curricula is important to address planetary health challenges, and to ensure nursing graduates are practicing holistically to their full scope (Flaten, Pechacek, Potter, & Mueller, 2023; Glauberman, Bray, & Freeman, 2023). According to Guzman et al. (2021) and Redvers et al. (2022), nursing programs in Canada must integrate planetary health in a manner that acknowledges Indigenous knowledge and wisdom, to provide students with an opportunity

to appreciate the harmonious relationship with our planet's ecosystems both in their personal and professional lives.

Several authors agree that planetary health should be integrated into nursing education to ensure this knowledge is translated into nursing practice, research, and advocacy initiatives (LeClair & Potter, 2022; Rosa & Upvall, 2019; Vandenberg, 2023). Vandenberg (2023) advocated for the integration of the Planetary Health Education Framework (Guzman & Potter, 2021) within nursing education, and a discussion of this framework is presented below. Best and colleagues (2023) asserted that planetary health education should be formalized and extended, and concepts within nursing curricula should be linked to entry-to-practice competencies. Tun et al. (2020) advocated for curriculum renewal, where educators and students collaborate to develop a planetary health curriculum. CASN released the *National Nursing Education Framework* in 2022, and a specific learning outcome for undergraduate nursing graduates is the ability to “describe global and planetary health issues and their effects on health” (p. 10), which may compel nursing education programs across Canada to integrate planetary health into nursing curricula.

Hanley and Jakubec (2019) advocated for the integration of environmental health content into nursing curriculums to enable students, as future nurses, to respond to the current ecological crisis. Additionally, Tun and colleagues (2020) promoted education on sustainable health care, including planetary health education, to ensure HCPs are trained to advocate for policy change on planetary health initiatives. They stated that educators and faculty members should be competent in integrating planetary health and sustainable healthcare within health curriculums, which will better prepare the next generation of health professionals in achieving planetary health (Tun et al., 2020).

Planetary Health Education Framework

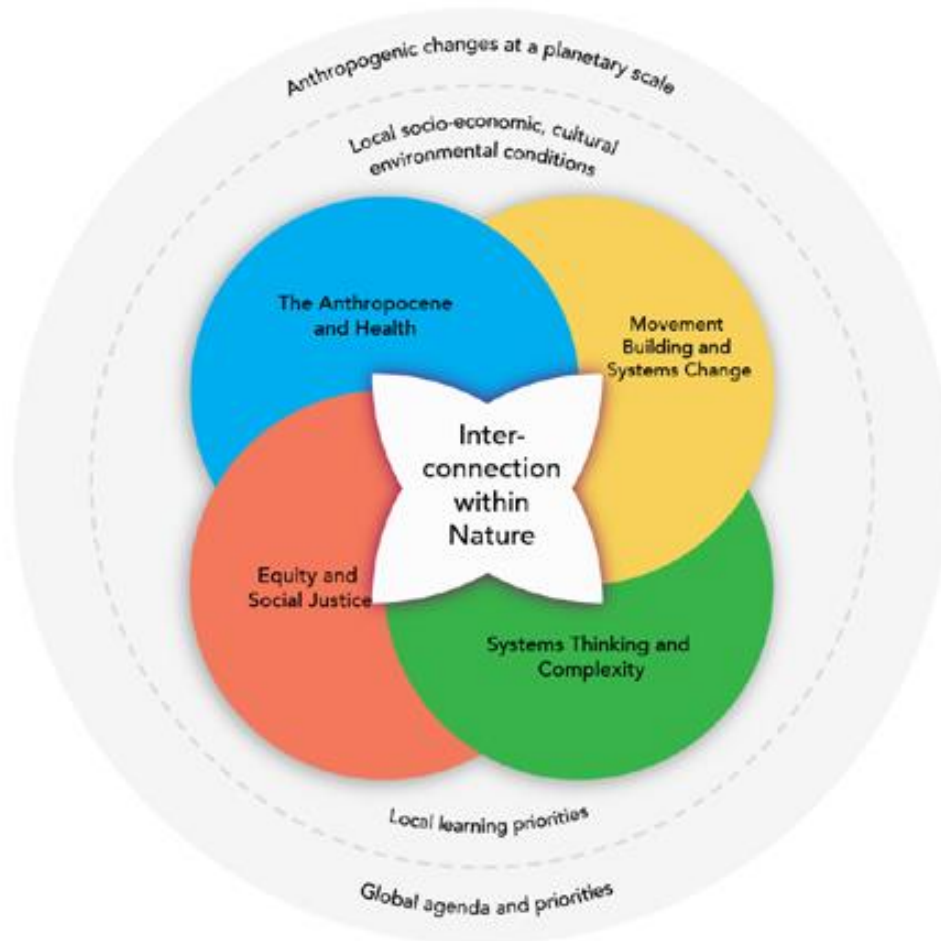
The Planetary Health Education Framework was commissioned by the Planetary Health Alliance and developed by a diverse taskforce of interdisciplinary leaders in planetary health (Guzman & Potter, 2021). It includes five foundational domains which comprise the essence of Planetary Health knowledge, values, and practice (Guzman & Potter, 2021; Guzman et al., 2021). The five domains are represented in an intertwined figure, which represents the interdependent and interconnected nature of each domain. These domains are elaborated on below and include: 1) interconnection within nature, 2) the Anthropocene and health, 3) equity and social justice, 4) movement building and systems change, and 5) systems thinking and complexity (Guzman & Potter, 2021; Guzman et al., 2021).

The Planetary Health Education Framework includes an equity-centered approach, which is paramount in planetary nursing (Astle, 2021). The primary values that directed the creation of the framework included inclusivity, diversity, humility, commitment, justice, equity, agency, autonomy, social cohesion, partnership, and creativity; all of which are necessary for collective action to achieve planetary health (Guzman & Potter, 2021).

While the use of the framework in various disciplines has not yet been determined, it allows local and global stakeholders, including nurses, to facilitate a transformative approach to ensure human populations and ecosystems attain complete vitality (Astle, 2021). The Planetary Health Education Framework (Figure 2.2) aims to guide practitioners and professionals to address and overcome the complex Planetary Health challenges we are currently facing (Guzman & Potter, 2021).

Figure 2.2

The Planetary Health Education Framework (Guzman & Potter, 2021)



Interconnection within Nature

Planetary health is centered on the human relationship with nature and human well-being (Myers & Frumkin, 2020). Understanding and reimagining the role of individuals within nature is foundational to planetary health and includes reflection on why humans continue to overexploit nature at an accelerated pace (Guzman & Potter, 2021; Guzman et al., 2021).

According to Ratima and colleagues (2019), longstanding Western views that removed humans

from the ecosystem are deteriorating, as climate change, depletion of the Earth's resources, and implications of human activity require immediate consideration of the interconnectivity of humans, other species, land, water, and air. Furthermore, recognizing the personal, cognitive, social, and emotional aspects of fostering compassion for our planet is the central feature of the framework (Guzman & Potter, 2021; Guzman et al., 2021).

Guzman and Potter (2021) believe that merging Indigenous and Western education and practice will foster the development of benefits for individuals, communities, and our planet. This domain acknowledges diverse knowledge and spiritual traditions, particularly Indigenous knowledge, that instills an appreciation of the interconnection with nature, as well as interdependence and reciprocal stewardship (Guzman & Potter, 2021; Guzman et al., 2021; Ratima et al., 2019).

Planetary nursing is an approach which intersects with the domain, *Interconnection with Nature*, where the focus shifts from humanity to the interdependence of humans, animals, and the environment, encompassing overall planetary well-being (Rosa & Upvall, 2019). According to Myers (2017), HCPs have an important role as educators and advocates to achieve a sustainable path to planetary health and well-being. All living species, whether it be humans, animals, or plants have a purpose, and respect and compassion are necessary for all living species. This respect can be achieved by establishing meaningful relationships with Indigenous peoples to learn how they are protecting their land and way of living (Astle et al., 2020).

The Anthropocene and Health

The Anthropocene is a concept describing the massive disruptions of the earth's system processes, resulting from the expanding human ecological footprint (Guzman & Potter, 2021; Guzman et al., 2021). According to Myers (2017), rapid increases in the global human

population and per-capita consumption have negatively influenced our planet, where according to Whitmee et al. (2015), as overall human health and life expectancy has increased, the health of the Earth's natural systems has decreased. Human activities are severely changing the Earth, through environmental impacts, such as biodiversity loss and climate change, surpassing the planetary limits on Earth (Ebi et al., 2020).

The focus of this domain is the awareness of how anthropogenic events, including climate change, influence health outcomes, such as changing infectious disease patterns (Guzman & Potter, 2021; Guzman et al., 2021). This awareness requires understanding of health promotion and disease prevention at various health levels, from individuals to populations. This domain also addresses the underlying and mediating factors that enhance or lessen health outcomes, which relate closely to SDOH, health equity, and social justice (Guzman & Potter, 2021; Guzman et al., 2021).

Nurses can develop competencies in identifying how anthropogenic changes to natural systems influence health outcomes. According to Kurth (2017) and Kurth and Potter (2022), nurses must consider the multilevel effects of climate strain on health and provide the necessary leadership to ensure resilient health systems. Planetary health includes an ethical component, where equity and climate justice are the primary focus (LeClair, Watts & Zahner, 2021; Myers & Frumkin, 2020). Climate justice refers to climate change as a human rights issue, where protecting public health is paramount (LeClair, Evans-Agnew, & Cook, 2022). Climate justice relates closely to social justice, which is a foundational value in nursing. As advocates for health equity and social justice, nurses have a role in climate justice by addressing socioeconomic inequities that exist and considering the unequal power distribution that create climate vulnerabilities for equity-denied populations (LeClair et al., 2022; Nicholas & Breakey, 2017;

Waldron, 2021). Nurses' commitment to social justice offers an opportunity to provide global leadership in human and planetary health and well-being, by reducing vulnerability to harmful effects of climate change and reducing or preventing greenhouse gas emissions (ICN, 2018; Nicholas & Breakey, 2017). Therefore, it is necessary that nurses be prepared to address climate change and VBDs in practice to fulfill their role as climate action leaders and advocates for social justice (ICN, 2018; Smith, 2019; Tiitta et al., 2021).

Systems Thinking and Complexity

Systems thinking strives to relate components to each other within the perception of a whole entity (Guzman & Potter, 2021). Systems thinking or systems-based understandings of ecology are necessary to understand how various planetary health elements interact and merge as part of complex structures (Guzamn & Potter, 2021; Myers & Frumkin, 2020). Planetary health exemplifies actions that can ripple through complex systems, leading to impacts on ecology, which validates the interdisciplinary nature of planetary health (Myers & Frumkin, 2020). The goal within this domain is to collaboratively design and implement transformative solutions to planetary health challenges using systems thinking. Learners must develop self-awareness to acknowledge their own biases and epistemological groundings to appreciate the evolving nature of knowledge (Guzman & Potter, 2021; Guzman et al., 2021).

Planetary nursing promotes planetary action and an appreciation of the interdependence of environment, animals, and humans, creating a holistic concept of One Mind – One Health – One Planet (Rosa, 2017). The concept of One Mind appreciates that all life is interconnected through a cohesive consciousness, meaning that humans share an experience in our very being and belonging as citizens of the planet (Rosa, 2017). One Health embodies the ethical relevance of humans, animals, and the environment (Lueddeke, 2016). The notion of One Planet

acknowledges that human actions have consequences at a planetary level for everyone (Rosa, 2017). To fulfil the One Mind – One Health – One Planet concept, nurses should facilitate partnerships with multidisciplinary leaders beyond the traditional healthcare system, which will promote a holistic nursing lens to health capacity building and planetary health endeavours (Rosa & Upvall, 2019). This was echoed by Ebi et al. (2020), who stated that resilient and sustainable development are critical for achieving planetary health.

Equity and Social Justice

Equity in planetary health incorporates the rights of both humans and nature, giving all populations and ecosystems the opportunity to achieve their full potential (Guzman & Potter, 2021). Striving for equity and justice through a planetary health lens involves addressing systemic disparities, such as power, wealth, opportunity, or health status, so equity-denied populations do not face disproportionate burdens of environmental and health impacts. To address inequities, attention must be placed on the health and wellbeing of populations' most vulnerable to poor health outcomes (Guzman & Potter, 2021; Guzman et al., 2021).

Planetary health recognizes that structural inequities, political injustices, colonialism, racism, and neoliberalism have contributed to a damaged environment (Guzman & Potter, 2021). Professionals must commit to identifying priorities for action and implementing practices that address the root causes of these injustices. Therefore, it is a moral imperative to increase efforts to manage natural systems in an equitable manner (Myers & Frumkin, 2020). Nurses can promote equity by prioritizing the needs of equity-denied populations and ecosystems, which includes supporting resilience, strengths-based approaches, and the capacity to anticipate and mitigate risks. Nurses require cultural humility, empathy, and the promotion of inclusive and diverse participation in defining solutions (Guzman & Potter, 2021). Achieving justice and

equity also involves a recognition of one's power, influence, and bias – and a responsibility to use these privileges in working toward a healthier planet, as well as prioritizing the input of the less privileged (Guzman & Potter, 2021; Guzman et al., 2021). Planetary health frameworks, such as the Planetary Health Education Framework, promote climate justice and provide opportunities for nurses to develop solutions to current climate issues (LeClair, Evans-Agnew, & Cook, 2022).

Movement Building and Systems Change

According to Guzman and Potter (2021), to solve the urgent planetary health crisis, urgent movement building is required. This requires “inclusive relationships, thoughtful strategy, effective communication, and transformational partnerships” (Guzman & Potter 2021, p. 38). Effective movements are needed to support systems change and transitioning to a just and equitable future, where individuals are inspired to take action. This requires the necessary skills, knowledge, tools, and attitudes of learners to reduce apathy, increase engagements, and create momentum for change (Guzman & Potter, 2021; Guzman et al., 2021). Myers and Frumkin (2020) asserted that humanity must join to lead the way in vigorous and positive action to movement to reverse the current trajectory we are on.

Implementing planetary health can serve to address the urgent environmental and health challenges, which can promote local and global communities to work towards well-being, justice, and a healthier planet (Guzman & Potter, 2021; Guzman et al., 2021). As mentioned earlier, it requires nurses to create networks and facilitate partnerships with multisector leaders outside of the traditional health care system, to ensure a holistic nursing lens on planetary health advocacy efforts, such as pollution, biodiversity loss, or climate change (CNA, 2024; Kurth, 2017; Rosa & Upvall, 2019). This was further mentioned by Prescott and Logan (2019), who

affirmed that planetary health successes can be achieved by interprofessional healthcare partnerships. Nurses can inspire people to take action through narrative that enables them to envision a healthier future. Furthermore, nurses can lead and collaborate with other disciplines on planetary health research, policy, and advocacy initiatives, such as healthcare sustainability or climate change issues (CNA, 2024).

Planetary Health in Nursing Practice

With adequate preparation, nurses can make valuable contributions to planetary health in their professional practice, through educating the public, training other nurses and healthcare professionals, promoting interdisciplinary healthcare, supporting conservation initiatives, seeking to better understand how we communicate regarding planetary health, advocating for equity-denied populations, engaging in climate policy development, acting as role models in both personal and professional settings, and in pursuing opportunities to advance planetary health (Kurth, 2017; Leffers & Butterfield, 2018; Rosa & Upvall, 2019; Rosa, Upvall, & Andrus, 2019). Nurses are uniquely placed to lead and support healthcare systems in addressing planetary health, such as responding to ecosystem disruptions and climate-related health concerns (CNA, 2024). For instance, nurses can become involved in emergency preparedness activities and participate in disaster crises by providing mental and physical health support (CNA, 2024).

Nurses who are educated and informed about planetary health are essential to incorporate this approach into their practice, and to influence future policy (Best et al., 2023). Nurses have a responsibility to promote equitable policies that uphold climate justice and planetary health principles both within clinical positions, as well as through partnerships with health and public health authorities (CNA, 2024; Evans-Agnew, LeClair, & Sheppard, 2024). Furthermore,

Kalogirou et al. (2020) affirmed that planetary health is a practical framework for change in nursing practice.

Strengths of Planetary Health

Advocates for planetary health recognizes that presently the world has a rare window of opportunity to safeguard our future (Whitmee et al., 2015). A planetary health approach acknowledges that humanity cannot be separated from the planet's ecosystems and focuses on sustainable development to prevent further degradation of these ecosystems (Ratima, 2019). Given the important role nurses have in addressing planetary health threats and calls to action, nurses must be prepared to support and advocate for integrating a planetary health approach in nursing practice. Therefore, analyzing the knowledge, attitudes, and practice of RNs toward climate driven VBDs in Canada provides an analysis of the extent to which nurses are practicing within a planetary health approach.

Limitations of Planetary Health

According to Redvers and colleagues (2020), planetary health is a predominantly Western construct, embedded within traditional Indigenous knowledge systems, with no clear distinction between the health of the planet and the health of self or the ecosystem as a whole. Planetary health often uses biomedical, traditional, and reductionistic approaches that focus on deficits of equity-denied groups, such as Indigenous Peoples (Fogarty et al., 2018; Watego et al., 2021). According to Tuck and colleagues (2014), these views diminish the lived experiences of Indigenous Peoples and reinforce postcolonial power structures that perpetuate Indigenous inequality and inequity. Indigenous worldviews have been silenced within healthcare; therefore, decolonized education and research, based on equity and allyship, through an Indigenous planetary health lens are needed (Redvers et al., 2020; Sinclair et al., 2021). This was echoed by

Jones and Avanthay Strus (2022) who believed that a reorientation of planetary health toward decolonialization and relationality are necessary to demonstrate the inseparability of human and ecological wellbeing.

Limitations of Planetary Health for Nursing

It should be noted that planetary health is a complex field, focusing on planetary systems and health (Prescott et al., 2019). There are global calls to action and numerous opportunities for nurses to engage in and advance planetary health; however, it is difficult for nurses to transform the current model of nursing and health care overall, moving from illness care to planetary health care (Kurth & Potter, 2022; Martin & Kaminski, 2021). Portela Dos Santos et al. (2023) acknowledged that conceptualization of the environment in direct relationship to individuals and their health limited the ability of nurses to visualize the importance of the environment to a broader level, and hindered nurses in understanding and articulating their professional roles in mitigating planetary health issues, such as climate change. Kalogirou et al. (2020) and Portela Dos Santos et al. (2023) have noted that nursing's ongoing reliance on the metaparadigm to explain nursing's role limits a meaningful understanding of the interdependence of person, health, and the environment. Portela Dos Santos et al. (2023) highlight the critical need for nurses to engage more deeply in addressing climate change by integrating their roles in environmental health, advocacy, and interventions to raise environmental awareness.

Furthermore, little effort is made to address climate sensitive VBDs in Canada, because they are not considered priority public health issues (CPHA, 2021). Currently, Canada positions planetary and human health in relation to economics and politics, which has created disconnect and a lack of urgency (CPHA, 2021). Prior to the COVID-19 pandemic, just under 6% of health funding was allocated to public health (Duong & Vogel, 2022). In Canada, health care is funded

and delivered within the socio-political context of smaller geographic locales/political entities (Government of Canada, 2019). Therefore, coordinated action is extremely difficult as evidenced by the failure of Conference of the Parties (COP) despite convincing evidence (Climate Action Tracker, 2024). The reluctance of governments and healthcare decision-makers in Canada to allocate research and healthcare funding to climate change and VBDs diminishes the practicality of HCPs addressing planetary health, climate change, and VBD in the practice setting (CPHA, 2021).

In addition to the factors mentioned above, Canada's public health system is lacking resources to function effectively, and the precarious funding cycles decrease the ability of the public health system to adequately prepare for public health threats (Duong & Vogel, 2022). Urgent action is needed by closing information gaps, investing in a public health workforce, enhancing public health governance and accountability, providing consistent funding, and updating public health competencies for HCPs to enable them to translate evidence into policy (Duong & Vogel, 2022; Jarvis et al., 2023). Furthermore, Canada's public health surveillance systems must be enhanced to ensure better preparedness for pandemics and infectious disease outbreaks (Duong & Vogel, 2022).

Climate Change

Climate change is an unprecedented global phenomenon. Watts et al. (2015) considered climate change to be the greatest health opportunity of this century; however, this is largely dependent on humanity's response to the challenge. According to Myers and Frumkin (2020), human beings today are well off, given the vast improvements in global human health and development, varying from significant increases in literacy and life expectancy to drastic reductions in extreme poverty over the last 70 years. Yet despite the advances in human health,

the earth's biosphere is worse off than ever before in history, where humankind's ecological footprint has expanded substantially (Myers & Frumkin, 2020).

As a core aspect of planetary health, climate change threatens every dimension of human health (Myers, 2017; Myers & Frumkin, 2020). Climate change has been defined as “long-term shifts in temperatures and weather patterns” (United Nations, 2024, para 1). It is considered a public health emergency in Canada, and governments at various levels, health organizations, Indigenous groups, and communities must take action to combat the subsequent health challenges on Canadians (CPHA, 2019). Human wellbeing and biosphere degradation cannot continue to be disengaged, transgressing planetary limits, because the consequences are far-reaching (Myers & Frumkin, 2020).

However, there have been positive developments in Canada on climate action, such as the recently released National Adaptation Strategy, which is a framework to reduce risks and promote preparedness and climate resiliency (Government of Canada, 2023). The Strategy provides a blueprint for action and sets clear priorities for action on adaptation within five key areas, namely disaster resilience, health and wellbeing, nature and biodiversity, infrastructure, and economy and workers (Government of Canada, 2023). A diagram of climate change impacts on Canadians is presented in Figure 2.3 below.

Figure 2.3

Climate Change Impacts on Canadians



(Government of Canada, 2023)

Climate-Related Health Implications

Climate change has direct, indirect, and social implications on human health, ranging from heat exhaustion and the worsening of chronic health conditions to mass migration and displacement of people from rising sea levels, drought, and conflict (Intergovernmental Panel on Climate Change (IPCC), 2023; Semenza & Ebi, 2019; WHO, 2023). Between 2030 and 2050

climate change is expected to cause approximately 250 000 additional deaths per year from malnutrition, malaria, diarrhea, and heat stress (IPCC, 2023; WHO, 2023).

Direct implications of climate change on human health include heat stress and injuries due to natural disasters (National Institute of Environmental Health Sciences, 2022). Natural disasters have increased because of climate warming, demonstrated by extreme flooding, hurricanes, heatwaves, wildfires, and severe weather, which can intensify injuries (Sloggy et al., 2021; World Meteorological Organization, 2022).

Indirect health implications of climate change include water scarcity, increases in malnutrition, and zoonotic diseases. Climate change and population growth are leading to severe water scarcity for approximately half of the global population, and this statistic is expected to increase (IPCC, 2023). Climatic disruption also affects food production, leading to malnutrition, and it is projected that 8 to 80 million people will be at risk for undernutrition in the future, with concentrations highest in the poorest countries of the world (IPCC, 2023). A third indirect implication of climate change on health relates to zoonotic or VBDs, such as malaria, dengue, WNV, and Lyme disease (IPCC, 2023; Myers & Frumkin, 2020), discussed later in this chapter.

Climate Migration

Migration can be defined as an individual's movement away from their usual residence (Semenza & Ebi, 2019). Migration is considered a SDOH, and an important factor within climate change adaptation frameworks (Schwerdtle et al., 2020). Climate change affects the drivers of human migration, which may be political, environmental, demographic, social, cultural, and economic in nature (Myers & Frumkin, 2020; Schwerdtle et al., 2020; Semenza & Ebi, 2019). Globalization, socio-economic disparities, demographic change, economic or political crisis, natural disasters, and conflict are examples of factors influencing migration, intensified by

climate change (Myers & Frumkin, 2020). According to Redvers et al. (2023), climate-induced migration is particularly distressing for Indigenous Peoples where their land and home environment no longer support their culture.

Migration is closely linked with VBDs risk, distribution, and incidence (Semenza & Ebi, 2019; WHO, 2020). The WHO (2020) found that migration, population growth, and conflict will continue to affect the distribution and incidence of VBDs. Climate change influences vector ecology, which increases the risk of VBDs transmission through the importation of vectors under suitable climatic and environmental conditions from endemic areas through human migration and travel (Ng et al., 2019; Semenza & Ebi, 2019).

Climate Sensitive Vector-Borne Diseases

Climatic effects, such as increases in rainfall, rising temperatures, drought, longer warm weather seasons, extreme weather events, and declining biodiversity all influence vector distribution (Bouchard et al., 2019; Ludwig et al., 2019; Ogden et al., 2022). Additionally, factors such as urbanization, habitat destruction, and pesticide application can impact vector distribution (Mojahed et al., 2022). The implications of climate change are increasingly visible in Canada and contribute to vector expansion and ensuing disease spread (Bouchard et al., 2019; CPHA, 2021; Ludwig et al., 2019; Ogden et al., 2022).

VBDs are transmitted by arthropods, primarily ticks and mosquitoes, spreading disease from human to human, such as malaria, or from animals to humans, such as WNV and Lyme disease (George et al., 2024). According to Mojahed and colleagues (2022), ticks are considered the most important vector globally that affect human health and cause disease, including Lyme disease. Mosquitoes are also important vectors in the transmission of diseases, for instance WNV. WNV and Lyme disease are considered the most common endemic climate sensitive VBDs in

Canada, and continuing surveillance reveals that incidence of these diseases is on the rise annually (Bouchard et al., 2019; Carignan et al., 2019; CPHA, 2021; Ludwig et al., 2019). However, various other VBDs are present in Canada, such as Cache Valley virus, California serogroup viruses, and Powassan virus, only to name a few (Ludwig et al., 2019).

Species within Canada are expanding their geographic distribution northward and beyond geographical boundaries at alarming rates (Khan et al., 2020; Nicol, 2019). This expansion is made possible by shifts in climate as well as animal migration patterns, deforestation, urbanization, and globalization (Mojahed et al., 2022; Nicol, 2019). Urban sprawl, urban poverty, and development also affect VBDs spread (Bouchard et al., 2019). Additionally, warmer weather supports longer transmission seasons and optimal environments for the establishment of foreign VBDs pathogens (Ogden & Gachon, 2019).

According to Nuttall (2022), Canada presents the most compelling evidence that climate change influences tick distribution and tick-borne diseases. A northward spread of infectious diseases currently endemic to the United States is occurring, where ticks carrying human granulocytic anaplasmosis and babesiosis are extending their range farther into Canada (National Collaborating Centre for Environmental Health, 2022). Ticks now populate more regions of Canada than ever before, and several new tick-borne diseases have emerged as public health concerns (National Collaborating Centre for Environmental Health, 2022; Nicol, 2019). The National Collaborating Centre for Environmental Health (2022) confirms that there are over 40 species of ticks currently found in Canada. According to Allehebi et al. (2022), babesiosis is an emerging VBD in Nova Scotia, where Lyme disease and anaplasmosis are already endemic, highlighting the need for enhanced surveillance of emerging tickborne diseases.

Harsh Canadian winters and a generally cooler climate hinder the establishment of global VBDs, such as malaria, dengue, chikungunya, and Zika (Ng et al., 2019; Ogden & Gachon, 2019). However, climate change advances the risk for introduction and local transmission of these “exotic” diseases in Canada, during warmer and longer summer seasons, extreme heat events, and in the presence of increased annual precipitation (Ng et al., 2019; Ogden & Gachon, 2019). Factors related to climate change and globalization, such as increased migration, international travel, and trade, further increase the probability of exotic VBDs spread (Ng et al., 2019; Ogden & Gachon, 2019; Oppong, 2020). Global movement of climate refugees also impacts the emergence of exotic VBDs into Canada (Ng et al., 2019).

Malaria is currently the most common travel acquired VBD, with approximately 500 Canadians returning home each year with the disease (Ng et al., 2019). Although it would be difficult for malaria to become endemic to Canada due to current climate conditions, the malaria parasites only require 20-30 days of warm weather (above 18°C) to become infectious in a human host (Ng et al., 2019). Additionally, in 2017 in Southern Ontario, the primary mosquito vector for dengue, chikungunya, Zika and yellow fever emerged (CPHA, 2021; Ng et al., 2019). Although evidence suggested this vector did not carry disease, climate change could increase the risk of disease transmission through a reduction in egg development time, a shortened incubation period, and increased vector longevity (Ng et al., 2019). Subsequently, exotic diseases such as malaria and chikungunya could become endemic within Canada over time given changes in climate conditions.

Lyme Disease

Lyme disease is caused by the bacterium *Borrelia burgdorferi*, transmitted by the bite of an infected black-legged tick, either the *Ixodes scapularis* tick in central and eastern Canada or

the *Ixodes pacificus* tick in western Canada (Gasmi et al., 2022; Government of Canada, 2023; Ogden et al., 2022). Reported Lyme disease rates in Canada increased from 144 cases in 2009 to 2634 cases in 2019 (Gasmi et al., 2022). Preliminary data indicates that there were 2,544 reported human Lyme disease cases in Canada in 2023 and Ontario had the highest number of confirmed cases (Government of Canada, 2024). Range expansion of the black-legged tick is expected to escalate in the coming decades because of climate change, further increasing human Lyme disease risk, particularly in eastern Canada (Gasmi et al., 2022).

A diagnosis of Lyme disease is primarily clinical, supported by symptoms, a history of possible tick exposure, and physical findings. Laboratory testing may be recommended to supplement clinical findings under certain circumstances, as not all individuals will develop symptoms; however, many people experience obstacles to obtaining a diagnosis of Lyme disease, and in some cases, never do, as discussed below. Canadians with confirmed Lyme disease are usually treated with two to four weeks of appropriate antibiotics (Government of Canada, 2023).

Controversies of Lyme Disease in Canada

The current policies for diagnosing and treating Lyme disease in Canada are highly controversial resulting from competing international guidelines, namely, the Infectious Diseases Society of America (IDSA), which represents physicians, scientists and other health care professionals who specialize in infectious diseases, and the International and Associated Disease Society (ILADS), a multidisciplinary medical society dedicated to Lyme and associated diseases, contributing to further challenges for patients affected by this disease (Government of Canada, 2017). Currently, the Government of Canada and the Association of Medical Microbiology and Infectious Disease Canada (AMMI) endorse the IDSA recommendations (AMMI, 2019;

Government of Canada, 2017; Lantos et al., 2021; Wormser et al., 2006) and disprove the ILADS guidelines.

IDSA Guidelines

The IDSA guidelines for the diagnosis and treatment of Lyme disease propose testing for Lyme disease in an accredited laboratory and treatment with a single course of oral antibiotics when a tick bite is confirmed or early infection is evident (Lantos et al., 2021; Wormser et al., 2006). Furthermore, they reject the chronicity or persistence of Lyme disease and continuing treatment with antibiotics for patients with chronic (greater than 6 months) subjective symptoms after the initial recommended course of antibiotics (Lantos et al., 2021; Wormser et al., 2006). The IDSA guidelines specify that prolonged treatment with antibiotics does not alter patient outcomes, and caution must be taken with patients experiencing ongoing debilitating symptoms, diagnosed through alternative serologic measures, which may not be attributed to Lyme disease (AMMI, 2019). Rather, the IDSA attributes ongoing symptoms to coinfections with other diseases, emotional state of the patient, or subjectivity and vagueness of the symptoms, as similar symptoms can also be found in “healthy people” (Lantos et al., 2021). Wormser et al. (2006) found that when patients were re-evaluated at university-based medical centers, “the majority of patients had no convincing evidence of ever having Lyme disease” (p. 1117). The authors further mentioned that over 50% of these patients did not have Lyme disease, but other disorders, such as depression or rheumatoid arthritis (Wormser et al., 2006).

The IDSA recommendations for the treatment of Lyme disease are favored around the globe. Both the Government of Canada (2017) and AMMI (2019) endorse the IDSA recommendations, while in the USA, the Centres for Disease Control (CDC) support these guidelines. The National Institute for Health and Care Excellence (NICE) in the United Kingdom

also provide guidelines on Lyme disease, which favor the IDSA stance on ongoing antibiotic treatment (2018).

ILADS Guidelines

The ILADS (2014) guidelines endorse the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) system for the treatment of Lyme disease to address the appropriateness of antibiotics for identified tick bites, the effectiveness of treatment for erythema migrans rashes (common in Lyme disease), and the use of antibiotics in patients with persistent symptoms of Lyme disease. These guidelines are meant to provide guidance to HCPs by proposing evidence-based treatment recommendations for Lyme disease, while respecting the goals and values of patients in treatment decisions to ensure shared decision-making. ILADS (2014) acknowledged it is too soon to standardize restrictive policies and protocols on the treatment of Lyme disease. Furthermore, alternate antibiotics and lengths of treatment should be accepted, as Lyme disease is a clinical diagnosis, and can become chronic, where long-term treatment with antibiotics may be necessary to alleviate suffering and improve quality of life (Davidsson, 2018; ILADS, 2014). According to ILADS (2014), there is evidence to demonstrate the negative impact chronic or persistent symptoms of Lyme disease can have on the overall health and quality of life of patients.

Patient Outcomes

According to Lloyd and Hawkins (2018), the diagnostic tests for Lyme disease are prone to false negative results, and the authors estimated that only one in six infected patients who underwent laboratory testing were diagnosed with Lyme disease. This contributes to inaccurate surveillance data and an underestimation of the incidence of Lyme disease, which influences the priority of public health policies, as well as diagnosis and treatment of those suffering from

Lyme disease in Canada (Lloyd & Hawkins, 2018). The circumstances surrounding the IDSA guidelines limit the ability of patients to make informed choices about diagnostic testing and treatment, because treatment protocols are strictly determined by the Government of Canada and AMMI and followed by physicians, with no opportunity to include other sources of evidence, such as the ILADS guidelines (Davidsson, 2018).

Governments and public health policymakers have not conducted objective reviews of the research on Lyme disease, as treatment protocols adhere to one specific international guideline (Davidsson, 2018). Therefore, many Canadians have pursued diagnosis and treatment outside the conventional healthcare system when a confirmed diagnosis of Lyme disease is not obtained (Lloyd & Hawkins, 2018; Morrison et al., 2021). Morrison et al. (2021) described how in their study, ongoing symptoms of Lyme disease were ignored by medical providers, and patients were subsequently given a psychiatric diagnosis, and humiliated by being called an “idiot”, “weak”, or “crazy” (p. 2710). Patients who are not treated face significant disease burden, diminished quality of life, and possible untimely death.

Similar studies have demonstrated that Lyme disease patients without effective treatment suffer from a decreased quality of life compared to the general population and are at risk of premature death (Davidsson, 2018). Rebman et al. (2017) depicted patients’ experiences of profound physical, emotional, and social limitations due to illness, pain, fatigue, or other symptoms, including “brain fog”, depression, anxiety, memory changes, difficulty concentrating, and sleep disruptions. These burdens were similarly expressed by Morrison et al. (2021) and Punch (2018) who discussed physical and emotional burdens, financial concerns, and challenges with social life. According to Van Hout (2018), Lyme disease is a complex and debilitating illness where patients experience both acute and persistent symptoms, which harm their overall

quality of life, but are poorly understood. As described above, the controversies which surround the IDSA and ILADS guidelines create challenges for governments, stakeholders, policy panelists, HCPs, and ultimately, the patients.

To address these challenges, Lyme disease patients should receive evidence-based, affirmative, patient-centered care for both acute and chronic symptoms of the disease, and HCPs should be provided education about Lyme disease transmission, diagnosis, and treatment inclusive of both the IDSA and ILADS guidelines (Punch, 2018). Improvement in care approaches, such as active engagement and empathy, are necessary for all HCPs to ensure greater patient satisfaction in the conventional health care system (Morrison et al., 2021). Provider disbelief, ignorance, disengagement, dismissal of patient's experiences, and attributing chronic symptoms to a psychiatric diagnosis must end (Morrison et al., 2021). Furthermore, HCPs are better able to provide strategic care and treatment interventions when they possess a comprehensive understanding of the complexities of living with Lyme disease, as well as patient needs and goals (Morrison et al., 2021). Therefore, HCPs should receive appropriate education on Lyme disease care and treatment to ensure competence in practice and positive patient outcomes.

West Nile Virus

WNV was first detected in Ontario in 2001 and is the most common mosquito-borne illness in Canada. It is transmitted through the bite of an infected *Culex* mosquito (Government of Canada, 2015; Ogden et al., 2022). According to current surveillance, WNV is found in parts of southern Quebec and Ontario, Saskatchewan, Manitoba, and Alberta, and in some areas of British Columbia (Government of Canada, 2023). The annual incidence of WNV fluctuates from year to year, ranging from 437 cases in 2018 to 47 human cases in Canada in 2022, which may

result from weather variations affecting the reproduction of mosquitos (Government of Canada, 2024b; Ludwig et al., 2019). Continued northward range expansion of WNV is predicted in both rural and urban regions in Canada (Khan et al., 2020; Ludwig et al., 2019; Ogden et al., 2022).

There is no treatment or vaccine for WNV; however, individuals are treated for their symptoms (Ogden et al., 2022). 70-80% of people who are infected will have no symptoms, and mild cases recover within a week, while 20% of people will develop acute clinical illness, with 1% experiencing severe illness (Ogden et al., 2022). Early detection is important to prevent severe complications, that can be confirmed through laboratory testing; however, diagnosis can be challenging as clients often present with non-specific symptoms (Ludwig et al., 2019; Ogden et al., 2022). Therefore, WNV remains a significant concern in Canada.

Role of Nurses in Climate Change

HCPs, including nurses, are highly trusted and given their large presence within the health care system, are well-positioned to play an integral role in the mitigation of climate change and preventing subsequent health effects (Adrian, 2020; CASN, 2020; Martin & Kaminski, 2021). This role can include supporting individuals, families, communities, and populations at risk for and affected by VBDs (Adrian, 2020; CASN, 2020; Martin & Kaminski, 2021). The Alliance of Nurses for Healthy Environments (ANHE) (2024), suggested that nurses have a professional obligation to address climate change and ensuing health risks, including VBDs, through research, education, advocacy, and practice. This view was shared by Adrian (2020), and the Canadian Association of Nurses for the Environment (CANE) (2024) who promoted nurses' role in climate change mitigation and climate-informed health programming to reduce climate health threats, such as VBDs.

While the CNA (2017) position statement titled *Climate Change and Health* has been retired as of 2024 and replaced with a position statement on planetary health, it was a foundational document guiding nursing practice on climate change. Both the ICN (2018) and the CNA (2017, 2024) recognized the important role nurses have in supporting climate change adaptation and mitigation through nursing practice, research, education, advocacy, and policy. McDermott-Levy and colleagues (2023) similarly stressed the importance of nursing involvement in both upstream and downstream climate policy advocacy and development, sustainable practice procedures, mitigation strategies, public education on climate change-related risks and illnesses, and community-based initiatives addressing vulnerable populations. According to Butterfield, Leffers, and Vasquez (2021), nurses have three crucial assets in their role as climate action leaders; first, they comprise about 60% of total health professionals globally, working in a variety of practice settings; second, they are trusted; and third, they have close relationships with equity-denied populations most at-risk of climate change health effects.

Kircher et al. (2022) studied the health impacts of climate change in Minnesota from the perspective of HCPs. They found that while most respondents recognized the health impacts of climate change, they also reported feeling uncomfortable discussing climate change with patients, and opportunities exist to develop targeted resources to support HCPs in addressing climate change. These views were shared by Kalogirou et al. (2020), who found that nurses had varying levels of knowledge about climate change and its relationship to health or practice. Climate change was a personal concern, and nursing's role in addressing it was not understood.

A Finnish study on nurses' perceptions and preparation in addressing health effects of climate change concluded that it is necessary to ensure nursing students and practicing nurses are educated on climate change and its impact on human health (Tiitta et al., 2021). Additionally,

Smith (2019) found that HCPs should be educated on infectious disease threats to improve care and enhance community resilience. In their protocol for a scoping review on nurses' perceptions of climate change, Diallo et al. (2023) stated that their preliminary search suggests a possible gap between the importance of the nursing role in addressing the health impacts of climate change and the nurses' lack of knowledge and awareness. The results assist nurses in raising awareness about their role in climate change.

Role of Nurses in Climate Sensitive VBDs

Consensus exists in the literature that nurses have a significant role to play in mitigating and addressing climate change and VBDs in practice, given their substantial presence within healthcare, as evidenced by the data that there were approximately 312,382 RNs in Canada eligible to practice in 2021 (CNA, 2017; 2024; ICN, 2018; Kalogirou et al., 2020; Martin & Vold, 2019). Despite the role nurses can perform, they lack awareness, knowledge, and resources to adequately address climate change and subsequent health threats in practice (Kalogirou et al., 2020; Leffers et al., 2017; Martin & Vold, 2019).

A scoping review mapping current literature on nurses' knowledge, attitudes, perceptions, and experiences towards climate driven VBDs was conducted, and subsequently published (Vandenberg et al., 2023). Literature retrieved in the scoping review confirmed that nurses have an integral role in mitigation of VBDs and should be knowledgeable about VBDs; however, a lack of literature existed on nurses' knowledge, perceptions, and attitudes toward VBDs, and whether nurses themselves feel prepared for their role. Current original research on this topic was lacking, as there were only three original research studies in the included articles.

A recent survey-based study of nurse practitioners in the United States found that nurse practitioners have knowledge gaps about preventing, diagnosing, recognizing, and treating Lyme

disease (Gyura et al., 2023). Survey participants were somewhat confident in the knowledge and understanding of Lyme disease, while they were not proficient in other areas, such as recognition of an erythema migrans rash. The authors concluded that nurse practitioners require additional education about Lyme disease (Gyura et al., 2023). Similarly, Beck, Marx, and Hinckley (2021) found that knowledge about Lyme disease diagnosis, testing, and tick-bite prevention was low in their study of clinicians in the United States from 2013-2015. Additionally, Mattoon et al. (2021) completed a qualitative study of primary care clinical providers in a Lyme disease endemic community and found that a moderate level of awareness on diagnosis and treatment of Lyme disease, but limited knowledge of other tick-borne diseases, namely anaplasmosis and babesiosis. The survey participants were interested in additional resources to facilitate patient education and enhance knowledge on tick-borne diseases (Mattoon et al., 2021).

As evidenced by the scant literature discussed above, a lack of literature in this topic area persists. After a thorough review of current literature, to my knowledge no recent studies examining nurses' knowledge, attitudes, and practices towards climate sensitive VBDs have been conducted since completion of the scoping review (Vandenberg et al., 2023). The lack of research on this topic highlighted the need for this research study, as well as the necessity for nurses to be competent in preventing and addressing VBDs in practice. The required guidelines for nursing practice are discussed below.

Guidelines for Undergraduate Nursing Education on Climate-Driven VBDs

In response to the escalating risk of climate-related health implications on Canadians, CASN released the *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases* in 2020. These guidelines utilized the CASN (2014) *Entry-to-Practice Public Health Nursing Competencies for Undergraduate Nursing Education* and contain five domains

with 34 learning outcomes that outline practice guidelines on climate driven VBDs for nurses entering health care practice settings (CASN, 2020). The guidelines provide targets for achievement, and were comprehensively developed, incorporating evidence, multi-stakeholder input, expert panels, and consultation with gender and Indigenous experts (CASN, 2020). The *CASN Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases* provide a blueprint for nursing action in education, research, and practice to move beyond the knowledge and skills in the guidelines to create sustainable change.

Domain 1: Public Health – VBDs

The first domain of the CASN (2020) guidelines specifies the role that HCP have in understanding climate change causes, driving factors, mitigation efforts. Furthermore, nurses are tasked with recognizing epidemiology and etiology of climate sensitive VBDs endemic to Canada, but also emerging exotic VBDs (CASN, 2020). This domain also encompasses the role nurses have in interprofessional collaboration and public health initiatives related to VBDs at local, provincial/territorial, and national levels (CASN, 2020). Nurses in all practice settings should ensure they are knowledgeable about climate change and subsequent health issues (Neal-Boylan, et al, 2019). According to Butterfield, Leffers, and Vasquez (2021), nurses can disseminate climate change messaging to clients and the public that is acceptable and influential.

Currently, climate change is considered the greatest global public health threat, and nurses have a professional responsibility to address both climate change and the subsequent health consequences (Adrian, 2020). According to Martin and Vold (2019), nurses should be knowledgeable on the profile of common VBDs in Canada, including incidence and transmission, to ensure these diseases are recognized and treated appropriately in the health

practice environment. Practicing nurses are called to critically reflect on their practice readiness to respond to climate associated health implications and VBDs in the clinical setting.

Domain 2: Populations Exposed to Potential Risks

Nurses must acknowledge the perspectives of Indigenous Peoples and those with lived experience of VBDs. Respecting and honoring the holistic relationship Indigenous Peoples have in relation to the land is crucial (Brand et al., 2023; CASN, 2020; Martin & Kaminski, 2021). This knowledge will enable nurses to understand how the SDOH, historical injustices, public policies, and circumstances/context impact VBDs vulnerability and subsequent health effects (CASN, 2020). In addition, understanding health-equity frameworks and Indigenous knowledge and expertise on climate change and planetary health are necessary for practice (Brand et al., 2023; CASN, 2020; Martin & Kaminski, 2021). Risk and protective factors for VBDs in Canada must be understood, to ensure appropriate care for equity-denied populations (Bardosh et al., 2017).

Nurses must be skilled at identifying populations at greatest risk of climate change related health consequences and developing strong communication strategies on risk reduction (Levison et al., 2018; Ogden et al., 2022). According to Butterfield and colleagues (2021), nurses often develop close relationships with equity-denied populations and communities facing barriers related to climate change and related health outcomes. Therefore, reducing burden of disease and advocating for health equity is important for equity-denied populations (Martin & Kaminski, 2021). Similarly, the ICN (2018) and CNA (2024) suggested that nurses must mitigate impacts of planetary decline and climate change on populations with a focus on priority groups.

Domain 3: Prevention (Primary and Secondary)

The third domain encompasses primary and secondary prevention, where CASN (2020) calls on practicing nurses to be able to identify key preventative measures to control VBDs, as well as communicate primary and secondary prevention and protection strategies to individuals, families, communities, and populations. Mitigation of VBDs is another important element of preventative nursing practice. This involves an appreciation of the vulnerabilities and protective factors that exist in communities and an attempt to mitigate the impacts of VBDs on health through primary prevention of human exposure to vectors (Bardosh et al., 2017; CASN, 2020). Additionally, secondary preventative measures, such as early detection of disease, accurate diagnosis, recognition of the signs and symptoms of VBDs, and awareness of how to address VBDs in practice is critical to prognosis and treatment success (Adams et al., 2021; CDC, 2024). Finally, as a crucial component of illness and disease prevention, surveillance must be thoroughly understood by nurses (CASN, 2020).

Patient and public health education are important aspects within nurses' scope of practice (CNA, 2024). Nurses should be sufficiently prepared to engage in effective risk communication and provide education to patients, families, and communities on climate mitigation and preventative measures necessary to reduce risks. Competent communication on reducing vector habitats and breeding sites, preventing human exposure, such as covering skin, using insect repellent with DEET, performing tick checks, and ensuring proper tick recognition and removal is important (Adams et al., 2021; CDC, 2024; Neal-Boylan et al., 2019).

Currently, the incidence and prevalence of VBDs is underestimated in Canada (Lloyd & Hawkins, 2018) and a robust monitoring and surveillance system for infectious diseases in Canada is lacking (CPHA, 2021). Given this fact, nurses must be knowledgeable on the

objectives of surveillance, surveillance measures, correlation of surveillance to practice, and limitations of surveillance (Stamler et al., 2019). Knowledge of surveillance measures for current endemic VBDs will help nurses assess vulnerability of communities and populations; therefore, ongoing high-quality surveillance is necessary (Levison et al., 2018; Ludwig, et al., 2019). Ogden and colleagues (2022) advocated for utilizing new technologies in surveillance and early warning systems, and a “One Health” approach where human, animal, and environmental health are merged, and professionals working in these disciplines work together to address relevant issues.

Domain 4: Treatment (Tertiary Prevention)

Nurses should be experts in engaging in patient-centered care strategies and current treatment approaches for VBDs and assist affected individuals, families, communities, and populations in navigating the health care system to improve prognosis and quality of life (CASN, 2020). Nurses are primarily involved in direct patient care, such as providing treatment to patients with VBDs (Neal-Boylan, et al, 2019). Additionally, an awareness of the inequities and impact of colonization on health care treatment and resources for Indigenous Peoples is necessary (CASN, 2020; NCCIH, 2024).

Otten and colleagues (2020) ranked Lyme disease second on a prioritization tool for endemic diseases in Canada, which confirmed that Lyme disease is significant in Canada. HCPs must be skilled in diagnosing and treating endemic, emerging, and exotic VBDs in Canada (CPHA, 2021); however, according to Boudreau, Lloyd, and Gould (2018) and CPHA (2021), VBDs are not given priority within Canada’s healthcare system, hindering appropriate diagnosis and treatment for those affected by VBDs. According to most recent data published by the World Health Organization (2017), VBDs contribute to approximately 17% of the overall global burden

of disease; disproportionately affecting populations experiencing poverty and creating economic impacts, health inequities, and increased healthcare spending.

As discussed earlier in this chapter, timely, applicable, patient-centred care of Lyme disease is highly controversial in Canada given the presence of competing international guidelines on the diagnosis and treatment of Lyme disease. Research has shown that Lyme disease patients without effective treatment suffer from a lower quality of life than the general population and are at risk of premature death (Davidsson, 2018), which demonstrates the need for nurses to support Lyme disease patients to improve their prognosis and quality of life (CASN, 2020).

Within tertiary prevention, nurses must be skilled in accurately diagnosing disease, recognizing of the signs and symptoms of VBDs, and providing appropriate treatment to patients (Dean, 2020; Gillespie, 2021). Furthermore, given the controversies around Lyme disease treatment in Canada, nurses are called to support and advocate for individuals with VBDs who have difficulty receiving a timely and accurate diagnosis within the conventional Canadian healthcare system. Greater emphasis on interprofessional collaboration is necessary, where nurses incorporate appropriate resources and evidence to inform decision-making while maintaining individual needs (CNA, 2020).

Indigenous Peoples in Canada are often hesitant to access conventional health care and are denied culturally safe and relevant treatment and care because of the presence of colonialism and racism (NCCIH, 2024). Nurses are called to demonstrate cultural safety in practice and address the power imbalances that exist between providers and patients (Martin & Kaminski, 2021; Muise, 2019). Providing culturally safe care to Indigenous Peoples first requires nurses to understand their own culture and how it might affect their care (Ward, Branch, & Fridkin, 2016).

Nurses are also called to recognize the historical injustices and the continued impact of colonization and racism on Indigenous Peoples that lead to poor health outcomes, particularly within mainstream health care settings (Muisse, 2019; NCCIH, 2024).

There are views that climate change is directly linked to colonialism, resulting from environmental changes inflicted on Indigenous Peoples over time (Jones, 2019; Whyte, 2017). Therefore, nurses are called to acknowledge historical events and continued effects of colonialism in health care settings to develop effective responses to mitigate climate change and subsequent VBDs in practice. This can be achieved by demonstrating cultural safety and honouring the *Truth and Reconciliation Commission of Canada: Calls to Action* (2015), particularly those calls to action on reducing health inequities and colonialism in health care settings. Additionally, the National Collaborating Centre for Indigenous Health (2024) recommended cooperative action across structural, systemic, and service sectors, which includes policy development, programs and services, engagement activities, and cultural safety training for HCPs to improve cultural safety for Indigenous Peoples.

Domain 5: Advocacy

The final domain describes the role of nurses in addressing health inequities faced by those living with VBDs, identifying culturally appropriate advocacy strategies to promote equitable access to health care, engaging in culturally safe partnerships, and reflecting on relevant public policies (CASN, 2020). Nurses must be aware of various applicable position statements, policies, ethical guidelines, and practice standards on climate change and VBDs (CASN, 2020; Law et al., 2021). Furthermore, nurses should be adept in addressing climate change and health implications at multiple levels of government, through public and health

policy advocacy and development (CASN, 2020; CNA, 2024; ICN, 2018; Neal-Boylan, et al, 2019).

Adrian (2020) called on all nurses to become involved at policy, political, strategic, and national levels to ensure climate change and health threats are addressed through swift policy action to promote and protect human health. Butterfield and colleagues (2021) believed nurses must assume leadership roles within climate action, where they can actively engage in sustainable initiatives in the practice setting. Additionally, increased funding and support is needed to promote nursing research in climate change mitigation to improve health outcomes (Butterfield et al., 2021). Ensuring nurses are knowledgeable and skilled in caring for individuals, communities, and populations at risk, or affected by climate driven VBDs, requires competence in advocacy and leadership.

Summary

This chapter provided an overview of relevant current literature on planetary health, climate change, VBDs, as well as the nurses' role related to these issues. Nurses are integral to Canada's health care system and are invaluable in mitigating climate-related health implications and restoring planetary health. Therefore, they must be knowledgeable about planetary health disruptions, such as climate change and subsequent disease threats. This knowledge will better prepare nurses to address these issues in a variety of health care settings, requiring a comprehensive array of competencies. The CASN (2020) *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases* situate the necessary knowledge and skills within nursing education in Canada; however, competencies for entry-level nursing practice have not yet been developed. Nurses must have a voice in advocating for resilient health systems to deal with VBDs, given the social, environmental, and climatic changes occurring, impacting the

distribution and incidence of VBDs. Achieving sustainable VBDs prevention and control in a changing world requires holistic thinking, a focus on equity, understanding of complex systems, evidence-informed practice, and a planetary health perspective (Bardosh et al., 2017).

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

The aim of this chapter is to describe the research design and methodology that was utilized for this research study. A description of the selected research design, applicable theoretical framework, methods of data collection, data management, and data analysis, as well as ethical considerations are discussed.

Research Questions Re-examined

The purpose of this study was to explore the knowledge, attitudes, and practices (KAP) of RNs in Canada related to climate sensitive VBDs, namely Lyme disease and WNv. The research questions that guided this study include:

- 1) What is the overall knowledge of climate sensitive VBDs of RNs in Canada?
- 2) What are the overall attitudes of RNs in Canada toward climate sensitive VBDs?
- 3) What are the practices and experiences of RNs in Canada addressing climate sensitive VBDs in the practice setting?
- 4) Does knowledge of climate sensitive VBDs vary: a) by position, b) by education, c) by practice area, d) by age, e) by years of practice, f) by province/territory, g) by urban/rural setting, h) by Indigeneity?
- 5) Do attitudes toward climate sensitive VBDs vary: a) by position, b) by education, c) by practice area, d) by age, e) by years of practice, f) by province/territory, , g) by urban/rural setting, h) by Indigeneity?
- 6) Do practices and experiences in addressing climate sensitive VBDs vary: a) by position, b) by education, c) by practice area, d) by age, e) by years of practice, f) by province/territory, g) by urban/rural setting, h) by Indigeneity?

Theoretical Framework

A theoretical framework guides research and provides structure for concepts that are found in the literature and can be referred to as a blueprint for research (Cameron, 2018).

Theoretical frameworks explain and interpret the phenomenon under study through a particular lens (Luft et al., 2022). Additionally, the theoretical framework influences the research question, guides methodological decisions, and informs the discussion of the findings (Luft et al., 2022).

Planetary Health is a pragmatic theoretical framework, suitable to guide nursing research, and therefore was used in this research study on the KAP of RNs toward climate sensitive VBDs in Canada.

Planetary Health

In his original work on planetary health, Myers (2017) theorized that evidence suggests that human disruption of the earth's natural systems is causing increased global burden of disease. Myers (2017) depicted the anthropogenic changes on human health in an illustration (Figure 3.1), where underlying factors such as steep growth in per capita consumption, demographic shifts including rapid population growth, and new technologies with detrimental environmental effects are transforming and disrupting ecological drivers and our planet's natural systems (Myers, 2017; Myers & Frumkin, 2020). Human activities are driving biophysical changes at unprecedented rates within six dimensions: 1) disruption of the global climate, 2) widespread air, water, and soil pollution, 3) swift biodiversity damage, 4) reconfiguration of carbon, nitrogen, and phosphorus cycles, 5) prevalent changes to land use and cover, and 6) fresh water and arable land resource scarcity (Myers, 2017).

The complex relationship between these dimensions results in altered air quality, freshwater accessibility, infectious disease contact, and food production, subsequently leading to

natural hazards, such as heat waves, droughts, floods, tropical storms, and wildfires (Myers, 2017). Successive health impacts of anthropogenic changes include malnutrition, infectious diseases, non-communicable diseases, displacement and conflict, and mental health disorders (Myers, 2017). Mediating factors, such as good governance, financial resources, philanthropy, appropriate uses of technology, and cultural considerations can mitigate the overall health effects (Myers, 2017).

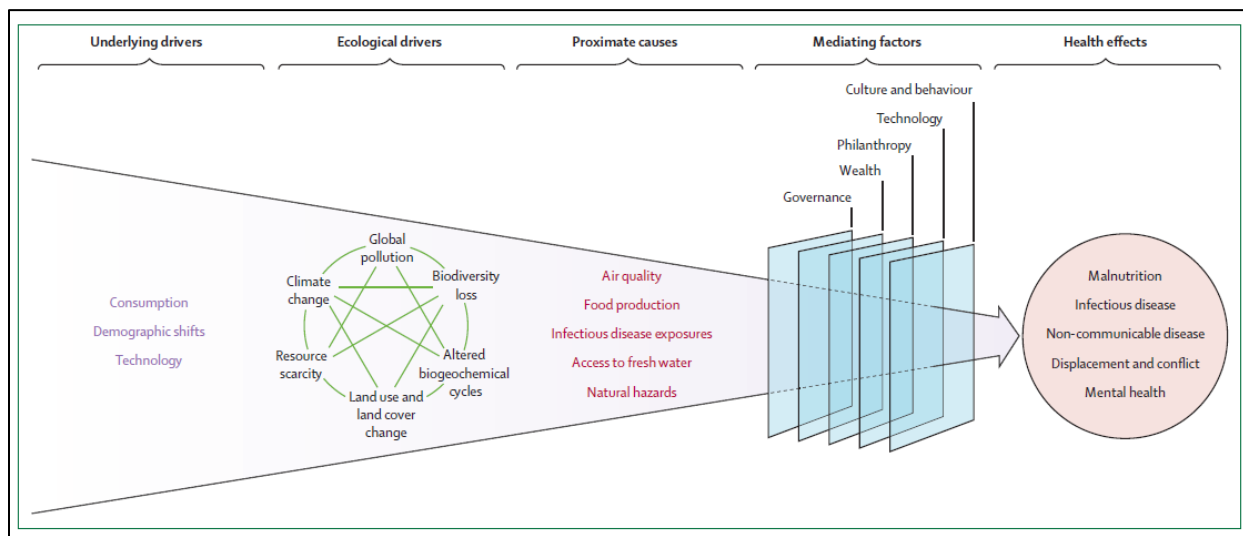
As a core aspect of planetary health, climate change threatens every dimension of human health (Myers, 2017; Myers & Frumkin, 2020). According to Myers and Frumkin (2020), there is clear data that climate change is affecting the distribution and prevalence of VBDs, such as Lyme disease, and many others around the globe. Therefore, nurses require both awareness and knowledge of health promotion and disease prevention at various health levels, from individuals to populations (Guzman & Potter, 2021; LeClair, Watts & Zahner, 2021; Myers & Frumkin, 2020).

Positioning the KAP of RNs toward climate driven VBDs in this research study offered an assessment of the extent to which nurses are practicing within a planetary health mindset, using the Planetary Health framework introduced by Myers (2017). While this research study did not focus broadly on planetary health with nurses, the survey aimed to determine how nurses view specific planetary health issues, such as climate change and infectious VBDs. The research aligned with components of Myer's (2017) schematic illustration of anthropogenic change on human health (see Figure 3.1), where climate change is the ecological driver, which causes exposure to infectious disease (proximate cause), and subsequent health effects, such as infectious VBDs. Mediating factors, such as governance, culture and behaviour, and philanthropy can limit the consequences of the underlying and ecological drivers and limit the

health outcomes. This framework can assist nurses in leading healthcare change and advocating for improved planetary health and a climate-resilient future. However, it must be noted that given the lack of research and funding to climate change and VBDs in Canada, limited opportunities exist for HCPs to address planetary health, including climate change and VBDs, in practice (CPHA, 2021).

Figure 3.1

Schematic illustrating impacts of anthropogenic changes on human health (Myers, 2017)



Research Approach

A research approach is the overall plan and procedure for research and consists of the philosophical worldview or paradigm assumptions informing the study, the research design related to the worldview, and the specific methods or procedures of research (Creswell, 2018). A paradigm is a worldview or belief system and the lens through which we view the world around us (Cameron, 2017; Davies & Fisher, 2018; Guba, 1990). The four most common worldviews which guide research include: postpositivism, constructivism, transformative, and pragmatism (Creswell, 2018). Research designs include qualitative, quantitative, and mixed methods

research, while research methods comprise the research questions, data collection, data analysis, interpretation, and validation (Creswell, 2018). A discussion of the three components of a research approach is presented in greater detail in the following sections.

Post-Positivist Research Paradigm

The research paradigm that guided this research study was post-positivism. The post-positivism paradigm evolved from the positivist paradigm. It is concerned with the subjectivity of reality and moves away from the purely objective stance of positivism, recognizing that we cannot be “positive” about knowledge claims when researching human behaviour and action (Cameron, 2017; Creswell, 2018). According to Guba and Lincoln (1994), post-positivists believe reality is imperfectly comprehensible, and that findings are always subject to pre-existing knowledge. Writers, such as Comte, Mill, Durkheim, Newton, and Locke, have developed the postpositivist tradition in the 19th century (Smith, 1983), recognizing that the traditional notion of absolute truth of knowledge was not possible (Cameron, 2017; Creswell, 2018).

According to Phillips and Burbules (2000), there are several key assumptions of post-positivism, namely that knowledge is conjectural, and absolute truth is not found. Furthermore, data and evidence shape knowledge and research seeks to develop relevant true statements, which can be used to describe casual relationships. Attempting to maintain objectivity is important, which is determined by reliability and validity (Phillips & Burbules, 2000); however, others note that modified objectivity is more appropriate as researchers are unable to completely control or remove external influences on participants (Ryan, 2019).

While objectivity is valued within postpositivism, researchers must view notions of certainty and truth more cautiously (Tanlaka, Ewashen, & King-Shier, 2019). Al-Motlaq and Chapman (2012) similarly asserted that absolute objectivity in nursing research is impossible.

The authors discussed several subjective decisions that quantitative researchers make within the postpositivist paradigm, namely subjectivity in the scope of an objective study, including subjectivity in reviewing literature, seeking ethical approval, selecting a design, choosing a sample, collecting data, analyzing data, interpreting data, drawing conclusions, and making recommendations (Al-Motlaq & Chapman, 2012).

Focusing on objectivity, or quantified knowledge, may prevent subjective or constructivist viewpoints that suggest worldviews and truth are dependent on perceptions and life experiences (Cameron, 2017; Creswell, 2018). Constructivism values knowledge development where people understand and perceive the world around them (Cameron, 2017). A postpositivist approach promotes generalizability of research findings, although caution must be taken to determine if the sample is representative of the population. Subjective meanings, such as historical, social, and cultural norms and experiences are valued within constructivism, rather than postpositivism (Creswell, 2018), and therefore contextual nuances and life experience are lost.

While a post-positivist approach guided this research study, the above-mentioned points on subjectivity are recognized as potential limitations of the study, and a testament that complete objectivity is fundamentally impossible. Essentially nursing research, whether it be qualitative or quantitative, searches for reality; however, it is subject to the researchers' judgment.

Research Design

A quantitative cross-sectional survey research design was used to conduct this research study. Quantitative research is an approach which examines relationships among variables through the testing of objective theories (Bloomfield & Fisher, 2019; Creswell, 2018). It uses a rigorous and controlled design to examine events or variables, which are measured using pre-

determined instruments and analyzed using statistical processes (Creswell, 2018; Polit & Beck, 2020). Considerations in quantitative research include objectivity in the conceptualization of the issue, control over the design, accuracy, feasibility, and internal and external validity (Lobiondo-Wood & Singh, 2018). As discussed above, the research study was informed by post-positivism, given the belief that complete objectivity is not possible with quantitative research.

Quantitative Research Design Appropriateness

The decision to select a quantitative research design was determined by postpositivist philosophical assumptions, as well as through an extensive literature and scoping review on the substantive area of research. This decision was further informed by the research questions and the target sample, where a quantitative design was appropriate. The quantitative research design provided baseline data on the topic, given the absence of Canadian nursing research on this subject matter. This data contributes to the current body of knowledge and informs future research, as study provided an in-depth analysis of the KAP of RNs, rather than articulate a list of practice-required competencies, addressing a gap in the existing literature.

Survey Research

Survey designs are one of two broad categories of research designs in quantitative research. Non-experimental or survey designs include cross-sectional and longitudinal studies using questionnaires or structured interviews as a means of data collection (Creswell, 2018). Survey designs are common in nursing research, and frequently involve questionnaires, which are useful for gathering large amounts of data (Watson, 2015).

Cross-Sectional Surveys

This research study utilized a cross-sectional survey that was distributed to practicing RNs across Canada. The purpose of survey research is to try to generalize information from a

sample to a population so assumptions can be made about characteristics, attitudes, or behaviors of the population (Babbie, 1990; Coates, 2004; Creswell, 2018). Surveys can describe a situation or population and have the potential to provide evidence which can inform nursing practice (Coates, 2004; Connelly, 2016). As such, measurement, accuracy, reproducibility, and generalizability are important with survey research (Coates, 2004).

Cross-sectional surveys examine data at a point in time, where data is collected with participants on only one occasion (Kesmodel, 2018; Lobiondo-Wood, Haber, & Singh, 2018; Rindfleisch et al., 2008). Surveys can be used to measure prevalence of health outcomes, identify determinants of health, and explain characteristics of a population (Wang & Cheng, 2020). Cross-sectional research can explore relationships and correlations, differences, and comparisons (Lobiondo-Wood et al., 2018), and can either be descriptive or analytical (Kesmodel, 2018; Wang & Cheng, 2020). Descriptive studies aim to provide assessments of attitudes, knowledge, or health behaviors, while analytical surveys assess associations between factors (Kesmodel, 2018; Wang & Cheng, 2020). Given that this research focused on studying the KAP of RNs, and examined variations between participants based on position, education, practice area, age, years of practice, geographical location, urban versus rural setting, and Indigeneity, the survey was both descriptive and analytical.

Advantages of Cross-Sectional Surveys

Advantages of cross-sectional survey designs include the relatively rapid completion of data collection and the ability to identify attributes of a population from a small group of individuals (Babbie, 1990; Connelly, 2016; Creswell, 2018). They are inexpensive and efficient to conduct and can adequately address many questions, compared to other research designs, such as experimental research (Connelly, 2016; Spector, 2019; Wang & Cheng, 2020). Additional

advantages include flexibility, where surveys can comprise many different aspects of human behavior and be used in various populations; feasibility, which refers to the capacity of the study to be successfully completed in an economical manner; and accuracy, where survey designs can maximize results and decrease errors (Connelly, 2016). Furthermore, cross-sectional studies are useful for establishing preliminary findings, which is beneficial for planning future research (Wang & Cheng, 2020). This survey provided baseline data on KAP of RNs toward climate driven VBDs, and this information will be used inform further research on RN practice readiness in meeting the challenges of VBDs.

Limitations of Cross-Sectional Surveys

Cross-sectional survey research also has disadvantages, where information obtained can be superficial, results can be biased or limited, and the breadth of information is emphasized over the depth of information (Coates, 2004; Connelly, 2016; Lobiondo-Wood et al., 2018). According to Coates (2004), surveys can be viewed as shallow and contribute to scientific knowledge in a limited manner; however, more rigorous forms of research designs, such as experimental clinical designs, may be more difficult to conduct within nursing.

Conducting survey research requires expertise in various research components, such as sampling, questionnaire development, and data analysis to support validity and reliability (Lobiondo-Wood et al., 2018). Selection bias, information bias, and confounding may be present (Connelly, 2016; Kesmodel, 2018). Selection bias is a challenge with cross-sectional studies, where the sample surveyed may not be representative of the overall population, which can reduce generalizability (Wang & Cheng, 2020) Information bias occurs when study variables are measured, collected, or analyzed inaccurately (Wang & Cheng, 2020).

A significant limitation of cross-sectional surveys on potential research findings includes common method variance (CMV) (Rindfleisch et al., 2008; Spector, 2019). CMV bias is particularly concerning with surveys that utilize a single-scale format, such as Likert scales, which reduces cognitive processing (Rindfleisch et al., 2008; Tehseen, Ramayah, & Sajilan, 2017). While researchers appear to agree that Likert scales are the most appropriate means of collecting survey data, this limitation can be overcome by utilizing different scales or alternate formats within the survey (Rindfleisch et al., 2008), which are featured in the survey used in this study.

Respondent attitudes and tendencies can also create CMV bias, where respondents answer questions in a consistent manner, depending on their mood, which can inflate correlations (Rindfleisch et al., 2008; Spector, 2019; Tehseen et al., 2017). Respondent susceptibility to socially desirable responses create bias, which can be overcome by expecting low levels of response bias resulting from informant characteristics and including educated individuals in the sample (Rindfleisch et al., 2008; Tehseen et al., 2017). For instance, participants in this study, although educated, given their credentials, may have answered questions based on how they thought they should respond, rather than how they actually felt. To control for this bias, participant's personal information was not attached to their responses, and survey responses were anonymous.

Finally, the survey context may also influence CMV bias, where more abstract constructs, such as measuring attitude, can create higher percentages of method variance (Rindfleisch et al., 2008; Tehseen et al., 2017). Given that CMV bias can influence research findings, measures were taken in the survey to protect anonymity of respondents to reduce

response bias, included alternate scale formats, and incorporated questions that were clear, specific, and concise (Tehseen et al., 2017).

Additionally, researchers using cross-sectional surveys should be careful not to make causal inferences (CI); defined as the capability to assume causation from observed empirical associations, which can limit cross-sectional research because all variables are assessed concurrently (Rindfleisch et al., 2008; Spector, 2019). CI includes factors such as temporal order, coherence, and covariation, discussed later in this paper, and other issues such as the halo effect, order effects, and common-method biases (Rindfleisch et al., 2008). These errors combined can threaten validity of cross-sectional survey research (Savitz & Wellenius, 2022). Therefore, in the survey, correlation was assessed, rather than causation.

Rationale for Cross-Sectional KAP Survey Design

Cross-sectional surveys are widely used and chosen for this research study for various reasons. They can be utilized as a starting point to address a research question and can build in complexity as more information becomes available (Spector, 2019). Cross-sectional surveys are suitable when the researcher is conducting exploratory research and does not know if pairs of variables are related, and whether moderators might exist, such as occurs when studying new variables within the research setting (Spector, 2019).

Cross-sectional surveys are also relevant when assessing attitudes and knowledge among participants, such as health professionals (Kesmodel, 2018). Given that this research examined the KAP of nurses, it was well-suited to a cross-sectional survey design. KAP theories presume that people choose courses of action that align with personal beliefs and preferences, and their knowledge is important in these preferences (Yang et al., 2018). KAP theories are common in

published research, as evidenced by several validated questionnaires in the literature (Alobuia et al., 2015; Howard et al., 2022; James, et al., 2006; Johnston et al., 2003).

A KAP survey is a representative study of a particular population to collect data on what is known, believed, and performed in relation to a specific topic (Andrade et al., 2020; WHO, 2008). Common knowledge and attitudes can be studied using KAP surveys, as they are essentially an educational diagnosis of a population (Kaliyaperumal, 2004). KAP surveys can further identify knowledge gaps, reasons for attitudes and beliefs, and factors influencing behaviors, which can be analyzed to facilitate understanding and action on an issue (WHO, 2008). KAP surveys can provide useful information, making them common in health sciences (Andrade et al., 2020).

KAP surveys are effective in establishing baseline data, including knowledge, misconceptions, attitudes, beliefs, and behaviors, on a particular topic (Andrade et al., 2020; WHO, 2008), especially when research is lacking on the subject or a novel situation arises (Andrade et al., 2020). Framing questions within a KAP survey commences with defining the required degree of knowledge within the target population, which is necessary to determine how knowledge influences attitudes and practices (Andrade et al., 2020). KAP surveys can be effective prior to implementing an intervention or program, and the survey may be repeated following the intervention to determine impact and effectiveness (Andrade et al., 2020; Kesmodel, 2018), such as education sessions for nurses on climate driven VBDs.

A KAP survey does not require a large budget and is straightforward to design, conduct, analyze, and interpret (Andrade et al., 2020). Consistent with the KAP model, surveys can be conducted using a self-administered questionnaire, reflecting the three primary constructs of knowledge, attitudes, and practices (Andrade et al., 2020; Deng et al., 2022), making it an

applicable tool to explore the KAP of RNs in Canada related to climate sensitive VBDs.

Conducting a KAP survey is important when no previous surveys have been conducted in the population of interest on the topic of study (Andrade et al., 2020).

The results of the recent scoping review, as well as a review of recent literature, indicate that research on this topic of interest has not been conducted (Vandenberg et al., 2023), and therefore a KAP survey was an appropriate tool to utilize in this research study. Despite the suitability for this topic, KAP surveys have several limitations. They do not promote a comprehensive understanding or examination of a situation. KAP surveys analyze opinions which are based on statements; however, there can be considerable gaps between what is said and what is actually done (Médecins du Monde, 2015). KAP surveys may not delineate the complexities of nursing practice, where knowledge does not necessarily translate to quality care and positive patient outcomes. Therefore, while the survey provided baseline data on this topic, additional research is required to understand the issue more broadly.

Survey Development

Current literature was reviewed to identify if an existing survey could be utilized; however, established tools located in the literature were not appropriate for the proposed research study. Existing surveys either broadly focused on climate change (Alvarez-Nieto et al, 2022; Ergin, Altinel, & Aktas, 2021; La Torre et al., 2020; Nigatu, Asamoah, & Kloos, 2014; Polivka, Chaundry, & Crawford, 2012; Sambath et al., 2022; Xiao et al., 2016; Yang et al., 2018) or were too specific in focus (Howard et al., 2022).

According to Connelly (2016) and Vogt and colleagues (2014), previously developed survey instruments spare time and often have the advantage of established content validity and reliability; however, when no appropriate measure is available in the literature for the variables a

researcher wants to study or if the situation to be studied is evolving, the researcher may need to develop or modify a survey. When modifying a survey, caution must be exercised as questions can be misinterpreted, and validity and reliability are no longer applicable (Sousa, Matson, & Dunn Lopez, 2017).

Lobiondo-Wood et al. (2018) mentioned that locating appropriate measurement tools in nursing literature is difficult, as the phenomena of interest can be intangible. Creswell (2018) and Vogt et al. (2014) stated that surveys can be intact, designed, or modified for a particular research project; however, if instruments are intact or modified, appropriate permission must be granted by the developer.

Therefore, the survey instrument which was created (see Appendix A) was adapted from Kircher et al. (2022), in their quantitative research on the understanding of the KAP of healthcare professionals toward climate change and health in Minnesota, USA. Permission was granted by the authors to adapt the *Minnesota Survey of Healthcare Professionals on Climate Change and Health* for this research study. Kircher and colleagues (2022) established validity and reliability of their survey instrument by piloting the survey tool with a sample of nurses and physicians in Minnesota.

While the survey from Kircher et al. (2022) focused broadly on climate change and health, it was chosen as it most closely aligned with the findings from the scoping review, the guiding research questions, and the Planetary Health theoretical framework. Questions were selected from the tool by Kircher et al. (2022) on climate change and health and were modified to meet study objectives. For instance, items on the original tool assessed respondent's self-reported levels of concern, preparation, comfort, and role in addressing climate change, and

thoughts on the ability to help patients or clients (Kircher et al., 2022). To align with study objectives, these items were adapted to focus specifically on climate sensitive VBDs.

The adapted survey tool included 50 items, which were divided into four sections: 1) Demographics, 2) Knowledge of VBD, 3) Attitudes towards VBD, and 4) Practices, Experiences, and Resources. Items in the demographics section included primary position, highest level of education, primary practice area, age, years of practice, province/territory of registration, location of residence (urban/rural), and whether the participant wished to declare Indigeneity. The knowledge section of the survey comprised 17 questions; 12 were Likert-scale questions on knowledge of climate change, and epidemiology, prevention, transmission, diagnosis, and treatment of Lyme disease and WNV. One additional Likert-scale question addressed controversies of Lyme disease in Canada. The remaining questions assessed knowledge of VBDs, prevalence of VBDs in Canada, considerations of climate change with Lyme disease and WNV, and completion of education on the topic.

The attitude section of the survey included 12 items, 10 of which were Likert-scale questions, and the remaining two items assessed influencing views on climate change and VBDs. Likert-scale items in this section focused on perceptions of climate change and related health risks, including VBDs in Canada, and participants' degree of confidence and preparedness in addressing concerns related to VBDs in practice. Two additional Likert-scale items focused on nurses' role in social justice and health equity and impact of VBDs on equity-denied populations, such as Indigenous Canadians. The final section of the survey contained 13 items about experiences with VBDs in the practice setting, such as discussions about climate change and VBDs with patients, encounters with patients in practice, and barriers to discussing VBDs in practice. Additional questions in this section included receiving information on VBDs in

practice, interest in increasing knowledge on VBDs, barriers to accessing resources on VBDs, resources that would interest participants, personal experiences with VBDs, and whether participants were aware of the CASN (2020) E-Resource on VBDs.

According to O'Connor (2022), surveys should gather the least amount of information from respondents to offer useful data about a phenomenon. Surveys which include an over-abundance of items can create complications, including poor response rates and inadequate findings (O'Connor, 2022). There were fifty items on the survey; however, all questions were formatted as single or multiple response, depending on the nature of the question.

Likert Scales

Likert scales were developed in 1932 by Rensis Likert to measure attitudes and are commonly used in medical research (Sullivan & Artino, 2013). Typical Likert scales include a 5 or 7-point ordinal scale, where responses can be rated or ranked, but the distance between responses cannot be measured, and differences between response are not necessarily equal (Jamieson, 2004; Sullivan & Artino, 2013). Programs, such as Statistical Package for the Social Sciences (SPSS), can convert ordinal scales to numbers or continuous measure scales, which provides interval data. However, controversy exists whether ordinal data, when converted to numbers, can be considered interval data (Carifio & Perla, 2008; Jamieson, 2004; Sullivan & Artino, 2013).

According to some experts, ordinal data should be analyzed using non-parametric statistics, which are less sensitive and less powerful than parametric statistics and can miss weak or emerging results (Carifio & Perla, 2008). However, others argue that it is acceptable to treat Likert responses as interval data at the scale level, sum Likert data items, and analyze the summations using both univariate and multivariate parametric tests (Carifio & Perla, 2008).

According to experts, sample size is the determining factor in whether non-parametric or parametric tests can be used to analyze Likert scale data. Parametric tests can be used if the sample size is adequate (at least 5-10 observations per group) and if the data is normally distributed (Jamieson, 2004; Sullivan & Artino, 2013). Given that the sample size in the current study was adequate, Likert data items were treated as scale data, and analyzed using appropriate parametric tests.

To reduce CMV bias, the survey included alternate question formats. Many of the items included a five-point Likert scale to indicate the degree to which the participants agreed or disagreed with a statement, namely: 1) strongly agree, 2) agree, 3) neutral, 4) disagree, and 5) strongly disagree. Likert scales are effective at assessing the degree of support or agreement with a statement, and responses can be totaled to create scales (Vogt, Gardner, & Haefele, 2012; Vogt et al., 2014). Other simple questions, which included *agree-disagree-unsure* were incorporated into the survey. Including a neutral option is prudent because it is an opinion valuable to investigate and prevents the participant from being compelled to select an option they do not endorse (Andrade et al., 2020; Vogt et al., 2014). Neutral options can also increase survey validity (Vogt et al. 2014). The KAP survey had two subscale scores for knowledge and attitudes as these sections contained Likert-scale data, and no total survey score was computed as the different concepts included ordinal, nominal, and scale data, and therefore could not be totaled into a combined construct (Andrade et al., 2020).

Alignment of Survey with Theoretical Framework

As discussed earlier in this chapter, the Planetary Health framework introduced by Myers (2017) was chosen as the theoretical framework to guide this research study, given the suitability to the research topic and questions (see Figure 3.1). Additionally, Myers' (2017) Planetary

Health framework guided the development of survey questions. Climate change is one of the six interacting dimensions or ecological drivers of biophysical changes on Myers' model. These drivers alter the environmental conditions for human health, which enhance exposure to infectious diseases, such as VBDs (Myers & Frumkin, 2020). The research questions were situated within the dimension of climate change, with a focus on VBDs as the health impact of anthropogenic changes. There is evidence that climate change is affecting the distribution and prevalence of VBDs around the globe (Myers & Frumkin, 2020). Planetary health focuses on understanding the human health impacts of environmental disruptions, which connects with the survey for this study, given that survey items situated the role of RNs in dimensions of planetary health, namely climate change and VBDs, in the practice setting.

Survey items addressed the impact of climate change on health, current knowledge of and attitudes toward climate change and VBDs, and the level of agreement or disagreement with the increasing risk of VBDs in Canada. Additionally, specific knowledge of prevention, incidence, transmission, epidemiology, diagnosis, and treatment of Lyme disease and WNV were included in the survey. The final questions addressed nurses' role and preparedness preventing and addressing climate change and VBDs in practice, as well as facilitators and barriers to accessing resources and information to enhance knowledge and partnerships with patients in addressing VBDs.

Appropriateness of the Survey in Addressing Research Questions

To determine the appropriateness of survey designs in addressing research questions, researchers must believe that potential participants have sufficient knowledge to answer the survey questions and that structured questions gather structured responses (Vogt et al., 2014).

In this study, the survey instrument was well-aligned with the broad research questions guiding the study, where the survey included questions to examine the KAP of RNs toward climate sensitive VBDs. These questions were followed by comparative questions which assessed the degree of variance of KAP by position, education level, practice area, age, years of practice, geographical location of practice, setting (urban/rural), and Indigeneity. The four sections of the survey, namely, demographics, knowledge of VBDs, attitudes toward VBDs, and practices, experiences, and resources, strongly supported the broad research questions.

Eight objective survey questions addressed participant demographics, including descriptive information about the participant, current position, education, years of experience, age, geographical location of practice, practice area, setting (urban versus rural), and whether participants considered themselves to be Indigenous, Metis, or Inuit. This data was analyzed to determine if there were variances in participant KAP by position, education level, current practice area, age, years of experience, and geographical location.

The second section of the survey contained questions assessing current knowledge of climate change and VBDs. Seventeen items assessed knowledge of climate change and VBDs, including epidemiology, transmission, incidence, prevention, diagnosis, treatment of Lyme disease and WNV, and treatment controversies related to Lyme disease. The final question in this section inquired about continuing education on the topic of research.

The third section comprised twelve subjective items assessing participant attitudes toward climate change and VBDs, including perceptions of climate change and subsequent health implications, vulnerability of populations to VBDs, health impacts of VBDs, role of the RN in mitigation and social justice advocacy, and preparedness and comfort in addressing VBDs in practice. Two questions addressed influencing sources on participant views of the topic.

The final section included thirteen items on practices and experiences in the selected practice area related to VBDs, including quantity of patient encounters with VBDs, VBDs education with patients, priority of VBDs knowledge in practice, as well as facilitators and barriers to accessing resources on VBDs. Additionally, questions on personal experiences and interest in continuing education on the topic were included. The survey offered a comprehensive overview of the KAP of registered nurses related to climate change and climate sensitive VBDs, which was beneficial in exploring this emerging field of research in Canada.

Variables in the Study

According to Creswell (2018), it is useful to depict variables, research questions, and survey items so a reader can easily determine how data collection relates to the variables and research questions which guide the study. Therefore, the following chart provides a visual overview of these elements. Given that this research study utilized a non-experimental approach, the independent variables mentioned below cannot be manipulated. Therefore, the independent or subject variables are characteristics of already existing groups and cannot be randomly assigned to participants (Bhandari, 2022; Creswell, 2018). The dependent or outcome variable changes in response to another variable and represents the outcome which is to be measured (Bhandari, 2022; Creswell, 2018).

Table 3.1

Variables in the Study

Independent or Subject Variable	Dependent or Outcome Variable	Research Question	Items on Survey
RN	Knowledge	What is the overall knowledge of climate sensitive VBDs of Registered Nurses (RNs) in Canada?	9 – 25
	Attitudes	What are the overall attitudes of RNs in Canada toward climate sensitive VBDs?	26 – 37

	Practices & Experiences	What are the practices and experiences of RNs in Canada addressing climate sensitive VBDs in the practice setting?	38 – 50
Position	Knowledge	Does knowledge of climate sensitive VBDs vary by position?	1, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by position?	1, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by position?	1, 38 – 50
Education	Knowledge	Does knowledge of climate sensitive VBDs vary by education?	2, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by education?	2, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by education?	2, 38 – 50
Practice Area	Knowledge	Does knowledge of climate sensitive VBDs vary by practice area?	3, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by practice area?	3, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by practice area?	3, 38 – 50
Age	Knowledge	Does knowledge of climate sensitive VBDs vary by age?	4, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by age?	4, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by age?	4, 38 – 50
Years of Practice	Knowledge	Does knowledge of climate sensitive vector-borne diseases vary by years of practice?	5, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by years of practice?	5, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by years of practice?	5, 38 – 50
Geographical Location of Practice	Knowledge	Does knowledge of climate sensitive VBDs vary by location?	6, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by location?	6, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by location?	6, 38 – 50
Urban/Rural Setting	Knowledge	Does knowledge of climate sensitive VBDs vary by setting?	7, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by setting?	7, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by setting?	7, 38 – 50

Indigeneity	Knowledge	Does knowledge of climate sensitive VBDs vary by Indigeneity?	8, 9 – 25
	Attitudes	Do attitudes toward climate sensitive VBDs vary by Indigeneity?	8, 26 – 37
	Practices & Experiences	Do practices and experiences in addressing climate sensitive VBDs vary by Indigeneity?	8, 38 – 50

Setting & Sample

The research study was directed to practicing RNs across Canada. According to the CNA (2024), there were approximately 312, 382 RNs in Canada in 2021. RNs were specifically chosen for this research study, given they are one of the largest groups of HCPs, and are well-positioned to play an integral role in the mitigation of planetary and climate-related health effects, through research, education, advocacy, and practice; however, they lack the necessary awareness and knowledge to fulfill their role (ANHE, 2024; CNA, 2024; ICN, 2018; Kalogirou et al., 2020; Martin & Vold, 2019).

To confirm inclusion criteria, participants must have been currently practicing as an RN in Canada and hold valid registration with their designated provincial or territorial professional licensing body. Participants must have had access to the Internet, as the survey was distributed using an online survey program, namely Qualtrics™. Additionally, they must have been able to read English, as the survey was distributed in English.

There was a total of 859 responses to the national survey which was distributed. Early in the data collection phase, it was discovered that there were invalid survey responses, where during an 8-hour period in September 2023, approximately 400 additional survey responses were received. Upon examination of the secondary Qualtrics™ survey data, it was noted that the responses included fraudulent names and email addresses. A thesis committee member with expertise in survey development was consulted, and upon review of survey settings in

Qualtrics™, it was noted that the “bot detection” setting was not enabled on the survey. The survey settings were updated following this incident, and subsequently, 411 responses were discarded during data analysis. According to Qualtrics™ (2024), bots are a threat to data quality and will complete many surveys in a short period of time. Qualtrics™ (2024) recommends that these responses be analyzed, discarded, and subsequently reported in the findings. In addition to the bot responses, there were 34 blank surveys, which were removed from analysis. Additionally, 32 surveys only included demographic information, and as these responses were incomplete, they were subsequently removed from data analysis. This left 382 survey responses in this study.

Recruitment

Participants were selected through a respondent-driven sampling (RDS) technique, which is a form of network sampling introduced by Heckathorn in 1997 (Heckathorn & Cameron, 2017). RDS is a rigorous sampling technique that collects chain-referral data which is used to locate samples that might be difficult to obtain (Haber & Singh, 2018; Heckathorn, 2011; Tiffany, 2006). This strategy evolved from snowball effect sampling and takes advantage of social and/or professional networks (Haber & Singh, 2018; Heckathorn & Cameron, 2017). Participants have a central role in recruiting and are encouraged to share the relevant study information with others in their networks who have similar characteristics (Haber & Singh, 2018). Researchers collaborate with formal and/or informal stakeholder organizations, who are known as “seeds”, and they subsequently identify and recruit potential study participants with diverse perspectives (Tiffany, 2006). Because a targeted sampling approach was utilized in this study, caution has been taken not to attempt to generalize research findings from this research to the larger populations of RNs in Canada.

Invitations to participate in this study were sent to all Canadian provincial and territorial nursing associations and regulatory bodies, national nursing associations, and nursing specialty and interest groups in Canada through email (see recruitment posters in Appendix B). Below is the list of all invited organizations:

- College of Registered Nurses of Alberta
- Alberta Association of Nurses
- Nurses and Nurse Practitioners of British Columbia
- College of Registered Nurses of Saskatchewan
- Association of Regulated Nurses of Manitoba
- Yukon Registered Nurses Association
- Registered Nurses Association of the Northwest Territories and Nunavut
- Nurses Association of New Brunswick
- Association of Professional Nurses of Saskatchewan
- Nova Scotia College of Nursing
- College of Registered Nurses of Newfoundland and Labrador
- College of Nurses of Ontario
- British Columbia College of Nurses and Midwives
- Prince Edward Island Nurses' Union
- United Nurses of Alberta
- BC Nurses' Union
- Saskatchewan Union of Nurses
- Manitoba Nurses Union

- Ontario Nurses Association
- Registered Nurses Association of Ontario
- Ordre des infirmières et infirmiers du Québec
- Nova Scotia Nurses' Union
- New Brunswick Nurses Union
- Registered Nurses' Union of Newfoundland & Labrador
- Canadian Nurses Foundation
- Community Health Nurses of Canada
- Canadian Nurses Association
- Canadian Federation of Nurses Unions
- Canadian Association of Critical Care Nurses
- National Emergency Nurses Association
- Canadian Council of Cardiovascular Nurses
- Canadian Association for Occupational Health Nurses
- Canadian Society of Gastroenterology Nurses
- Canadian Gerontological Nursing Association
- Canadian Association of Nurses in Oncology
- Canadian Palliative Care Nurses Association
- Canadian Association of Medical and Surgical Nurses
- Canadian Association of Nephrology Nurses and Technologists
- Canadian Orthopedic Nurses Association
- Canadian Association of Pediatric Nurses

- National Association of Paraneesthesia Nurses of Canada
- Canadian Association of Perinatal and Women’s Health Nurses
- Operating Room Nurses Association of Canada
- Canadian Federation of Mental Health Nurses
- Nurses Specialized in Wound, Ostomy and Continence Canada
- Canadian Association of Schools of Nursing
- Canadian Indigenous Nurses Association
- Canadian Association of Nurses for the Environment
- Alberta Primary Care Nurses Association
- WNRCASN

The initial email was sent to the above-listed organizations on August 30, 2023. Fifteen organizations responded positively to the invitation to participate, and indicated they would distribute the survey to their members. Ten organizations declined to distribute the survey, citing privacy legislation or inability to distribute items unrelated to the organization to members. Four organizations indicated they would distribute the survey for a fee, which was not feasible in this research study. A second email was sent on September 27, 2023, to organizations that did not respond to the initial email, and positive responses were received from an additional six organizations.

An additional email was sent on October 12, 2023, to organizations who had not responded to earlier emails, as well as organizations willing to assist with recruitment, to inquire whether they would be willing to send out the notice to members again or include the invitation to participate in monthly newsletters until December 2023. All organizations were willing to do so. Furthermore, social media, such as Facebook and Instagram, were utilized, where research

announcements were posted to five national networks of HCPs and RNs that I was a member of on three occasions between August 30, 2023, and December 10, 2023 (see recruitment posters in Appendix B). The survey was closed on December 15, 2023, given that minimal survey responses were received in December 2023.

Qualtrics Survey

The cross-sectional, web-based survey was distributed to participants using Qualtrics™. Participants could either click the unique anonymous link to the survey or use the QR code generated for the survey. Participants were unable to submit multiple submissions. Given that the target population was practicing RNs across Canada, a cross-sectional survey, distributed online, was appropriate.

Advantages to online survey tools, such as Qualtrics™, are that it can ensure anonymity, it is cost-effective, participants can complete the survey at a convenient time, and researchers can access a large sample size over a widespread geographical area (O'Connor, 2022; Polit & Beck, 2020; Sullivan-Bolyai et al., 2018). Furthermore, participant time is reduced, and data collection can be completed in an efficient manner (Sullivan-Bolyai et al., 2018), which was a significant advantage for nurses in the current context.

Disadvantages can include computer illiteracy among participants, low response rates, and missing data (Sullivan-Bolyai et al., 2018). A discussion of the process addressing missing data in the survey is presented earlier in this chapter. An assumption made about Canadian RNs is that in general they are computer literate given the nature of their employment. However, a low response rate was a significant concern given the current nursing landscape in Canada following the COVID-19 pandemic.

Statistics demonstrate that more nurses have been working overtime, and nurses are working significantly more overtime hours (Statistics Canada, 2024). A Canadian survey in 2021 revealed that two-thirds of nurses reported they had worked three of their last five shifts without full staff, and 70% reported their workplaces were regularly over capacity (Canadian Federation of Nurses Unions (CFNU), 2022). Respondents also felt health care quality had deteriorated and 25% of nurses indicated patient safety was failing in their workplace (CFNU, 2022). Furthermore, two out of three respondents indicated their mental health was worse than the previous year, and 94% of respondents reported experiencing symptoms of burnout (CFNU, 2022). Early career nurses were the most likely to consider leaving the profession, for a variety of reasons; however, burnout was listed as the primary factor (57%) (CFNU, 2022).

Research by Bahrami (2016), although somewhat dated, found that job stress among nurses can lead to reduced creativity, decreased personal satisfaction, work fatigue, reduced energy, and overall poorer quality of life. Therefore, based on this research, an assumption can be made that nurses experiencing burnout and high levels of workplace stress may be less inclined to complete a survey, particularly if the topic does not appeal to them. To mitigate the challenges conducting research in the current Canadian context, surveys have many advantages over other research designs, such as qualitative studies involving focus groups or in-depth interviews, which require additional participant time (Creswell, 2018).

Given the above-mentioned considerations, the aim was to ensure the survey was valid and reliable, and I engaged in thorough recruitment to ensure an appropriate sample was achieved to allow for appropriate testing to occur (Coates, 2004). G*Power software was utilized to compute statistical power for different statistical tests used in data analysis (Faul et al., 2009). As I planned to conduct comparative statistics between groups, based on primary position (4

groups), level of education (5 groups), practice area (20 groups), age (10 groups), years of practice (6 groups), province/territory of practice (13 groups), location of residence (3 groups), and Indigeneity (3 groups), and each comparator contained different number of groups, it was difficult to calculate a G*Power statistic for all statistical analyses.

Based on the G*Power calculation, a sample size of 324 was needed in this study to ensure adequate power to conduct a one-way ANOVA between six independent means. Given the sample size was 382 participants in this study, the G*Power statistic was achieved for five out of the eight comparative analyses which were conducted using ANOVA. Comparative statistics for practice area, province/territory of practice, and age did not meet the recommended sample size. Since data were normally distributed, I proceeded to use a one-way ANOVA for these items as well; however, caution was taken in interpreting the findings for the comparative statistics between province/territory, age, and practice area. According to G*Power, a sample size of 500 would have been required to conduct a one-way ANOVA with 20 groups.

A financial incentive to participate was included in this survey study, as it can increase enrollment and research indicates it does not produce undue consequences (Halpern et al., 2021; Smith et al., 2019). Upon completion of the primary Qualtrics™ survey, participants were invited to complete a secondary survey, where they entered their name and contact information (email and phone number) for a chance to win one of five \$50 Amazon gift cards. This process ensured that the survey data was not linked to personal information and survey responses remained anonymous. Once the survey closed, I used a random number generator tool online to select five numbers and I used those numbers to randomly select the winning participants from the corresponding survey number in Qualtrics™. Participants were sent an email that they had

won an Amazon gift card, and upon their response confirming their email address, a \$50 e-gift card was emailed to them.

Data Management

Given that this survey was distributed to participants using Qualtrics™, anonymity of respondents was achieved. Research records will be retained for five years from the date of degree awarded which is related to the research project (University of Alberta, 2013; University of Lethbridge, 2023). Data will be stored on a secure, password-protected and encrypted, work laptop. Data will also be stored in the Federated Research Data Repository (FRDR), so it is available to other researchers following the study (FRDR, 2023).

Data Analysis

Data was analyzed using Statistical Package for the Social Sciences (SPSS), which is a statistical software platform, and has the capability to perform advanced statistical procedures (IBM, n.d.). Missing variables were replaced with the median in survey items 26, 27, 28, 29, 30, 31, 32, 33, 34, and 35, as there were 3-4% of missing variables in each item and variables were missing in a non-random manner. Missing variables were replaced with the median in questions 38, 39, 40, and 42, as there was over 5% of missing variables for those items and the data was classified as ordinal.

Descriptive statistics were generated for initial analysis of all survey responses, which are presented in Chapter Four. Statistical significance was defined as $p < 0.05$. In addition, tests of difference and association were conducted, namely one-way analysis of variance (ANOVA), analysis of covariance (ANCOVA), Kruskal-Wallis, and Chi-square tests, discussed below.

As outlined earlier in this chapter, controversy exists on the ability of researchers to convert ordinal data, such as Likert scales, to interval data, and conduct univariate and

multivariate parametric tests on the data (Carifio & Perla, 2008). Some experts suggest that sample size is the determining factor in whether non-parametric or parametric tests can be used to analyze Likert scale data. If the sample size is adequate and the data is normally distributed, parametric tests can be used (Jamieson, 2004; Sullivan & Artino, 2013).

Researchers commonly collect data from a sample of a total population, and parametric tests can determine statistical significance of variables, based on assumptions about normal distribution (Sullivan & Artino, 2013). Non-parametric tests do not assume normal distribution, and thus require a larger sample size than parametric test to achieve a similar statistical power to detect significant difference or associations (Sullivan & Artino, 2013). Therefore, descriptive statistics like mean and standard deviation can be inappropriate ways to accurately represent Likert scale data when normality is violated, and in this case the median or mode should be used as a measure of central tendency for Likert scales (Jamieson, 2004; Sullivan & Artino, 2013).

Conversely, according to Carifio & Perla (2008), treating Likert scale data as ordinal prevents the use of more sophisticated and powerful modes of analyses, which can limit the rich, powerful, and more nuanced understanding of the data. Carifio and Perla (2008) contend that it is appropriate to describe Likert scale data using means and standard deviations, and parametric tests, such as ANOVA can be used to analyze Likert scale data. Additionally, they believe it is acceptable to calculate Pearson correlation coefficients using Likert scale summative ratings, and use these correlations for various multivariate techniques, such as multiple regression, factor analysis, and meta-analysis, which can provide more powerful analysis of Likert scale data (Carifio & Perla, 2008).

This view is shared by Norman (2010), who believed that parametric tests can be used with ordinal data, such as Likert scales, as they are more robust and tend to give the correct

answer, regardless of whether there are extreme violations to statistical assumptions, such as normal distribution of data. Furthermore, Rickards, Magee, and Artino (2012) established it is acceptable to create Likert groups, and create “survey scales”, where the total score or mean score for the selected scale items is calculated using tests such as the Cronbach alpha, Kappa test, or factor analysis to determine how intercorrelated the components of the scale are and that the grouped items measure the appropriate variable.

The Shapiro-Wilk statistic was used to determine normality, and the result was greater than 0.8 for all knowledge Likert scale items in the survey, which indicates the distribution of data was normal. Therefore, parametric tests, using a one-way ANOVA, were conducted to determine comparisons across demographics to answer the research questions addressing participant knowledge.

The Shapiro-Wilk statistic was also used to determine normality of attitude Likert scale items on the survey, and the result was less than 0.8 for six Likert scale items, meaning data was not normally distributed. To ensure validity and accuracy of statistical results, I proceeded to use both a parametric test (one-way ANOVA) and non-parametric test (Kruskal-Wallis) on these items. Similar results were obtained for both tests; where a significant difference between groups was found with the Kruskal-Wallis test, a significant difference was also produced with ANOVA. Given these findings, I proceeded to use parametric tests on all Likert scale items because the sample size was relatively large, with most groups containing at least 15 to 20 respondents. Additionally, non-parametric tests convert data to ranks which reduces power, and parametric tests have more statistical power than nonparametric tests, detecting a significant effect when one truly exists.

Non-parametric Kruskal-Wallis and chi-square tests were used to analyze comparisons for the remaining items in the survey, given that these questions were categorized as ordinal and nominal data. Diligence is important when analyzing data, as researchers can increase the chance of coming to the wrong conclusion about research results if the wrong statistical technique is used (Jamieson, 2004). To demonstrate objectivity and diligence throughout data analysis, procedures and results were discussed with my research supervisory committee, including a committee member who possesses expertise in the application of statistics in health sciences.

The subsequent sections of this chapter offer an examination of validity and reliability as measures of quantitative research rigour (Heale & Twycross, 2015), followed by an examination of covariates and confounding variables, as they relate to survey research.

Rigour

When conducting quantitative research, the criteria of reliability and validity are used to ensure the quality of the research (Watson, 2015). Collectively, these factors are known as rigour (Bloomfield & Fisher, 2019). Rigour can be described as the amount of control the researcher exerts to prevent the effects of extraneous or confounding variables on the dependent variable (Shields & Smyth, 2016). It can also be referred to as the quality, believability, and trustworthiness of the study findings (Lobiondo-Wood et al., 2018). However, when rigor has been established in a research study, generalizability of results must be considered with caution, as results from one sample and/or setting may not sufficiently inform practice in another area (Coates, 2004). Therefore, as research on this topic accumulates, opportunities to apply evidence into practice will also increase.

Internal and External Validity

The validity of a survey tool should be established to demonstrate that questions are worded appropriately to ensure accurate responses (O'Connor, 2022). Internal validity refers to whether an indicator (or set of indicators) designed to gauge a concept accurately measures what the researcher is interested in (Creswell, 2018; Lobiondo-Wood, Haber, & Singh, 2018; O'Connor, 2022; Vogt et al., 2012; Watson, 2015). To assess external validity, the sample should be representative of the population under study to ensure findings are generalizable to that population (Andrade, 2018; Vogt et al., 2012). Therefore, significant efforts were taken to ensure a sufficient and representative sample was achieved. However, because a convenience or targeted sampling approach was utilized in this study, caution has been taken not to attempt to generalize findings from this research.

There are three types of validity: 1) content or face, 2) construct, and 3) criterion (Creswell, 2018; Lobiondo-Wood et al., 2018; Rattray & Jones, 2007). Content validity measures comprehensiveness or domain of a construct, and whether the survey adequately assesses all aspects of the topic to be studied (Creswell, 2018; Heale & Twycross, 2015; Lobiondo-Wood et al., 2018; O'Connor, 2022). This can be achieved through expert review or using the content validity index and a modified kappa index (Andrade et al., 2020; O'Connor, 2022). According to Connelly (2016), surveys should be developed from relevant literature and at a minimum, content validity should be determined by expert review. To ensure content validity, the adapted survey was pilot tested with eight content experts who were involved in the development of the *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases* with the Canadian Association of Schools of Nursing (CASN, 2020).

Construct validity refers to the ability of the concepts of survey questions to correspond with current theory and scientific knowledge (Creswell, 2018; Lobiondo-Wood et al., 2018; O'Connor, 2022), such as the theoretical framework guiding the study. It can also be defined as the degree to which a research instrument measures the intended construct (Heale & Twycross, 2015). A discussion of the alignment of the survey questions to the planetary health theoretical framework was presented earlier in this chapter to conform to construct validity.

Factor analysis can be completed to assess construct validity on survey instruments; however, often numerous research studies are needed to evaluate construct validity of a survey tool (Lobiondo-Wood et al., 2018; O'Connor, 2022). Factor analysis can also be used to determine internal consistency, where measures of reliability are essential for validity (Vogt et al., 2014). Factor analysis is a procedure which provides information about the degree to which a set of items measures the same fundamental concept or the same measurement of a concept and assesses the extent to which the individual items on a scale cluster around one or more elements (Lobiondo-Wood et al., 2018). Construct validity was measured using factor analysis in the survey instrument, and results of the factor analysis are presented in Chapter Four.

Thirdly, criterion validity addresses the extent to which the scores in a survey measure agree with an accepted instrument, or “gold standard” that is deemed an ideal measure of the variables (O'Connor, 2022); however, according to Kesmodel (2018) and Polit and Beck (2022), this is not always possible, as there may not be reliable measures for comparison. Criterion validity can be assessed by analyzing a correlation coefficient, which tests the association between survey results and the external independent tool (O'Connor, 2022). It can also be achieved by calculating sensitivity and specificity, where sensitivity assesses the capability of a survey to detect true positives, and specificity measures the ability of a survey to discriminate all

cases of true negatives (O'Connor, 2022). In the case of this survey, criterion validity cannot be assessed, as there was no existing objective standard of an established survey instrument for this research topic.

Reliability

Reliability is concerned with the consistency of measures, such as a survey (Creswell, 2018; Heale & Twycross, 2015; O'Connor, 2022). It is the extent to which an instrument produces the same measurement each time it is used (Lobiondo-Wood et al., 2018; O'Connor, 2022; Watson, 2015). Reliability is related to consistency, accuracy, precision, and stability, and represents the ratio of accuracy to inaccuracy in a measurement, such as a survey (Lobiondo-Wood et al., 2018).

There are three reliability tests, which include: test retest, inter-rater, and internal consistency (O'Connor, 2022). First, test retest, or stability, measures the consistency of a survey over time and whether survey responses from the same participant were similar on two or more instances (Lobiondo-Wood et al., 2018; O'Connor, 2022). Stability is particularly important in longitudinal studies; however, given this survey was cross-sectional, stability testing was not conducted (Lobiondo-Wood et al., 2018; Loven Wickman et al., 2019).

Secondly, inter-rater reliability, or equivalence, measures the consistency of a survey across raters to determine if a rater scores survey items in the same way continuously (Lobiondo-Wood et al., 2018; O'Connor, 2022). Common statistical tests to determine inter-rater reliability include Cohen's kappa and the intra-class correlation coefficient (Dancey et al., 2012; Lobiondo-Wood et al., 2018; Ryu et al., 2013). This type of reliability did not apply to this survey, given the fact it was not an observational study, and different raters were not assigning rates or scores to variables.

Thirdly, internal consistency, or homogeneity, deals with the consistency of respondents in answering survey items that are measuring the same concept but asked in different ways (Creswell, 2018; Lobiondo-Wood et al., 2018; O'Connor, 2022). One of the most common tests for measuring the internal consistency of a survey is the Cronbach's alpha coefficient (Creswell, 2018; Lobiondo-Wood et al., 2018; O'Connor, 2022; Paans et al., 2010; Vogt et al., 2014). A Likert-scale response format is very suitable for testing internal consistency using a Cronbach's alpha because the values for Cronbach's alpha coefficient range from 1 (indicating perfect internal reliability) to 0 (indicating none) (Lobiondo-Wood et al., 2018). This coefficient tests how closely the survey responses are related and a value of over 0.7 is used to mark the acceptable level of internal reliability (Lobiondo-Wood et al., 2018; Nunnally, 1978; Vogt et al., 2014). According to Vogt and colleagues (2014), factor analysis can also be used to measure internal consistency to determine if questions are measuring the same underlying concept, and therefore factor analysis was also conducted in this survey, with reported results in Chapter Four.

To measure internal consistency of the survey, Cronbach's alpha coefficient tests were conducted. For the knowledge Likert-scale items of the survey, the result was 0.934, whereas the score was 0.822 for the attitude Likert-scale items on the survey. For all ordinal questions in the survey, the Cronbach's alpha was 0.894. These results indicate that the survey demonstrated an acceptable level of internal reliability.

There is a recently developed comprehensive survey reporting guideline, called Checklist for Reporting of Survey Studies (CROSS), which enhances transparency and replicability of survey research, and can be incorporated into nursing research to ensure survey studies are better designed, conducted, and reported (Sharma et al., 2021). To demonstrate transparency and

replicability of the survey study, the CROSS checklist, developed by Sharma et al. (2021) was completed (See Appendix C).

Covariation & Confounding Variables

Well-constructed cross-sectional surveys establish covariation, which can reveal relationships between variables (Spector, 2019). Covariates are variables that influence the outcome but are not relevant to the research question, and therefore the researcher should control for them because this can increase statistical power and improve accuracy of results (Vogt et al., 2014). A covariate correlates with the dependent variable and can either be an independent variable or a confounding variable (Kellett, 2018; Vogt et al., 2014).

In cross-sectional studies, confounding occurs when a variable is correlated with the exposure and affects the outcome (Wang & Cheng, 2020). Confounding variables are extraneous variables which are distributed unequally among groups being compared, and affect both the independent and dependent variables, creating erroneous results where the actual association of concern is either over- or under-represented (Asiamah et al., 2021). Cross-sectional studies are expected to control for potential confounders to ensure internal validity is achieved (Asiamah et al., 2021). Confounding variables must meet three conditions: 1) an association with the exposure being studied, 2) an association with the outcome being studied, and 3) not in the causal path between exposure and outcome (Wang & Cheng, 2020).

Multivariable regression analysis or binary logistic regression, such as an ANCOVA, can be conducted to control for confounding by including the covariates as control variables (Asiamah et al., 2021; Wang & Cheng, 2020; Williams, 2016; Vogt et al., 2014). The regression model is developed for the outcome and exposure, as well as other confounding variables. Based on the regression equation, the effect of the variable of study can be statistically analyzed with

confounding variables that are held constant (Wang & Cheng, 2020). When analyzing cross-sectional survey data for associations between an exposure and an outcome, researchers should be careful not to make causal inferences. If this occurs, selection and information bias and confounding are present (Kesmodel, 2018).

SPSS was utilized to explore any confounding variables in the study, and it was determined that education level appeared to be a confounder for province/territory of registration, for the total attitude Likert scale score ($p = 0.006$). To ensure validity and accuracy of statistical results, I proceeded to use a one-way ANCOVA on this item.

Cross-sectional researchers must view potential confounders as primary threats to internal validity that must be adjusted for to avoid inaccurate conclusions. The sample in the research study should be representative of the population, so results are generalizable to the whole population, and not biased based on characteristics of survey respondents (Andrade, 2018; Vogt et al., 2012). Through controlling for the confounding variable, discussed above, the results of this research study are valid and provide meaningful insights into the topic of research.

Ethical Procedures

Ethical approval for this research study was sought and granted through the appropriate Research Ethics Office at the University of Alberta (see Appendix D). A cover letter outlining the study purpose, informed consent, the principal investigator's contact information, and ethics committee contact details was included in the QualtricsTM Survey (see Appendix E). The consent document explains that participants can opt to exit the survey at any time without their data being recorded prior to submitting the survey. Once the survey was submitted, the option to withdraw was prevented. Participant remained anonymous; however, unidentifiable demographic

information was collected on respondents. Participants were required to consent to the survey before submitting responses.

Summary

This chapter provides a detailed overview of the methodology of the research study. This quantitative study utilized a cross-sectional KAP survey as the research design and Planetary Health as the theoretical framework to explore the KAP of RNs in Canada towards climate driven VBDs. Given the emerging health threats related to climate change in Canada, research in this area is necessary to preserve human and planetary health.

CHAPTER FOUR: RESEARCH FINDINGS

This chapter presents the research findings of this study, including demographic information of study participants. There were a total of 859 responses to the national survey. In addition to the approximately 400 bot responses, there were 34 blank surveys, which were removed from analysis. A further 32 surveys included demographic information only, and as these responses were incomplete, they were subsequently removed from data analysis. This left 382 survey responses in this study. Based on G*Power software computations for statistical tests (Faul et al., 2009), a sample size of 324 was needed in this study to ensure adequate power to conduct a one-way ANOVA between six independent means. Details on limitations of the sample size are included in Chapter Three.

Demographics

The first section of the survey contained questions about participants and their practice setting. Demographic information of study participants is depicted in Table 4.1 below. Most (67.8%) survey respondents indicated that they worked as a frontline care provider. Highest level of education varied, with 66.8% of respondents holding a baccalaureate degree. A wide range of practice areas were listed on the survey tool, and areas with the highest responses included educational institutions (9.2%), medical-surgical nursing (11.8%), public health (13.4%), and other (16.2%), where the participants indicated specialty practice areas including clinical informatics, cardiology, hemodialysis, global health, corrections, and wound and ostomy care. Respondents' ages ranged from 20 years to 66+ years of age, with the most frequent category being those aged between 36 and 45 (31.4%). Years of practice as an RN also varied, where most participants indicated they had practiced between 11-20 years (30.1%). Survey responses were received from all provinces and territories in Canada, except from Prince Edward Island. The

highest number of respondents were from Alberta (32.7%) and British Columbia (21.2%), with Nova Scotia (12.8%) and Saskatchewan (11.8%) close behind. Most respondents indicated that they lived in an urban setting (69.4%), and 35 (9.2%) respondents declared as Indigenous, Metis, or Inuit.

Table 4.1

Demographic Characteristics of Study Participants (n = 382)

Characteristics	n (%)
Primary Position	
Frontline Care Provider	259 (67.8)
Nurse Educator	63 (16.5)
Nurse Manager	17 (4.5)
Other	43 (11.3)
Highest Level of Education	
Diploma	34 (8.9)
Baccalaureate Degree	255 (66.8)
Master's Degree	71 (18.6)
PhD	17 (4.5)
Other	5 (1.3)
Current Primary Practice Area	
Critical Care	22 (5.8)
Educational Institution	35 (9.2)
Emergency Department	21 (5.5)
Geriatrics	21 (5.5)
Home Health	23 (6.0)
Hospice Care	1 (0.3)
Medical-Surgical	45 (11.8)
Mental Health	15 (3.9)
Neonatal Care	6 (1.6)
Obstetrics	12 (3.1)
Occupational Health	12 (3.1)
Oncology	7 (1.8)
Operating Room	12 (3.1)
Orthopedics	1 (0.3)
Pediatrics	14 (3.7)
Primary Care	17 (4.5)
Public Health	51 (13.4)
School Nursing	4 (1.0)
Travel Nursing	1 (0.3)
Other*	62 (16.2)
Age	
20-25	32 (8.4)
26-30	45 (11.8)
31-35	54 (14.1)
36-40	62 (16.2)
41-45	58 (15.2)
46-50	34 (8.9)
51-55	43 (11.3)

56-60	32 (8.4)
61-65	14 (3.7)
66+	8 (2.1)
Years of Practice as a Registered Nurse	
Less than 5	70 (18.3)
5-10	80 (20.9)
11-20	115 (30.1)
21-30	57 (14.9)
31-40	45 (11.8)
41 or more	15 (3.9)
Province or Territory of Registration and Practice	
British Columbia	81 (21.2)
Alberta	125 (32.7)
Saskatchewan	45 (11.8)
Manitoba	8 (2.1)
Ontario	35 (9.2)
Quebec	14 (3.7)
Nova Scotia	49 (12.8)
Prince Edward Island	0 (0.0)
New Brunswick	4 (1.0)
Newfoundland & Labrador	16 (4.2)
Nunavut	1 (0.3)
Northwest Territories	1 (0.3)
Yukon Territory	3 (0.8)
Where do you live?	
Urban Setting	265 (69.4)
Rural Setting	112 (29.3)
Unsure	2 (0.5)
Are you Indigenous, Metis, or Inuit?	
Yes	35 (9.2)
No	335 (87.7)
Prefer not to answer	12 (3.1)

n = 382 total responses *Free text response

Indigenous, Metis, and Inuit Demographic Characteristics

The study findings revealed greater knowledge of climate change and VBD, as well as increased awareness of, confidence toward, preparedness, and experiences with VBDs in practice demonstrated by Indigenous, Metis, and Inuit participants, discussed in greater detail in this chapter. To gain a better understanding of the characteristics of Indigenous, Metis, and Inuit participants in the study, demographic information is presented in Table 4.2 below.

Table 4.2***Demographic Characteristics of Indigenous, Metis, and Inuit Participants (n = 35)***

Characteristics	n (%)
Primary Position	
Frontline Care Provider/Staff Nurse	22 (62.9)
Nurse Educator	11 (31.4)
Nurse Manager	2 (5.7)
Highest Level of Education	
Diploma	2 (5.7)
Baccalaureate Degree	22 (62.9)
Master's Degree	9 (25.7)
PhD	2 (5.7)
Current Primary Practice Area	
Critical Care	2 (5.7)
Educational Institution	11 (31.4)
Geriatrics	1 (2.9)
Home Health	4 (11.4)
Medical-Surgical	4 (11.4)
Mental Health	3 (8.6)
Obstetrics	1 (2.9)
Occupational Health	1 (2.9)
Oncology	2 (5.7)
Pediatrics	1 (2.9)
Primary Care	1 (2.9)
Public Health	2 (5.7)
School Nursing	1 (2.9)
Other*	1 (2.9)
Age	
20-25	1 (2.9)
26-30	4 (11.4)
31-35	4 (11.4)
36-40	9 (25.7)
41-45	9 (25.7)
46-50	2 (5.7)
51-55	2 (5.7)
56-60	1 (2.9)
61-65	1 (2.9)
66+	2 (5.7)
Years of Practice as a Registered Nurse	
Less than 5	5 (14.3)
5-10	9 (25.7)
11-20	14 (40.0)
21-30	1 (2.9)
31-40	2 (5.7)
41 or more	4 (11.4)
Province or Territory of Registration and Practice	
British Columbia	8 (22.9)
Alberta	12 (34.3)
Saskatchewan	3 (8.6)
Ontario	4 (11.4)
Quebec	4 (11.4)
Nova Scotia	1 (2.9)

New Brunswick	2 (5.7)
Newfoundland & Labrador	1 (2.9)
Where do you live?	
Urban Setting	31 (88.6)
Rural Setting	4 (11.4)

35 responses *Free text response

Knowledge of Climate-Driven Vector-Borne Diseases

The second section of the survey assessed current perceived knowledge of the most common climate sensitive VBDs in Canada. Almost 95% percent of respondents were aware that VBDs are caused by viruses, bacteria, or parasites that are transmitted to humans from animals or insects. 298 (78%) of respondents knew that Lyme disease and WNV are the two most prevalent VBDs in Canada, while 26 (7%) of respondents believed this statement was false, and 57 (15%) were unsure. Only 13% of participants indicated that they completed continuing education or formal education on climate sensitive VBDs. Responses are indicated in Table 4.3 below.

Table 4.3

Knowledge of Vector-Borne Diseases

Survey Item	True/Yes n (%)	False/No n (%)	Unsure n (%)
Vector-borne diseases are caused by viruses, bacteria, or parasites that are transmitted to humans from animals or insects.	361 (94.5)	7 (1.8)	13 (3.4)
Lyme disease and West Nile virus are the two most prevalent vector-borne diseases in Canada.	298 (78.0)	26 (6.8)	57 (14.9)
Have you completed any continuing education or formal education on climate-sensitive vector-borne diseases?	51 (13.4)	323 (84.6)	8 (2.1)

Total Responses n = 382

Considerations in Nursing Care

Participants' responses to survey items addressing considerations in care about climate change and VBDs varied and are depicted in Table 4.4 below. For each question, approximately half of the respondents indicated they do not see patients, which is understandable given the number of participants who indicated they worked in nursing practice areas outside of frontline care.

Table 4.4

Considerations in Nursing Care

Survey Item	Never n (%)	Rarely n (%)	Sometimes n (%)	Often n (%)	Always n (%)	I Don't Know n (%)	I Don't See Patients n (%)
When you care for patients or clients with Lyme disease, how often do you consider that climate change is playing a role in causing or exacerbating the condition?	29 (7.6)	37 (9.7)	55 (14.4)	53 (13.9)	27 (7.1)	4 (1.0)	176 (46.1)
When you care for patients or clients with West Nile virus, how often do you consider that climate change is playing a role in causing or exacerbating the condition?	24 (6.3)	35 (9.2)	41 (10.7)	34 (8.9)	26 (6.8)	4 (1.0)	217 (56.8)

Total Responses = n = 382

Descriptive Statistics of Knowledge Likert-scale Items

Many questions in the knowledge section of the survey were Likert-scale items, and participants indicated their level of agreement or disagreement with the statements (see Table 4.4 below). 204 (53%) participants either strongly agreed or agreed with the statement, "I feel knowledgeable about climate change and subsequent health implications." 149 (39%) of respondents strongly agreed and agreed with feeling knowledgeable about epidemiology of

Lyme disease in Canada, while 174 (46%) participants disagreed or strongly disagreed with this statement. When asked about knowledge of epidemiology of WNV, 92 (24%) of participants marked strongly agree or agree, while 224 (59%) marked disagree or strongly disagree.

Knowledge of primordial, primary, secondary, tertiary, and quaternary prevention also varied, with 220 (58%) participants lacking knowledge of prevention of Lyme disease and 254 (67%) lacking knowledge of prevention of WNV in Canada. 258 (68%) of respondents were knowledgeable about transmission of Lyme disease, and 191 (50%) were knowledgeable about transmission of WNV. Knowledge about diagnosis of Lyme disease and WNV varied, with 168 (44%) of participants lacking knowledge of diagnosis of Lyme disease, and 222 (58%) lacking knowledge of WNV diagnosis. 141 (37%) of respondents marked strongly agree or agree with the statement about knowledge of treatment of Lyme disease, while 81 (21%) of respondents felt they were knowledgeable on treatment of WNV. Knowledge on the controversies in treatment of Lyme disease in Canada also varied, with 125 (33%) of participants indicating they were aware of the controversies, while 185 (49%) of participants indicated no awareness. The final Likert scale question in this section measured participant desire to increase knowledge of VBDs, to which 218 (57%) of respondents marked strongly agree or agree. It is also important to note that there were a significant percentage of neutral responses to each of the Likert scale questions in this section, (ranging from 12% to 25%) as depicted in the Table 4.5 below.

Table 4.5*Likert Scale Items - Knowledge of Climate Sensitive VBDs*

Likert-Scale Survey Item	Strongly Agree n (%)	Somewhat Agree n (%)	Neither Agree nor Disagree n (%)	Somewhat Disagree n (%)	Strongly Disagree n (%)
I feel knowledgeable about climate change and subsequent health implications.	47 (12.3)	157 (41.1)	53 (13.9)	89 (23.3)	35 (9.2)
I feel knowledgeable about epidemiology of Lyme disease in Canada.	28 (7.3)	121 (31.7)	57 (14.9)	109 (28.5)	65 (17.0)
I feel knowledgeable about epidemiology of West Nile virus in Canada.	25 (6.5)	67 (17.5)	65 (17.0)	135 (35.3)	89 (23.3)
I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of Lyme disease in Canada.	25 (6.5)	81 (21.2)	53 (13.9)	106 (27.7)	114 (29.8)
I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of West Nile virus in Canada.	17 (4.5)	56 (14.7)	53 (13.9)	120 (31.4)	134 (35.1)
I feel knowledgeable about transmission of Lyme disease in Canada.	58 (15.2)	200 (52.4)	50 (13.1)	47 (12.3)	24 (6.3)
I feel knowledgeable about transmission of West Nile virus in Canada.	41 (10.7)	150 (39.3)	53 (13.9)	80 (20.9)	54 (14.1)
I feel knowledgeable about diagnosis of Lyme disease in Canada.	35 (9.2)	116 (30.4)	60 (15.7)	114 (29.8)	54 (14.1)
I feel knowledgeable about diagnosis of West Nile virus in Canada.	23 (6.0)	68 (17.8)	67 (17.5)	129 (33.8)	93 (24.3)
I feel knowledgeable about treatment of Lyme disease in Canada.	32 (8.4)	109 (28.5)	53 (13.9)	109 (28.5)	75 (19.6)

I feel knowledgeable about treatment of West Nile virus in Canada.	22 (5.8)	59 (15.4)	47 (12.3)	131 (34.3)	120 (31.4)
I feel knowledgeable about the controversies in treatment of Lyme disease in Canada.	33 (8.6)	92 (24.1)	70 (18.3)	103 (27.0)	82 (21.5)
Increasing my knowledge of climate-sensitive vector-borne diseases is a priority for me.	59 (15.4)	159 (41.6)	94 (24.6)	52 (13.6)	18 (4.7)

Total Responses n = 382

Overall Knowledge Scores

Several variables were recoded into reverse order to obtain an overall knowledge score, as well as scores on knowledge of both Lyme disease and WNV. The total possible knowledge score of twelve Likert scale items in the knowledge section of the survey was 60, while the minimum possible score was 12. The mean knowledge score for respondents was 33.11 ($SD = 11.21$) or 55.2%, while the median score was 32, and the modal score was 34. Similar results were obtained when including survey items nine and ten, namely knowledge of VBDs, with the 12 Likert scale items. Maximum possible knowledge score was 64, while the minimum score was 14. The mean overall knowledge score was 36.75 ($SD = 11.296$) or 57.4%, the median was 36, and the mode was 38.

The total possible score of five Likert scale items on Lyme disease knowledge was 25, while the minimum score was 5. The mean Lyme disease knowledge score for respondents was 14.54 ($SD = 5.23$) or 58.2%, while the median was 15, and the mode was 11. The total possible score of five Likert scale items on WNV knowledge was 25, while the minimum score was 5. The mean WNV knowledge score for respondents was 12.57 ($SD = 5.26$) or 50.3%, while the median was 12, and the mode was 10. Participants reported a higher overall knowledge of Lyme

disease compared to WNV, when comparing the mean for each disease. Results are presented in Table 4.6 below.

Table 4.6

Total Knowledge Scores

	Total Knowledge Likert Items (12 items)	Total Knowledge Score (14 items)	Lyme Disease Knowledge Score (5 items)	West Nile Virus Knowledge Score (5 items)
n	371	371	373	377
Missing	11	11	9	5
Mean	33.11	36.75	14.544	12.570
Median	32.00	36.00	15.00	12.00
Mode	34.00	38.00	11.00	10.00
Standard Deviation	11.21	11.30	5.23	5.26
Minimum	12.00	14.00	5.00	5.00
Maximum	60.00	64.00	25.00	25.00

Knowledge Variations

The Shapiro-Wilk statistic was used to determine normality, and the result was greater than 0.8 for all Likert scale items in this section, which indicates the distribution of data was normal. Therefore, Parametric tests, using a one-way analysis of variance (ANOVA), were conducted to determine comparisons across demographics to answer the following research question: “Does knowledge of climate sensitive VBD vary by position, education, practice area, age, years of practice, province/territory, urban/rural setting, and Indigeneity. Each Likert scale item and the total knowledge scores, with post hoc pairwise using Tukey’s/Dunnett’s C tests for significant ANOVA results ($p = <0.05$) are presented in Table 4.7 below.

SPSS was also utilized to explore any confounding variables; however, there did not appear to be any confounders in this section of the survey. Confounding variables are extraneous variables which are distributed unequally among groups being compared, and affect both the

independent and dependent variables, creating erroneous results where the actual association of concern is either over- or under-represented (Asiamah et al., 2021). Cross-sectional studies are expected to control for potential confounders to ensure internal validity is achieved (Asiamah et al., 2021).

Likert-Scale ANOVA Results

Significant differences for the item “I feel knowledgeable about climate change and subsequent health implications” were found, where frontline staff reported feeling less knowledgeable than nurse educators, while those with a PhD and master’s degree felt more knowledgeable than those with a diploma. Significantly higher perceptions of knowledge were also reported by those in educational institutions compared to medical/surgical, geriatrics, occupational health, and those who listed their practice area as “other”. Significant differences were noted between three provinces, where knowledge ranked highest in Quebec, followed by British Columbia and Saskatchewan. Additionally, significant higher knowledge was found between nurses who identified as Indigenous, Metis, or Inuit compared to participants who were not.

For the item: “I feel knowledgeable about the epidemiology of Lyme disease in Canada”, perceived knowledge was significantly higher among public health nurses compared to those who marked their practice area as “other”, statistically higher among nurses aged 51-55 compared to those aged 56-60, and statistically higher among nurses who reported that they were Indigenous, Metis, or Inuit. Significant differences were noted between provinces, where knowledge ranked higher among RNs in Quebec, followed by Ontario, Nova Scotia, British Columbia, Alberta, and Saskatchewan.

The item: “I feel knowledgeable about the epidemiology of West Nile virus in Canada” also produced several significant results, where nurse managers reported greater knowledge than frontline care providers and nurses practicing in educational institutions indicated significantly greater knowledge than those who marked their practice area as “other”. Nurses who indicated that they were Indigenous, Metis, or Inuit also reported significantly higher knowledge than those who were not or preferred not to answer. Knowledge ranked significantly higher in Quebec and Ontario, followed by British Columbia, Saskatchewan, Nova Scotia, and Newfoundland & Labrador.

Significant differences were noted between provinces for the item “I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of Lyme disease in Canada”, where nurses in Quebec reported significantly higher overall knowledge, followed by Nova Scotia Ontario, British Columbia and Alberta, and Saskatchewan with the lowest reported knowledge. Furthermore, Indigenous, Metis, and Inuit nurses reported significantly higher knowledge than participants who were not.

There were more significant results for the item: “I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of West Nile virus in Canada.” Significantly higher knowledge was reported by nurse managers than frontline care providers, and for nurses working in educational instructions compared to those in emergency departments and those who classified their practice area as “other”. Mean scores for provinces also differed significantly, where nurses in Quebec ranked highest for knowledge compared to those in British Columbia, Nova Scotia, Saskatchewan, Newfoundland and Labrador, and Nunavut and the Territories. Indigenous, Metis, and Inuit nurses reported significantly higher knowledge than participants who were not and those who preferred not to answer the question.

Knowledge of the transmission of Lyme disease in Canada varied significantly across provinces, with significantly higher knowledge reported by nurses in Nova Scotia compared to Alberta and Newfoundland and Labrador. Knowledge of the transmission of WNV also differed, with nurses in Manitoba reporting significantly higher knowledge, followed by Quebec, Saskatchewan, Ontario, Alberta, Nova Scotia, and lastly, Newfoundland and Labrador.

Significant differences among ethnicity and provinces were found with the item “I feel knowledgeable about diagnosis of Lyme disease in Canada”, where Indigenous, Metis, and Inuit nurses reported significantly greater knowledge compared than those who did not identify with these cultural groups. Nurses in Nova Scotia and Quebec reported significantly higher knowledge than nurses in Alberta, Newfoundland and Labrador, and Saskatchewan. Knowledge of diagnosis of WNV in Canada was significantly higher for nurse managers than frontline care providers, and for Indigenous, Inuit, and Metis nurses, while significant differences were found between nurses’ knowledge in Quebec compared to Newfoundland and Labrador.

Knowledge about the treatment of Lyme disease in Canada significantly differed across provinces, with nurses in Quebec, Nova Scotia, and Ontario reporting significantly higher knowledge compared to British Columbia, Alberta, Saskatchewan, and Newfoundland and Labrador. Additionally, significant differences were noted with Indigeneity, where Indigenous, Metis, and Inuit nurses reported significantly greater perceived knowledge. Knowledge about the treatment of WNV in Canada was significantly higher for nurse managers than frontline care providers, and for Indigenous, Metis, and Inuit nurses, and differed significantly across provinces, with nurses in Quebec reporting significantly higher knowledge than nurses in British Columbia, Alberta, Saskatchewan, Nova Scotia, and Newfoundland and Labrador.

The item: “I feel knowledgeable about the controversies in treatment of Lyme disease in Canada” also produced significant differences across provinces, where nurses in New Brunswick, Nova Scotia, and Ontario reported significantly higher knowledge compared to Newfoundland and Labrador. Additionally, Indigenous, Metis, and Inuit nurses reported significantly greater knowledge for this item. Significant differences also presented for the final item: “Increasing my knowledge of climate-sensitive vector-borne diseases is a priority for me.” Nurses who practiced for 31-40 years reported this item as a significantly higher priority than nurses who practiced for 21-30 years, while nurses in Nova Scotia and Ontario indicated significantly higher priority for this item than nurses in Saskatchewan. Indigenous, Metis, and Inuit nurses also reported that this item was a significantly greater priority for them compared to others.

Significant differences across groups also existed for the total score of knowledge Likert scale items. Nurse managers reported significantly higher overall knowledge compared to frontline care providers, and those in educational institutions also had significantly higher knowledge scores than nurses who marked their practice area as “other”. Indigenous, Metis, and Inuit nurses reported significantly higher overall knowledge compared to those participants who were not, while nurses in Quebec had a significantly higher overall knowledge score than nurses in British Columbia, Alberta, Newfoundland and Labrador, and Saskatchewan.

I was also interested in determining if there were significant differences among groups for overall knowledge of both Lyme disease and WNV. For Lyme disease, significant differences existed between provinces, where nurses in Nova Scotia reported significantly higher overall knowledge compared to British Columbia, Alberta, and Saskatchewan. Nurses in Quebec also reported significantly higher overall knowledge compared to Alberta and Saskatchewan, while

nurses in Ontario reported significantly higher Lyme disease knowledge compared to Alberta and Saskatchewan, and similarly, nurses in New Brunswick reported significantly greater knowledge compared to Saskatchewan. Additionally, Indigenous, Metis, and Inuit nurses reported significantly greater knowledge compared to those who did not identify with these groups.

Significant differences also existed among groups for overall knowledge of WNv. Mean scores for frontline care providers were significantly lower than nurse educators and nurse managers, while nurses who marked their position as “other” had significantly lower knowledge than nurse managers. Significantly greater knowledge scores were found for Indigenous, Metis, and Inuit nurses compared to those who were not members of these groups or who preferred not to answer. Across provinces, nurses in Quebec had significantly higher overall knowledge compared to British Columbia, Alberta, Nova Scotia, and Newfoundland and Labrador. Nurses in Ontario also had significantly higher overall knowledge scores compared to Newfoundland and Labrador.

Table 4.7

Significant ANOVA Results of Knowledge Likert-Scale Survey Items

I feel knowledgeable about climate change and subsequent health implications.	
Primary Position	[F(3, 377) = 4.597 **] Mean score for frontline care provider (M = 2.88, SD = 1.175) was significantly different (p = 0.002) than nurse educator (M = 2.26, SD = 1.159).
Education	[F(4, 376) = 3.778 **] Mean score for diploma (M = 3.29, SD = 1.244) was significantly different (p = 0.017) than master’s degree (M = 2.52, SD = 1.240), and significantly different (p = 0.011) than PhD (M = 2.13, SD = 1.258).
Practice Area	[F(14, 366) = 2.336 **] Mean score for Educational Institutions (M = 1.97, SD = 1.087) was significantly different (p = 0.046) than Geriatrics (M = 3.10, SD = 1.136), significantly different (p = 0.008) than Medical/Surgical (M = 3.04, SD = 1.107), significantly different (p = 0.045) than Occupational Health (M = 3.33, SD = 1.435), and significantly different (p = 0.011) than Other (M = 2.95, SD = 1.193)

Province/Territory	[F(9, 371) = 2.526 **] Mean score for Saskatchewan (M = 3.18, SD = 1.230) was significantly different (p = 0.045) than British Columbia (M = 2.47, SD = 1.119), and significantly different (p = 0.022) than Quebec (M = 1.93, SD = 0.829).
Indigeneity	[F(2, 378) = 4.214 *] Mean score for Yes (M = 2.23, SD = 1.24) was significantly different (p = 0.015) than No (M = 2.82, SD = 1.19).

I feel knowledgeable about epidemiology of Lyme disease in Canada.

Practice Area	[F(14, 365) = 1.778 *] Mean score for Public Health (M = 2.69, SD = 1.260) was significantly different (p = 0.036) than Other (M = 3.49, SD = 1.216).
Age	[F(9, 370) = 2.249 *] Mean score for 51-55 (M = 2.83, SD = 1.102) was significantly different (p = 0.037) than 56-60 (M = 3.78, SD = 1.039).
Province/Territory	[F(9, 370) = 4.928 ***] Mean score for Saskatchewan (M = 3.82, SD = 1.134) was significantly different (p = 0.040) than British Columbia (M = 3.10, SD = 1.190), significantly different (p = <0.001) than Nova Scotia (M = 2.73, SD = 1.221), significantly different (p = <0.001) than Ontario (M = 2.60, SD = 1.193), and significantly different (p = 0.006) than Quebec (M = 2.43, SD = 1.016). Mean score for Ontario (M = 2.60, SD = 1.193) was also significantly different (p = 0.039) than Alberta (M = 3.35, SD = 1.243).
Indigeneity	[F(2, 377) = 10.72 ***] Mean score for Yes (M = 2.29, SD = 1.27) was significantly different (p = <0.001) than No (M = 3.27, SD = 1.22).

I feel knowledgeable about epidemiology of West Nile virus in Canada.

Primary Position	[F(3, 114) = 4.167 **] Mean score for frontline care provider (M = 3.64, SD = 1.144) was significantly different (p = 0.011) than nurse manager (M = 2.71, SD = 1.160).
Practice Area	[F(14, 149.96) = 1.677 *] Mean score for Educational Institution (M = 2.91, SD = 1.505) was significantly different (p = 0.042) than Other (M = 3.79, SD = 1.124).
Province/Territory	[F(9, 63.45) = 3.464 **] Mean score for Quebec (M = 2.43, SD = 1.399) was significantly different (p = 0.019) than British Columbia (M = 3.62, SD = 1.231); significantly different (p = 0.033) than Saskatchewan (M = 3.62, SD = 1.173); significantly different (p = 0.003) than Nova Scotia (M = 3.86, SD = 0.935); and significantly different (p = 0.001) than Newfoundland & Labrador (M = 4.25, SD = 0.683). Mean score for Ontario (M = 3.03, SD = 1.294) was also significantly different (p = 0.022) than Newfoundland & Labrado (M = 4.25, SD = 0.683).
Indigeneity	[F(2, 49.74) = 9.32 ***] Mean score for Yes (M = 2.63, SD = 1.59) was significantly different (p = <0.001) than No (M = 3.60, SD = 1.14), and was significantly different (p = 0.042) than prefer not to answer (M = 3.58, SD = 0.90).

I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of Lyme disease in Canada.

Province/Territory	[F(9, 369) = 4.418 ***] Mean score for Quebec (M = 2.43, SD = 1.089) was significantly different (p = 0.041) than British Columbia (M = 3.60, SD = 1.298); was significantly different (p = 0.027) than Alberta (M = 3.62, SD = 1.191); and significantly different (p = <0.001) than Saskatchewan (M = 4.22, SD = 1.064).
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	Mean score for Saskatchewan (M = 4.22, SD = 1.064) was significantly different (p = 0.002) than Nova Scotia (M = 3.16, SD = 1.280); and significantly different (p = 0.016) than Ontario (M = 3.23, SD = 1.395).
Indigeneity	[F(2, 376) = 10.93 ***] Mean score for Yes (M = 2.60, SD = 1.48) was significantly different (p = <0.001) than No (M = 3.64, SD = 1.24).
I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of West Nile virus in Canada.	
Primary Position	[F(3, 114.4) = 4.90 **] Mean score for frontline care provider (M = 3.91, SD = 1.130) was significantly different (p = 0.006) than nurse manager (M = 2.94, SD = 1.144).
Practice Area	[F(14, 171.73) = 2.380 **] Mean score for Educational Institution (M = 3.09, SD = 1.564) was significantly different (p = 0.020) than Emergency Department (M = 4.29, SD = 0.956), and significantly different (p = <0.001) than Other (M = 4.21, SD = 1.010).
Province/Territory	[F(9, 69.38) = 4.174 ***] Mean score for Quebec (M = 2.71, SD = 1.267) was significantly different (p = 0.016) than British Columbia (M = 3.90, SD = 1.158); was significantly different (p = 0.007) than Nova Scotia (M = 4.04, SD = 0.988); significantly different (p = 0.002) than Saskatchewan (M = 4.16, SD = 1.147); significantly different (p = 0.002) than Newfoundland & Labrador (M = 4.38, SD = 0.806); and significantly different (p = 0.021) than Nunavut & the Territories (M = 4.80, SD = 0.447).
Indigeneity	[F(2, 48.58) = 12.39 ***] Mean score for Yes (M = 2.74, SD = 1.58) was significantly different (p = <0.001) than No (M = 3.89, SD = 1.11), and was significantly different (p = 0.007) than prefer not to answer (M = 3.92, SD = 0.996)
I feel knowledgeable about transmission of Lyme disease in Canada.	
Province/Territory	[F(9, 71.18) = 3.466 ***] Mean score for Nova Scotia (M = 1.92, SD = 0.919) was significantly different (p = 0.006) than Alberta (M = 2.60, SD = 1.125); and was significantly different (p = 0.008) than Newfoundland & Labrador (M = 3.06, SD = 1.340).
I feel knowledgeable about transmission of West Nile virus in Canada.	
Province/Territory	[F(9, 368) = 3.999 ***] Mean score for Newfoundland & Labrador (M = 3.88, SD = 1.204) was significantly different (p = 0.029) than Alberta (M = 2.78, SD = 1.180); was significantly different (p = 0.07) than Saskatchewan (M = 2.53, SD = 1.079); was significantly different (p = 0.035) than Manitoba (M = 2.13, SD = 0.835); was significantly different (p = 0.017) than Ontario (M = 2.57, SD = 1.290); and was significantly different (p = 0.027) than Quebec (M = 2.36, SD = 1.277). Mean score for Nova Scotia (M = 3.42, SD = 1.235) was significantly different (p = 0.020) than Saskatchewan (M = 2.53, SD = 1.079).
I feel knowledgeable about diagnosis of Lyme disease in Canada.	
Province/Territory	[F(9, 369) = 5.311 ***] Mean score for Nova Scotia (M = 2.40, SD = 1.086) was significantly different (p = <0.001) than Alberta (M = 3.39, SD = 1.164); was significantly different (p = <0.001) than Saskatchewan (M = 3.53, SD = 1.198); and was significantly different (p = 0.043) than Newfoundland & Labrador (M = 3.50, SD = 1.211). Mean score for Saskatchewan (M = 3.53, SD = 1.198) was significantly different (p = 0.041) than Quebec (M = 2.36, SD = 1.151).
Indigeneity	[F(2, 376) = 9.67 ***] Mean score for Yes (M = 2.29, SD = 1.36) was significantly different (p = <0.001) than No (M = 3.20, SD = 1.19).
I feel knowledgeable about diagnosis of West Nile virus in Canada.	
Primary Position	[F(3, 376) = 4.526 **]

	Mean score for frontline care provider (M = 3.63, SD = 0.072) was significantly different (p = 0.003) than nurse manager (M = 2.59, SD = 0.939).
Province/Territory	[F(9, 81.14) = 2.388 *] Mean score for Newfoundland & Labrador (M = 4.19, SD = 0.834) was significantly different (p = 0.045) than Quebec (M = 2.79, SD = 1.424).
Indigeneity	[F(2, 48.86) = 7.041 **] Mean score for Yes (M = 2.74, SD = 1.58) was significantly different (p = <0.001) than No (M = 3.61, SD = 1.15).
I feel knowledgeable about treatment of Lyme disease in Canada	
Province/Territory	[F(9, 368) = 6.924 ***] Mean score for Nova Scotia (M = 2.32, SD = 1.163) was significantly different (p = <0.001) than British Columbia (M = 3.35, SD = 1.216); was significantly different (p = <0.001) than Alberta (M = 3.50, SD = 1.193); was significantly different (p = <0.001) than Saskatchewan (M = 3.71, SD = 1.218); and was significantly different (p = 0.004) than Newfoundland & Labrador (M = 3.73, SD = 1.223). Mean score for Quebec (M = 2.21, SD = 0.802) was significantly different (p = 0.042) than British Columbia (M = 3.35, SD = 1.216); was significantly different (p = 0.007) than Alberta (M = 3.50, SD = 1.193); was significantly different (p = 0.002) than Saskatchewan (M = 3.71, SD = 1.218); and was significantly different (p = 0.027) than Newfoundland & Labrador (M = 3.73, SD = 1.223). Mean score for Saskatchewan (M = 3.71, SD = 1.218) was significantly different (p = 0.042) than Ontario (M = 2.83, SD = 1.294).
Indigeneity	[F(2, 375) = 7.27 ***] Mean score for Yes (M = 2.51, SD = 1.42) was significantly different (p = 0.001) than No (M = 3.32, SD = 1.26).
I feel knowledgeable about treatment of West Nile virus in Canada.	
Primary Position	[F(3, 126.1) = 4.945 **] Mean score for frontline care provider (M = 3.85, SD = 1.154) was significantly different (p = 0.008) than nurse manager (M = 2.88, SD = 1.054).
Province/Territory	[F(9, 45.88) = 3.293 **] Mean score for Quebec (M = 2.50, SD = 1.401) was significantly different (p = 0.003) than British Columbia (M = 3.89, SD = 1.129); was significantly different (p = 0.023) than Alberta (M = 3.65, SD = 1.235); was significantly different (p = 0.022) than Saskatchewan (M = 3.76, SD = 1.151); was significantly different (p = 0.003) than Nova Scotia (M = 3.96, SD = 1.051); and was significantly different (p = <0.001) than Newfoundland & Labrador (M = 4.50, SD = 0.516).
Indigeneity	[F(2, 48.06) = 7.86 ***] Mean score for Yes (M = 2.86, SD = 1.59) was significantly different (p = <0.001) than No (M = 3.80, SD = 1.16).
I feel knowledgeable about the controversies in treatment of Lyme disease in Canada.	
Province/Territory	[F(9, 370) = 3.523 ***] Mean score for Newfoundland & Labrador (M = 4.25, SD = 0.683) was significantly different (p = 0.020) than Ontario (M = 2.94, SD = 1.282); was significantly different (p = 0.004) than Nova Scotia (M = 2.83; SD = 1.342); and was significantly different (p = 0.043) than New Brunswick (M = 2.00, SD = 1.155).
Indigeneity	[F(2, 45.27) = 6.16 **] Mean score for Yes (M = 2.57, SD = 1.52) was significantly different (p = 0.001) than No (M = 3.38, SD = 1.24).
Increasing my knowledge of climate-sensitive vector-borne diseases is a priority for me.	
Years of Practice	[F(5, 376) = 2.247 *] Mean score for 21-30 (M = 2.86, SD = 1.202) was significantly different (p = 0.015) than 31-40 (M = 2.18, SD = 0.960).
Province/Territory	[F(9, 372) = 3.660 ***]

	Mean score for Saskatchewan (M = 3.02, SD = 1.033) was significantly different (p = 0.010) than Ontario (M = 2.17, SD = 0.747); and was significantly different (p = <0.001) than Nova Scotia (M = 2.08; SD = 1.152).
Indigeneity	[F(2, 25.97) = 10.43 ***] Mean score for Yes (M = 1.80, SD = 0.797) was significantly different (p = <0.001) than No (M = 2.57, SD = 1.053), and was significantly different (p = 0.008) than prefer not to answer (M = 2.83, SD = 1.115)
Total Knowledge Likert Scale Score	
Primary Position	[F(3, 130.02) = 3.377 *] Mean score for frontline care provider (M = 32.13, SD = 10.36) was significantly different (p = 0.043) than nurse manager (M = 39.47, SD = 8.70).
Practice Area	[F(14, 356) = 2.158 **] Mean score for Educational Institution (M = 38.97, SD = 15.03) was significantly different (p = 0.017) than Other (M = 30.08, SD = 11.00).
Province/Territory	[F(9, 361) = 3.471 ***] Mean score for Quebec (M = 42.79, SD = 11.10) was significantly different (p = 0.039) than British Columbia (M = 32.46, SD = 11.00); was significantly different (p = 0.021) than Alberta (M = 32.12, SD = 11.30); was significantly different (p = 0.006) than Saskatchewan (M = 30.00, SD = 10.17); and was significantly different (p = 0.012) than Newfoundland & Labrador (M = 27.86, SD = 7.53).
Indigeneity	[F(2, 48.28) = 10.76 ***] Mean score for Yes (M = 45.51, SD = 15.62) was significantly different (p = <0.001) than No (M = 35.77, SD = 10.47).
Total Lyme Disease Knowledge Score	
Province/Territory	[F(9, 363) = 5.900 ***] Mean score for Nova Scotia (M = 20.51, SD = 5.50) was significantly different (p = 0.046) than British Columbia (M = 17.11, SD = 5.80); was significantly different (p = <0.001) than Alberta (M = 16.05, SD = 5.82); was significantly different (p = <0.001) than Saskatchewan (M = 14.51, SD = 5.28). Mean score for Quebec (M = 21.50, SD = 4.99) was significantly different (p = 0.029) than Alberta (M = 16.05, SD = 5.82); was significantly different (p = 0.003) than Saskatchewan (M = 14.51, SD = 5.28). Mean score for Saskatchewan (M = 14.51, SD = 5.28) was significantly different (p = 0.004) than Ontario (M = 19.57, SD = 6.18); was significantly different (p = 0.003) than New Brunswick (M = 24.50, SD = 5.97). Mean score for Ontario (M = 19.57, SD = 6.18) was significantly different (p = 0.048) than Alberta (M = 16.05, SD = 5.82).
Indigeneity	[F(2, 370) = 11.16 ***] Mean score for Yes (M = 18.26, SD = 6.08) was significantly different (p = <0.001) than No (M = 14.09, SD = 5.00).
Total West Nile Virus Knowledge Score	
Primary Position	[F(3, 129.76) = 5.692 ***] Mean score for frontline care provider (M = 11.99, SD = 4.95) was significantly different (p = 0.046) than nurse educator (M = 13.92, SD = 6.19), and was significantly different (p = 0.003) than nurse manager (M = 16.53, SD = 4.33). Nurse manager (M = 16.53, SD = 4.33) was significantly different (p = 0.037) than other (M = 12.52, SD = 5.12).
Province/Territory	[F(9, 367) = 4.2 ***] Mean score for Quebec (M = 17.21, SD = 6.33) was significantly different (p = 0.010) than British Columbia (M = 11.78, SD = 5.16); was significantly different (p = 0.021) than Alberta (M = 12.99, SD = 5.22); was significantly different (p = 0.002) than Nova Scotia (M = 10.90, SD = 4.48); and was significantly different (p = <0.001) than Newfoundland & Labrador (M = 8.81, SD = 3.21).

	Mean score for Ontario (M = 14.17, SD = 5.76) was significantly different (p = 0.018) than Newfoundland & Labrador (M = 8.81, SD = 3.21).
Indigeneity	[F(2, 48.59) = 8.96 ***] Mean score for Yes (M = 16.57, SD = 7.621) was significantly different (p = <0.001) than No (M = 12.17, SD = 4.83); and was significantly different (p = 0.019) than prefer not to answer (M = 11.91, SD = 3.73).

Note. * p<0.05; **p<0.01; ***p<0.001

Non-Parametric Test Results

A non-parametric chi-square test was used to analyze three items in the knowledge section of the survey, given that these data were not normally distributed and classified as nominal. A significant chi-square statistic was obtained between urban and rural settings for the following item: “Vector-borne diseases are caused by viruses, bacteria, or parasites that are transmitted to humans from animals or insects.” Follow-up pairwise comparisons using the Bonferroni correction found significant differences between rural and unsure (p = <0.01), and urban settings and unsure (p = <0.01), where knowledge was significantly higher for both urban and rural settings compared to those who were unsure about their location.

No significant differences between groups were found for the item: “Lyme disease and West Nile virus are the two most prevalent vector-borne diseases in Canada”; however, there were significant differences between groups for the item: “Have you completed any formal education on climate sensitive vector-borne diseases?”. Follow-up pairwise comparisons using the Bonferroni correction found significant differences between those who declared Indigeneity on the survey, between yes and no (p = <0.001), between yes and prefer not to answer (p = <0.05) and no and prefer not to answer (p = <0.05), where significantly more nurses who declared Indigeneity completed formal education compared to others.

A non-parametric Kruskal-Wallis test was used to analyze the remaining two items in the knowledge section of the survey, given that these data were not normally distributed and

classified as ordinal. The item: “When you care for patients or clients with Lyme disease, how often do you consider that climate change is playing a role in causing or exacerbating the condition?” produced significant differences in mean rank between groups for practice position and Indigeneity. Significant pairwise comparisons were found between nurse managers and frontline care providers ($p = <0.05$), nurse managers and other ($p = <0.05$), and nurse managers and nurse educators ($p = <0.01$). Considerations that climate change is playing a role in causing or exacerbating Lyme disease for patients were significantly higher for nurse educators and nurses who listed their position as “other” than for frontline staff and nurse managers; however, it is important to note that the increased mean for nurse educators and whose practice area was “other” was likely a result of the survey item choice selection “I don’t see patients with Lyme disease”. Significant pairwise comparisons were also found between yes and no responses for declaring Indigeneity ($p = <0.05$), where considerations were greater for “yes” than “no”. Significant differences in mean ranks between groups of provinces existed ($p = <0.05$); however, no significant pairwise comparisons were found.

The final item: “When you care for patients or clients with West Nile virus, how often do you consider that climate change is playing a role in causing or exacerbating the condition?” did not produce any significant differences by education, age, practice area, years of practice, or province/territory; however, there were significant differences in mean ranks between practice position and Indigeneity. Significant pairwise comparisons were found between nurse managers and frontline care providers ($p = <0.05$), nurse managers and other ($p = <0.05$), and nurse managers and nurse educators ($p = <0.05$). Considerations for this factor were significantly higher for nurse educators, frontline staff and other than for nurse managers, which could correlate with roles in caring for patients, where the increased mean for nurse educators, frontline

staff, and those who marked “other” was likely a result of the survey item choice selection “I don’t see patients with WNV”. For Indigeneity, significant pairwise comparisons were found between yes and no ($p = <0.01$), and yes and prefer not to answer ($p = <0.05$), with considerations higher for “yes” than “no” and “prefer not to answer”. Significant non-parametric test results are presented in Table 4.8 below.

Table 4.8

Significant Chi-Square and Kruskal-Wallis Results of Knowledge Survey Items

Vector-borne diseases are caused by viruses, bacteria, or parasites that are transmitted to humans from animals or insects.	
Urban/Rural	Significant chi-square statistic was obtained, $X^2(4, N = 378) = 19.67$ *** Significant pairwise comparisons between Urban and Unsure $X^2(2, N = 266) = 10.71$ **, and Rural and Unsure ($X^2(1, N = 114) = 27.49$ ***
When you care for patients or clients with Lyme disease, how often do you consider that climate change is playing a role in causing or exacerbating the condition?	
Primary Position	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(3, N = 381) = 11.88$ ** Significant pairwise comparisons between nurse manager and frontline care provider *, nurse manager and other *, nurse manager and nurse educator**.
Province/Territory	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(3, N = 381) = 18.41$ * No Significant pairwise comparisons.
Indigeneity	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(2, N = 381) = 6.53$ * Significant pairwise comparisons between yes and no*
When you care for patients or clients with West Nile virus, how often do you consider that climate change is playing a role in causing or exacerbating the condition?	
Primary Position	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(3, N = 381) = 11.59$ ** Significant pairwise comparisons between nurse manager and frontline care provider**, nurse manager and other*, nurse manager and nurse educator*.
Indigeneity	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(2, N = 381) = 10.86$ ** Significant pairwise comparisons between yes and no**, and yes and prefer not to answer*
Have you completed any formal education on VBDs?	
Indigeneity	Significant chi-square statistic was obtained, $X^2(2, N = 370) = 65.0$ *** Significant pairwise comparisons between yes and no, $X^2(2, N = 370) = 65.0$ ***, no and prefer not to answer, $X^2(2, N = 347) = 12.64$ **, and yes and prefer not to answer, $X^2(2, N = 47) = 9.99$ **

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Attitudes Toward Climate-Driven Vector-Borne Diseases

The third section of the survey assessed perceptions of risk for climate sensitive VBDs in Canada and degree of confidence in addressing concerns related to these diseases. This section included two questions on attitude influences, and ten Likert-scale survey items, presented in Table 4.9 below.

Descriptive Statistics of Attitude Likert-scale Items

Almost all respondents (95%) indicated their agreement with the statement: “Climate change is happening.” Most respondents (90%) also indicated that climate change directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations they care for. 312 participants (82%) were concerned about the health impacts of climate sensitive VBDs on patients, clients, families, groups, communities, and populations. 84% of respondents strongly agreed or agreed that nurses are positioned to help patients, clients, families, groups, communities, and populations understand the health impacts associated with VBDs.

Personal attitude Likert scale items varied from the responses above. 63% of respondents disagreed or strongly disagreed with the statement on feeling prepared to address VBDs with patients, clients, families, groups, communities, and populations. Over half of participants (56%) indicated they did not feel confident counselling patients, clients, families, groups, communities, and populations about climate change and health, while 258 participants (65%) lacked confidence to counsel patients, clients, families, groups, communities, and populations on climate sensitive VBDs.

The majority of participants (80%) felt that nurses should play an active role in discussing climate sensitive VBDs with patients, clients, families, groups, communities, and

populations. 293 participants (77%) also strongly agreed or agreed that Indigenous Canadians disproportionately experience negative health effects from climate change. Additionally, 90% of respondents strongly agreed or agreed that it is important for healthcare professionals to advocate for social justice by addressing socioeconomic inequities which exist among populations that are at risk of VBDs. Full results are presented in Table 4.9 below.

Table 4.9

Likert Scale Items - Attitudes Toward Climate Sensitive VBDs

Likert-Scale Survey Item	Strongly Agree n (%)	Somewhat Agree n (%)	Neither Agree nor Disagree n (%)	Somewhat Disagree n (%)	Strongly Disagree n (%)
Climate change is happening.	303 (79.3)	58 (15.2)	16 (4.2)	4 (1.0)	1 (0.3)
Climate change directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations in my care.	264 (69.1)	80 (20.9)	28 (7.3)	9 (2.4)	1 (0.3)
As a nurse, I am concerned about the health impacts of climate-sensitive vector-borne diseases on patients/clients, families, groups, communities, and populations.	171 (44.8)	141 (36.9)	47 (12.3)	19 (5.0)	4 (1.0)
Nurses are positioned to help patients/clients, families, groups, communities, and populations understand the health impacts from climate-sensitive vector-borne diseases.	202 (52.9)	119 (31.2)	40 (10.5)	15 (3.9)	6 (1.6)
I feel well prepared to address climate-sensitive vector-borne diseases with patients/clients, families, groups, communities, and populations.	29 (7.6)	56 (14.7)	57 (14.9)	154 (40.3)	86 (22.5)
I feel confident counseling patients, families, groups,	31 (8.1)	77 (20.2)	59 (15.4)	137 (35.9)	78 (20.4)

communities, and populations about climate change and health.					
I feel confident counseling patients, families, groups, communities, and populations about climate-sensitive vector-borne diseases.	27 (7.1)	44 (11.5)	53 (13.9)	147 (38.5)	111 (29.1)
Nurses should play an active role in discussing climate-sensitive vector-borne diseases with their patients/clients, families, groups, communities, and populations.	138 (36.1)	166 (43.5)	56 (14.7)	15 (3.9)	7 (1.8)
Indigenous Canadians disproportionately experience negative health effects from climate change.	174 (45.5)	119 (31.2)	60 (15.7)	17 (4.5)	12 (3.1)
It is important for healthcare professionals to advocate for social justice by addressing socioeconomic inequities which exist among populations that are at risk of vector-borne diseases.	228 (59.7)	115 (30.1)	24 (6.3)	8 (2.1)	7 (1.8)

Total Attitude Score & Participant Attitude Influences

The total attitude score of ten Likert scale items in the attitude section of the survey was 45, while the minimum possible score was 10. There were no missing values in the analysis, leaving 382 responses. The mean attitude score for respondents was 22.26 ($SD = 6.10$), while both the median and the mode was 22. The remaining two items in the attitude section of the survey inquired about views on climate change and VBDs. Participant views on climate change were influenced primarily by media, while views on VBDs were influenced primarily by professional resources. Responses are presented in the figures below.

Figure 4.1

Factors Influencing Views on Climate Change

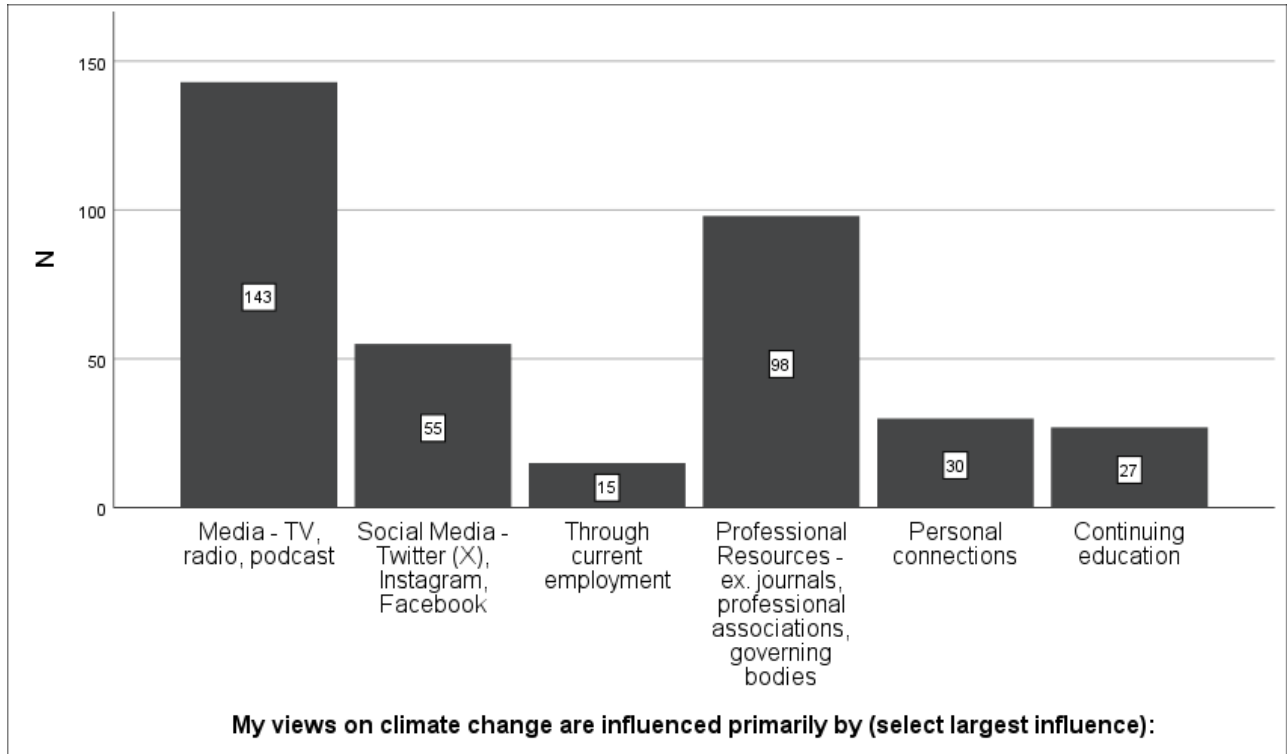
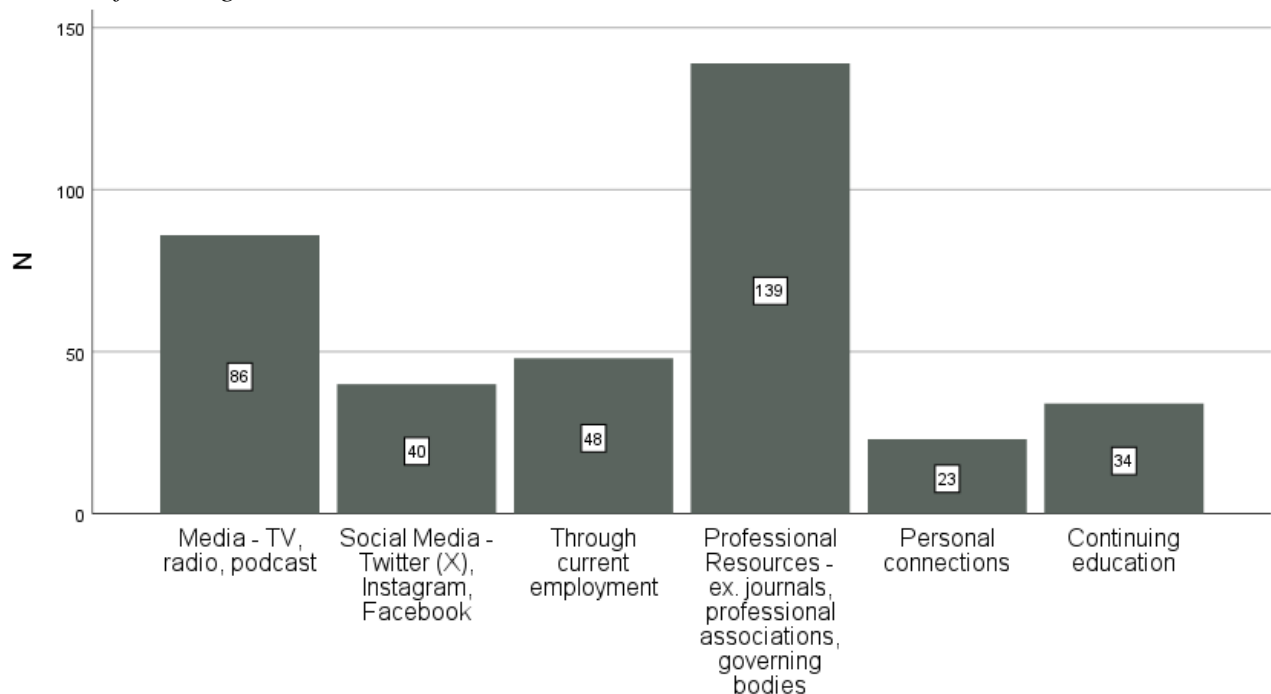


Figure 4.2

Factors Influencing Views on Vector-Borne Diseases



My views on vector-borne diseases are influenced primarily by (select largest influence):

Attitude Variations

SPSS was utilized to determine comparisons across demographics to answer the following research question: “Do attitudes toward climate sensitive VBD vary by position, education, practice area, age, years of practice, and province/territory?”. The Shapiro-Wilk statistic was used to determine normality, and the result was less than 0.8 for six Likert scale items, meaning data was not normally distributed. To ensure validity and accuracy of statistical results, I proceeded to use both a parametric test (one-way ANOVA) and non-parametric test (Kruskal-Wallis) on these items. Similar results were obtained for both tests; where a significant difference between groups was found with the Kruskal-Wallis test, a significant difference was also produced with ANOVA. Given these findings, I proceeded to use parametric tests on all

Likert scale items because the sample size was relatively large, with most groups containing at least 15 to 20 respondents. Additionally, non-parametric tests convert data to ranks which reduces power, and parametric tests have more statistical power than nonparametric tests, detecting a significant effect when one truly exists.

SPSS was also utilized to explore if there were any confounding variables in the survey items on the attitude section of the survey, and it was determined that education level appeared to be a confounder for province/territory of registration, for the total attitude Likert scale score ($p = <0.05$). To ensure validity and accuracy of statistical results, I proceeded to use a one-way ANCOVA on this item. Each Likert scale item and the total attitude score, along with post hoc pairwise comparisons using Tukey's/Dunnett's C post-hoc tests for the significant ANOVA results ($p = <0.05$), and the post hoc pairwise comparisons using Bonferroni confidence interval adjustment for the significant ANCOVA result ($p = <0.05$) are presented in Table 4.10 below.

Likert-Scale ANOVA Results

There were no statistically significant differences between groups for the Likert-scale survey item: "Climate change is happening." For the second item: "Climate change directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations in my care", significant differences were detected by level of education, where nurses with a PhD, master's degree, baccalaureate degree, and diploma agreed with the statement more than those who marked their education as "other". There was also a significant difference in practice area, where a significantly higher number of nurses in public health agreed with this statement compared to nurses working in obstetrics, and for settings, where more nurses in urban settings agreed with the statement than nurses in rural areas.

The statements: “As a nurse, I am concerned about the health impacts of climate-sensitive vector-borne diseases on patients/clients, families, groups, communities, and populations” and “Nurses are positioned to help patients/clients, families, groups, communities, and populations understand the health impacts from climate-sensitive vector-borne diseases” revealed significant differences between nurses who had a PhD and master’s degree compared to those who marked “other” for their education level. Additionally, nurses in Nova Scotia reported feeling greater concern about the health impacts of VBDs on patients, families, groups, communities, and populations compared to nurses in Saskatchewan.

Significant differences existed for the item: “I feel well prepared to address climate-sensitive vector-borne diseases with patients/clients, families, groups, communities, and populations”, where feelings of preparedness among nurses in Quebec was statistically higher than for nurses in British Columbia, Alberta, Saskatchewan, and Newfoundland and Labrador. Additionally, nurses who declared Indigeneity reported statistically greater preparedness compared to those who did not declare or preferred not to answer.

Confidence in counseling patients, families, groups, communities, and populations about climate change and health, was significantly different across practice areas, where nurses in educational facilities reported statistically greater confidence compared to those in geriatrics and “other”. Nurses in Quebec also reported statistically higher confidence for this item than nurses in Alberta, Saskatchewan, and Newfoundland and Labrador, while nurses in British Columbia reported statistically greater confidence than nurses in Saskatchewan. Significantly greater confidence was also felt by Indigenous, Metis, and Inuit nurses compared to other survey respondents.

Confidence in counseling patients, families, groups, communities, and populations about VBDs yielded similar results, where nurses in educational institutions and public health reported statistically higher confidence levels than those who indicated their practice area as “other”. Statistically higher confidence among nurses was reported in Quebec, significantly differing from Nova Scotia, British Columbia, Alberta, Saskatchewan, and Newfoundland and Labrador. Similarly, Indigenous, Metis, and Inuit nurses reported statistically greater confidence than those who did not declare Indigeneity, or who preferred not to answer.

There were statistical differences across groups for the item: “Nurses should play an active role in discussing climate-sensitive vector-borne diseases with their patients/clients, families, groups, communities, and populations”, where nurses in urban settings agreed with this statement more than nurses in rural settings, and nurses who declared Indigeneity compared to those who did not or who preferred not to answer.

Significant differences across groups were also found for the Likert-scale item: “Indigenous Canadians disproportionately experience negative health effects from climate change”, where nurses in urban settings agreed with this statement to a statistically greater extent than nurses in rural settings, and nurses who declared Indigeneity compared to those who preferred not to answer.

There were also significant differences for the final Likert-scale item: “It is important for healthcare professionals to advocate for social justice by addressing socioeconomic inequities which exist among populations that are at risk of vector-borne diseases”, with nurse educators agreeing with this statement more than nurse managers. Additionally, Indigenous, Metis, and Inuit nurses, and nurses with a master’s degree placed statistically higher value on advocacy than others and those with a diploma or baccalaureate degree.

Variations in Overall Attitude Likert Scale Items

Significant differences were noted for the overall score of attitude Likert scale items, where nurses with a master’s degree and PhD reported statistically higher mean scores than nurses with a diploma, baccalaureate degree, and those who marked their education as “other”. Scores were also statistically higher among nurses in educational institutions compared to those in medical/surgical and “other” practice areas. Additionally, attitude scores were statistically higher for nurses in urban areas compared to those in rural settings, and for Indigenous, Metis, and Inuit nurses compared to those who were not or who preferred not to answer. After controlling for education using an ANCOVA, significant differences across provinces also existed for the total score of attitude Likert scale items, where nurses in Nova Scotia had significantly higher overall attitude mean scores than nurses in Saskatchewan, as presented in Table 4.11.

Table 4.10

Significant ANOVA Results of Attitude Likert-Scale Survey Items

Climate change directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations in my care.	
Education	[F(4, 14.16) = 6.032 **] Mean score for Other (M = 3.00, SD = 1.225) was significantly different *** than Diploma (M = 1.59, SD = 0.783); was significantly different *** than Baccalaureate Degree (M = 1.46, SD = 0.741); was significantly different *** than master’s degree (M = 1.24, SD = 0.643); and was significantly different *** than PhD (M = 1.18, SD = 0.753).
Practice Area	[F(14, 180.21) = 1.906, *] Mean score for Public Health (M = 1.31, SD = 0.635) was significantly different * than Obstetrics (M = 2.00, SD = 0.970).
Urban/Rural	[F(2, 5.71) = 5.97 *] Mean score for Urban (M = 1.36, SD = 0.67) was significantly different ** than Rural (M = 1.61, SD = 0.89).
As a nurse, I am concerned about the health impacts of climate-sensitive vector-borne diseases on patients/clients, families, groups, communities, and populations.	
Education	[F(4, 377) = 4.762 ***] Mean score for Other (M = 2.80, SD = 0.837) was significantly different * than master’s degree (M = 1.49, SD = 0.673); and was significantly different * than PhD (M = 1.53, SD = 0.943). Mean score for Baccalaureate Degree (M = 1.87, SD = 0.758) was significantly different * than master’s degree (M = 1.49, SD = 0.673).

Province/Territory	[F(9, 23.21) = 1.647, *] Mean score for Saskatchewan (M = 2.16, SD = 0.903) was significantly different * than Nova Scotia (M = 1.49, SD = 0.739).
Nurses are positioned to help patients/clients, families, groups, communities, and populations understand the health impacts from climate-sensitive vector-borne diseases.	
Education	[F(4, 15.39) = 4.580 *] Mean score for Other (M = 2.80, SD = 1.304) was significantly different * than master's degree (M = 1.44, SD = 0.770); and was significantly different * than PhD (M = 1.29, SD = 0.588).
Indigeneity	[F(2, 379) = 3.14 *] Mean score for No (M = 1.70, SD = 0.944) was significantly different * than prefer not to answer (M = 2.25, SD = .754).
I feel well prepared to address climate-sensitive vector-borne diseases with patients/clients, families, groups, communities, and populations.	
Province/Territory	[F(9, 71.66) = 3.522 ***] Mean score for Quebec (M = 2.29, SD = 1.069) was significantly different ** than British Columbia (M = 3.53, SD = 1.215); was significantly different * than Alberta (M = 3.63, SD = 1.133); was significantly different *** than Saskatchewan (M = 3.89, SD = 1.092); and was significantly different *** than Newfoundland & Labrador (M = 4.31, SD = 0.602).
Indigeneity	[F(2, 50.00) = 10.98 ***] Mean score for Yes (M = 2.63, SD = 1.52) was significantly different *** than No (M = 3.65, SD = 1.14), and was significantly different * than prefer not to answer (M = 3.67, SD = 0.89).
I feel confident counseling patients, families, groups, communities, and populations about climate change and health.	
Practice Area	[F(14, 162) = 2.232 **] Mean score for Educational Institution (M = 2.71, SD = 1.447) was significantly different ** than Geriatrics (M = 4.05, SD = 0.921); and was significantly different * than Other (M = 3.70, SD = 1.087).
Province/Territory	[F(9, 53.75) = 3.243 **] Mean score for Quebec (M = 2.29, SD = 0.914) was significantly different ** than Alberta (M = 3.55, SD = 1.167); was significantly different *** than Saskatchewan (M = 3.98, SD = 1.033); and was significantly different * than Newfoundland & Labrador (M = 3.75, SD = 0.931). Mean score for Saskatchewan (M = 3.98, SD = 1.033) was significantly different ** than British Columbia (M = 3.10, SD = 1.319).
Indigeneity	[F(2, 379) = 15.41 ***] Mean score for Yes (M = 2.37, SD = 1.37) was significantly different *** than No (M = 3.53, SD = 1.19).
I feel confident counseling patients, families, groups, communities, and populations about climate-sensitive vector-borne diseases.	
Practice Area	[F(14, 168.42) = 2.061 *] Mean score for Educational Institution (M = 3.26, SD = 1.482) was significantly different * than Other (M = 4.16, SD = 0.954). Mean score for Public Health (M = 3.38, SD = 1.254) was significantly different * than Other (M = 4.16, SD = 0.954).
Province/Territory	[F(9, 372) = 3.835 ***] Mean score for Quebec (M = 2.36, SD = 1.151) was significantly different *** than British Columbia (M = 3.84, SD = 1.229); was significantly different *** than Alberta (M = 3.78, SD = 1.135); was significantly different *** than Saskatchewan (M = 3.98, SD = 1.076); was significantly different * than Nova Scotia (M = 3.63, SD = 1.131); and was significantly different *** than Newfoundland & Labrador (M = 4.25, SD = 0.775).
Indigeneity	[F(2, 47.08) = 11.84 ***]

	Mean score for Yes (M = 2.69, SD = 1.59) was significantly different *** than No (M = 3.83, SD = 1.11).
Nurses should play an active role in discussing climate-sensitive vector-borne diseases with their patients/clients, families, groups, communities, and populations.	
Urban/Rural	[F(2, 376) = 8.26 ***] Mean score for Urban (M = 1.84, SD = 0.85) was significantly different ** than Unsure (M = 4.00, SD = 1.41).
Indigeneity	[F(2, 379) = 6.18 **] Mean score for Yes (M = 1.51, SD = 0.66) was significantly different * than No (M = 1.94, SD = 0.91), and was significantly different ** than prefer not to answer ((M = 2.50, SD = 1.17).
Indigenous Canadians disproportionately experience negative health effects from climate change.	
Urban/Rural	[F(2, 11.78) = 5.92 *] Mean score for Urban (M = 1.78, SD = 0.95) was significantly different *** than Rural (M = 2.13, SD = 1.17).
Indigeneity	[F(2, 379) = 5.433 **] Mean score for Yes (M = 1.63, SD = 0.84) was significantly different ** than prefer not to answer (M = 2.75, SD = 1.14).
It is important for healthcare professionals to advocate for social justice by addressing socioeconomic inequities which exist among populations that are at risk of vector-borne diseases.	
Primary Position	[F(3, 378) = 2.921 *] Mean score for Nurse Manager (M = 2.00, SD = 1.323) was significantly different * than Nurse Educator (M = 1.40, SD = 0.773).
Education	[F(7, 58.92) = 4.906 **] Mean score for master's degree (M = 1.28, SD = 0.637) was significantly different * than Diploma (M = 1.91, SD = 1.111); and was significantly different * than Baccalaureate degree (M = 1.60, SD = 0.853).
Indigeneity	[F(2, 16.91) = 11.13 ***] Mean score for Yes (M = 1.26, SD = 0.51) was significantly different *** than prefer not to answer ((M = 2.67, SD = 1.16).
Total Attitude Likert Scale Score	
Education	[F(4, 377) = 7.802 ***] Mean score for Diploma (M = 24.74, SD = 4.88) was significantly different *** than master's degree (M = 19.87, SD = 5.61); and was significantly different * than PhD (M = 19.06, SD = 6.90). Mean score for Other (M = 29.40, SD = 3.51) was significantly different ** than master's degree (M = 19.87, SD = 5.61); and was significantly different ** than PhD (M = 19.06, SD = 6.90). Mean score for master's degree (M = 19.87, SD = 5.61) was significantly different ** than Baccalaureate degree (M = 22.66, SD = 6.05).
Practice Area	[F(14, 367) = 2.432 **] Mean score for Educational Institution (M = 18.83, SD = 6.08) was significantly different * than Medical/Surgical (M = 23.72, SD = 6.55); and was significantly different * than Other (M = 23.38, SD = 5.81).
Urban/Rural	[F(2, 376) = 6.78 **] Mean score for Urban (M = 21.56, SD = 5.87) was significantly different ** than Rural (M = 23.78, SD = 6.39).
Indigeneity	[F(2, 379) = 12.61 ***] Mean score for Yes (M = 17.77, SD = 6.49) was significantly different *** than No (M = 22.60, SD = 5.89), and was significantly different *** than prefer not to answer ((M = 25.67, SD = 4.94).

Note. * p<0.05; **p<0.01; ***p<0.001

Table 4.11

Significant ANCOVA Result of Total Attitude Likert-Scale Survey Item

Total Attitude Likert Scale Score	
*Controlling for Education for Province/Territory	
Practice Area	[F(14, 367) = 2.432 **] Mean score for Educational Institution (M = 18.83, SD = 6.08) was significantly different * than Medical/Surgical (M = 23.72, SD = 6.55); and was significantly different * than Other (M = 23.38, SD = 5.81).

Note. * p<0.05; **p<0.01; ***p<0.001

Practices, Experiences, and Resources

The final section of the survey contained questions about experiences and practices in participants' practice areas related to VBDs, as well as accessing resources on VBDs. The first two questions in this section inquired about discussions in practice about climate change and VBDs on health. Over half of respondents indicated they do not discuss the impacts of climate change (53%) or VBDs (63%) on health with patients or clients. Full results are presented in Table 4.12 below. Responses to the third survey item in this section addressing encounters with clients with climate sensitive VBDs in practice are presented in Figure 4.3 below, where 259 participants indicated they never or rarely encountered a patient with a VBD in practice.

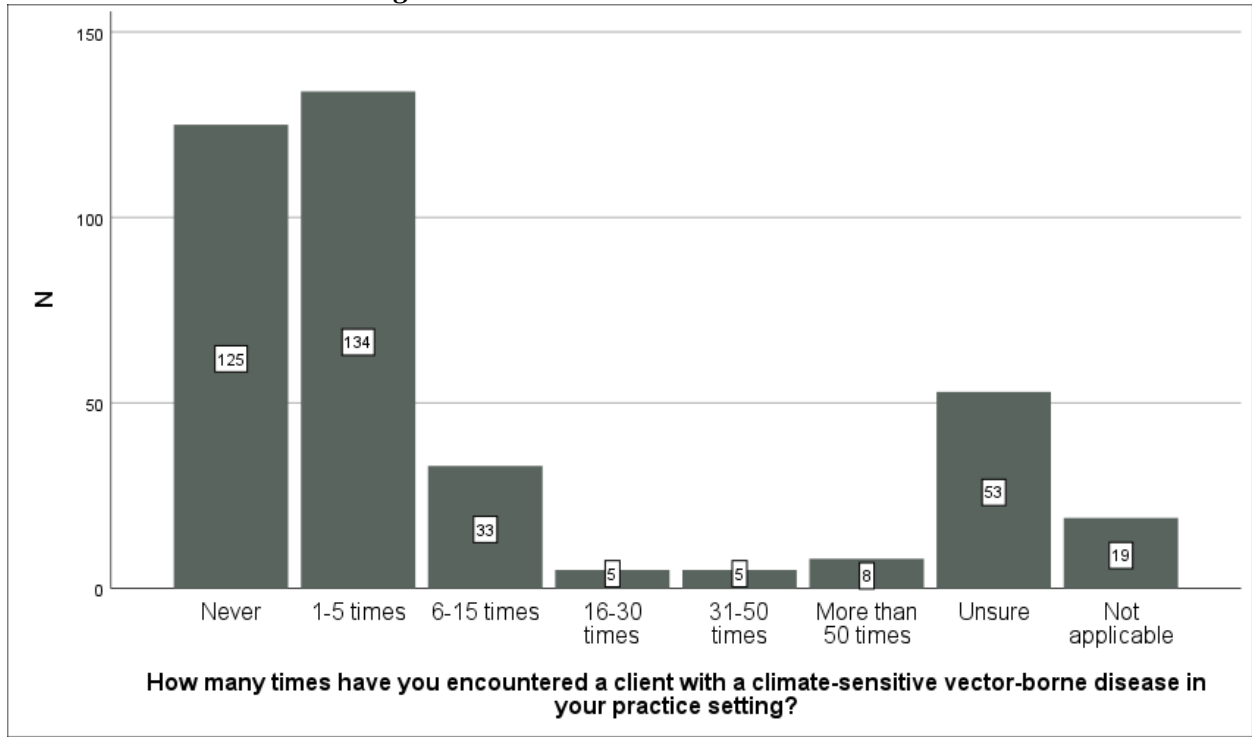
Table 4.12*Discussions in Nursing Practice*

Survey Item	All n (%)	Most n (%)	Some n (%)	A Few n (%)	None n (%)	Not Applicable* n (%)
What proportion of your patients or clients do you discuss the impact of climate change on their health?	4 (1.0)	15 (3.9)	48 (12.6)	85 (22.3)	203 (53.1)	27 (7.1)
What proportion of your patients or clients do you discuss the impact of climate-sensitive vector-borne diseases on their health?	4 (1.0)	12 (3.1)	31 (8.1)	62 (16.2)	240 (62.8)	33 (8.6)

Total Responses = 382 *not involved in patient care

Figure 4.3

Encounters in Practice Settings



Barriers in Practice

Survey items in this section also included questions about barriers to discussing climate sensitive VBDs with clients and barriers to accessing resources on climate sensitive VBDs. The most common barriers preventing discussions with patients or clients about VBDs included lack of knowledge (58%), lack of time (38%), and lack of patient interest (30.9%). The greatest barriers to accessing resources on VBDs included lack of time (52%), lack of knowledge where to locate reliable information (39%), and lack of motivation (21%). Participants were able to enter free text in the “other” category for both survey items, and a wide range of responses were received, including competing priorities, clients not believing that climate change is occurring, not having given this topic thought prior to the survey, not currently working with patients, or not relevant to their practice area.

Resources

Resources related to VBDs which may be helpful to respondents were presented, including a free text response. Highest responses were received from respondents for continuing education opportunities (69%) and patient or client educational materials (62%). Free text responses included data and statistics about VBDs in Canada, key assessments for VBDs in the practice setting, and government guidelines or recommendations on climate change and VBDs in healthcare practice settings. Full results are presented in Table 4.13 below.

Table 4.13*Barriers and Resources*

Survey Item	n (%)
Barriers preventing discussing climate-sensitive vector-borne diseases with patients or clients.	
Lack of knowledge regarding how to approach this issue with my patients or clients.	221 (57.9)
Lack of time.	145 (38.0)
My patients or clients would not be interested.	118 (30.9)
My patients or clients would not be knowledgeable enough about climate-sensitive vector-borne diseases to discuss this issue.	97 (25.4)
Discussing this issue with my patients or clients will not make much difference in their overall health.	81 (21.2)
Other*	69 (18.1)
Not applicable – I don't face barriers discussing climate-sensitive vector-borne diseases with patients or clients.	44 (11.5)
Climate change is not occurring.	8 (2.1)
Barriers preventing accessing resources on climate-sensitive vector-borne diseases.	
Continuing education course on climate change and health (including vector-borne diseases).	263 (68.8)
Patient or client education materials.	236 (61.8)
Research articles demonstrating the link between climate change and vector-borne diseases.	221 (57.9)
Treatment or assessment options.	216 (56.5)
Case studies or clinical care examples demonstrating best practices for discussing climate change and health with patients or clients.	200 (52.4)
I am not interested in this topic.	16 (4.2)
I don't need any resources.	10 (2.6)
Other*	10 (2.6)
Resources related to climate-sensitive vector-borne diseases that would be helpful.	
Continuing education course on climate change and health (including vector-borne diseases).	263 (68.8)
Patient or client education materials.	236 (61.8)
Research articles demonstrating the link between climate change and vector-borne diseases.	221 (57.9)
Treatment or assessment options.	216 (56.5)
Case studies or clinical care examples demonstrating best practices for discussing climate change and health with patients or clients.	200 (52.4)
I am not interested in this topic.	16 (4.2)
I don't need any resources.	10 (2.6)
Other*	10 (2.6)
If interested in a continuing education course, preferred format:	
Open access (free complete course which is available for use)	217 (56.8)
Asynchronous (course content is available at any time)	81 (21.2)
Virtual synchronous (students log in and participate in class at a specific time)	24 (6.3)
Unsure	24 (6.3)
I am not interested.	17 (4.5)

Total Responses = 382

*Free text response

Practices and Experiences with VBDs

Additional survey items in this section included several specific questions, which are summarized below in Table 4.14. The majority of participants (74%) had never received information about VBDs in their practice setting. Most participants (71%) indicated they were interested in a continuing education course or online modules about VBDs if available; however, only 42 (11%) of participants were aware of the CASN E-Resource on VBDs. The preferred format for a continuing education course was an open access course (57%), and responses are presented in Figure 4.4 below. 130 respondents (34%) had personal experience with VBDs outside of their work/clinical setting. The final survey question asked respondents how they heard about the survey, with the highest percentage of respondents indicating professional association (48%).

Table 4.14

Practices & Experiences with VBDs

Survey Item	True/Yes n (%)	False/No n (%)	Unsure n (%)
Have you ever received specific information about climate-sensitive vector-borne diseases for your practice setting?	61 (16.0)	283 (74.1)	17 (4.5)
If a continuing education course or online modules on climate-sensitive vector-borne diseases were available to you, would you be interested?	271 (70.9)	20 (5.2)	72 (18.8)
Have you had personal experience with vector-borne diseases outside of your clinical/work setting?	130 (34.0)	225 (58.9)	8 (2.1)
Are you aware of the Canadian Association Schools of Nursing E-Resource on vector-borne diseases?	42 (11.0)	316 (82.7)	5 (1.3)

Figure 4.4

Preferred Format for Continuing Education Course

If you are interested in a continuing education course, what format would you prefer?

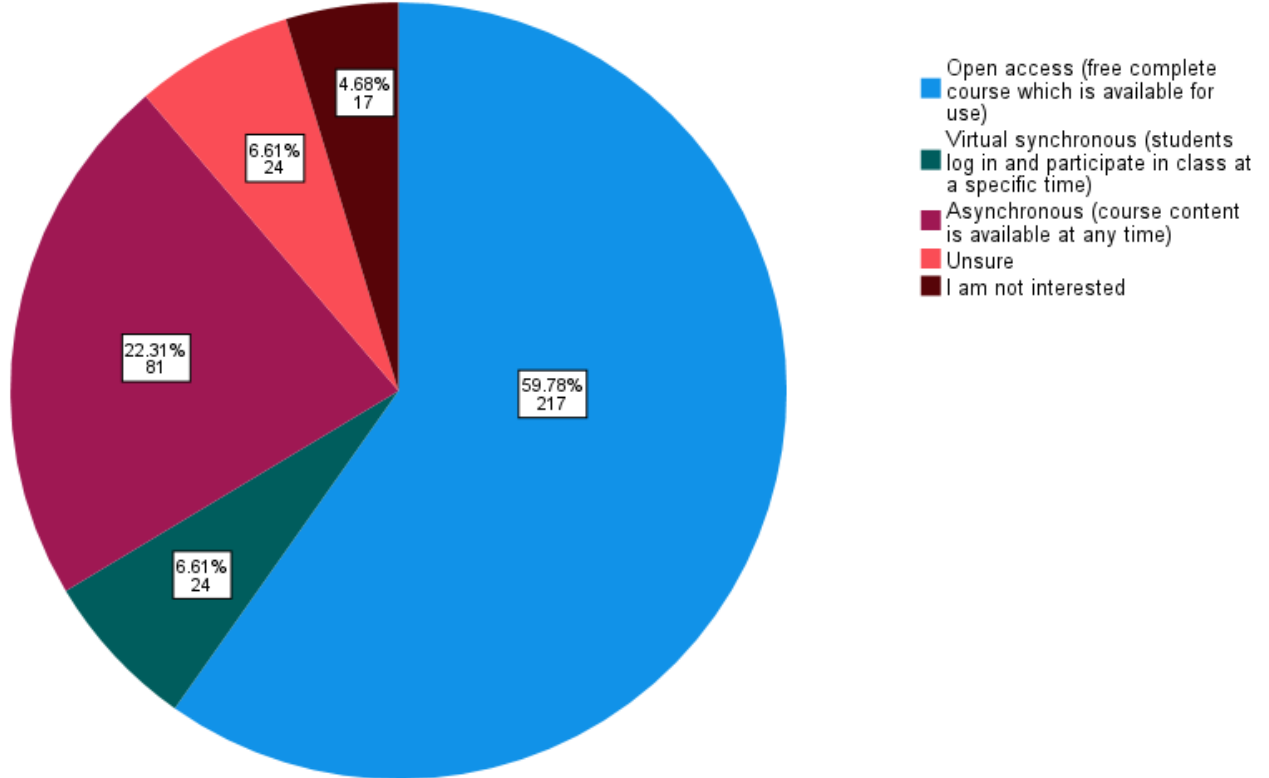
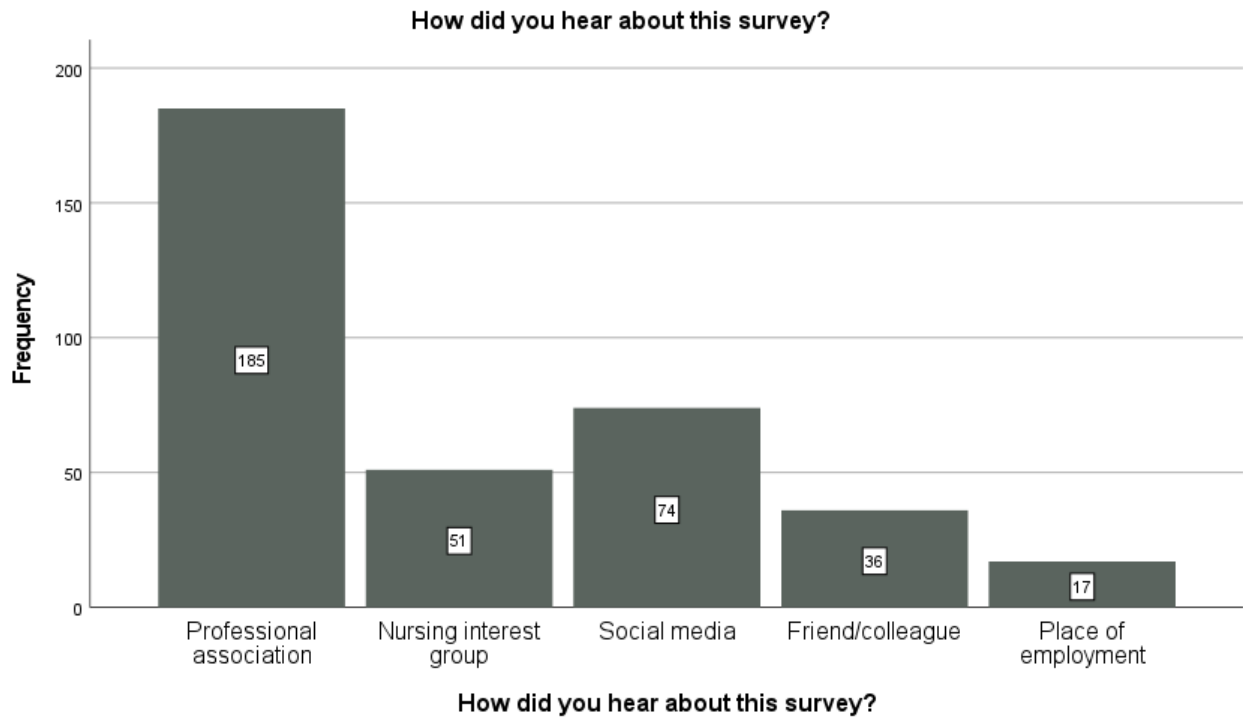


Figure 4.5

How Participants Heard about Survey



Practice and Experience Variations

SPSS was utilized to determine comparisons across demographics to answer the following research question: “Do practices and experiences in addressing climate sensitive VBD vary by position, education, practice area, age, years of practice, province/territory, urban/rural setting, and Indigeneity?” The questions in this section of the survey that were categorized as nominal data were analyzed using a non-parametric Chi-Square test, while the questions that were classified as ordinal data were analyzed using a non-parametric Kruskal-Wallis test to determine comparisons. Significant results are presented in Table 4.15 below.

Non-Parametric Test Results

A non-parametric Kruskal-Wallis test was conducted, and significant differences in mean rankings existed between provinces/territories for the question: “What proportion of your patients or clients do you discuss the impact of climate change on their health?”. Statistically greater number of nurses in Quebec discussed climate change and health compared to nurses in British Columbia Saskatchewan, Alberta, and Newfoundland, and a statistically larger number of Indigenous, Metis, and Inuit nurses, compared to participants who did not declare Indigeneity. For the question, “What proportion of your patients or clients do you discuss the impact of climate-sensitive vector-borne diseases on their health?”, there were significant pairwise comparisons for age, years of practice, and Indigeneity. Nurses aged 66+ discussed VBDs with clients more than nurses in other age groups, while Indigenous, Metis, and Inuit nurses and nurses with 5-10 years of experience discussed VBDs with clients more than those with 11-20 years of experience.

The survey item: “How many times have you encountered a client with a climate-sensitive vector-borne disease in your practice setting?” yielded several significant differences in mean rankings between groups. Nurse educators reported encountering clients with VBDs statistically more often than frontline staff, while nurses with a master’s degree reported statistically greater number of encounters compared to nurses with a baccalaureate degree or diploma. Additional significant differences were noted, where nurses aged 20-25 and those with less than five years of experience encountered patients’ fewer times than those in other age groups or those with more experience. Indigenous, Metis, and Inuit nurses also encountered patients statistically more often in practice compared to participants who did not declare Indigeneity.

A significant chi-square statistic was obtained for the following survey item: “Have you ever received specific information about climate-sensitive vector-borne diseases for your practice setting?” Follow-up pairwise comparisons using the Bonferroni correction found significant differences between groups. A statistically greater number of nurses working in public health reported receiving information compared to nurses working in medical/surgical practice ($p = <0.01$), and a statistically significant result was also obtained between nurses working in educational institutions compared to medical/surgical practice ($p = <0.05$). Additionally, nurses between the ages of 36-40 reported receiving specific information on VBDs compared to those ages 20-25 ($p = <0.001$), as did nurses who declared Indigeneity compared to those who did not ($p = <0.001$).

A significant chi-square statistic was obtained for the following survey item: “If continuing education on climate sensitive vector-borne diseases was available to you, would you be interested?” Follow-up pairwise comparisons using the Bonferroni correction ground significant differences between Indigeneity. A statistically greater number of nurses who declared Indigeneity were interested in continuing education compared to participants who preferred not to answer ($p = <0.05$).

For the survey item: “Have you had personal experience with vector-borne diseases outside of your clinical/work setting?”, significant differences existed between nurses in various positions, with nurse managers reporting significantly more personal experience with VBDs compared to nurse educators ($p = <0.05$), frontline nurses ($p = <0.01$), and nurses who marked their position as “other” ($p = <0.05$). Additionally, nurses who declared Indigeneity reported significantly greater personal experience with VBDs compared to participants who did not declare Indigeneity ($p = <0.001$).

The final survey item which was analyzed was: “Are you aware of the Canadian Association Schools of Nursing E-Resource on vector-borne diseases?”, where significant differences were also found. Nurse educators ($p = <0.001$) and nurse managers ($p = <0.001$) reported significantly greater awareness of the CASN guidelines compared to frontline staff, while agreement with the statement was significantly higher for nurses with a PhD ($p = <0.001$), and a master’s degree ($p = <0.01$), than for nurses with a baccalaureate degree. Significant differences existed across practice areas, where more nurses in educational institutions were significantly more aware of the CASN guidelines compared to nurses working in critical care, public health, medical/surgical, geriatrics, pediatrics, emergency departments, operating room, obstetrics, and occupational health. Significant differences were noted across provinces, with significant differences between nurses in Quebec compared to British Columbia, Alberta, Saskatchewan, Nova Scotia, and Newfoundland, with nurses in Quebec perceiving greater awareness of the CASN guidelines. Finally, Indigenous, Metis, and Inuit nurses were significantly more aware of the CASN guidelines compared to participants who did not declare Indigeneity ($p = <0.001$) or who preferred not to answer ($p = <0.01$). Full results are presented in Table 4.15 below.

Table 4.15

Significant Chi-Square and Kruskal-Wallis Results of Practice & Experience Survey Items

What proportion of your patients or clients do you discuss the impact of climate change on their health?	
Province/Territory	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(9, N = 382) = 29.04$ *** Significant pairwise comparisons between Quebec and Alberta *, Quebec and Saskatchewan**, Quebec and Newfoundland & Labrador * Significant pairwise comparisons between BC and Saskatchewan *
Indigeneity	Kuskal-Wallis test found significant differences in mean rank between groups, $X^2(2, N = 382) = 6.15$ * Significant pairwise comparisons between yes and no *
What proportion of your patients or clients do you discuss the impact of climate-sensitive vector-borne diseases on their health?	

Age	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(9, N = 382) = 18.64 *$ Significant pairwise comparisons between ages 66+ and 61-65 *, 66+ and 46-50 * and 66+ and 56-60 *
Years of Practice	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(5, N = 382) = 11.55 *$ Significant pairwise comparisons between those with 5-10 years and 11-20 years of practice*
Province/Territory	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(9, N = 382) = 22.39 *$ No significant pairwise comparisons.
Indigeneity	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(2, N = 382) = 12.12 **$ Significant pairwise comparisons between yes and no ***
How many times have you encountered a client with a climate-sensitive vector-borne disease in your practice setting?	
Primary Position	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(3, N = 382) = 15.02 **$ Significant pairwise comparisons between frontline staff and nurse educators * and frontline staff and other *
Education	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(4, N = 382) = 19.24 ***$ Significant pairwise comparisons between diploma and master's degree *, and BN to master's degree ***
Age	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(9, N = 382) = 21.68 *$ Significant pairwise comparisons between ages 20-25 and 46-50 *, ages 20-25 and 61-65 *
Years of Practice	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(5, N = 382) = 15.74 *$ Significant pairwise comparisons between less than 5 years and 11-20 years *, and less than 5 years to 5-10 years *
Indigeneity	Kruskal-Wallis test found significant differences in mean rank between groups, $X^2(2, N = 382) = 7.63 *$ Significant pairwise comparisons between yes and no *
Have you ever received specific information about climate-sensitive vector-borne diseases for your practice setting?	
Practice Area	Significant chi-square statistic was obtained, $X^2(28, N = 361) = 61.20 ***$ Significant pairwise comparisons between educational institutions and med/surg, $X^2(2, N = 79) = 8.44 *$ Significant pairwise comparisons between public health and med/surg $X^2(2, N = 100) = 10.41 **$
Age	Significant chi-square statistic was obtained, $X^2(18, N = 361) = 32.43 *$ Significant pairwise comparisons between ages 20-25 and 36-40, $X^2(2, N = 90) = 18.86 ***$ Significant pairwise comparisons between ages 20-25 and 56-60, $X^2(2, N = 59) = 7.062 *$
Indigeneity	Significant chi-square statistic was obtained, $X^2(4, N = 361) = 43.6 ***$ Significant pairwise comparisons between yes and no, $X^2(2, N = 350) = 42.60 ***$
Have you had personal experience with vector-borne diseases outside of your clinical/work setting?	
Primary Position	Significant chi-square statistic was obtained, $X^2(6, N = 363) = 12.9 *$ Significant pairwise comparisons between nurse managers and nurse educators, $X^2(2, N = 77) = 9.29 *$, between nurse managers and frontline staff, $X^2(2, N = 261) = 10.66 **$, and nurse managers and others, $X^2(2, N = 59) = 10.17 *$
Province/Territory	Significant chi-square statistic was obtained, $X^2(18, N = 363) = 40.63 **$ No significant pairwise comparisons.
Indigeneity	Significant chi-square statistic was obtained, $X^2(4, N = 363) = 32.06 ***$

	Significant pairwise comparisons between yes and prefer not to answer, $X^2(2, N = 45) = 8.373 *$
If continuing education on climate-sensitive vector-borne diseases was available to you, would you be interested?	
Indigeneity	Significant chi-square statistic was obtained, $X^2(4, N = 48) = 13.39 *$ Significant pairwise comparisons between yes and no, $X^2(2, N = 352) = 25.50 ***$
Are you aware of the Canadian Association Schools of Nursing E-Resource on vector-borne diseases?	
Primary Position	Significant chi-square statistic was obtained, $X^2(6, N = 363) = 31.71 ***$ Significant pairwise comparisons between nurse educators and frontline staff, $X^2(2, N = 304) = 17.4 ***$, and between nurse managers and frontline staff, $X^2(2, N = 261) = 13.13 ***$
Education	Significant chi-square statistic was obtained, $X^2(8, N = 363) = 20.03 *$ Significant pairwise comparisons between PhD and BN, $X^2(2, N = 261) = 15.02 ***$, and master's degree and BN, $X^2(2, N = 311) = 9.59 **$
Practice Area	Significant chi-square statistic was obtained, $X^2(28, N = 363) = 62.69 ***$ Significant pairwise comparisons between educational institution and critical care, $X^2(1, N = 55) = 7.28 **$, public health, $X^2(1, N = 89) = 14.8 ***$, med/surg, $X^2(2, N = 79) = 13.58 ***$, geriatrics, $X^2(1, N = 52) = 8.22 **$, pediatrics, $X^2(2, N = 48) = 7.860 *$, emergency department, $X^2(2, N = 53) = 9.91 **$, operating room, $X^2(1, N = 46) = 7.86 **$, obstetrics, $X^2(2, N = 51) = 11.91 **$, and occupational health, $X^2(2, N = 46) = 9.87 **$
Age	Significant chi-square statistic was obtained, $X^2(18, N = 363) = 30.85 *$ No significant pairwise comparisons.
Years of Practice	Significant chi-square statistic was obtained, $X^2(10, N = 363) = 27.95 **$ No significant pairwise comparisons
Province/Territory	Significant chi-square statistic was obtained, $X^2(18, N = 363) = 42.8 ***$ Significant pairwise comparisons between Quebec and British Columbia, $X^2(2, N = 92) = 11.87 **$, Quebec and Alberta, $X^2(2, N = 133) = 17.17 ***$, Quebec and Saskatchewan, $X^2(2, N = 53) = 15.37 ***$, Quebec and Nova Scotia, $X^2(2, N = 60) = 21.48 ***$, and Quebec and Newfoundland & Labrador, $X^2(2, N = 30) = 7.48 *$
Indigeneity	Significant chi-square statistic was obtained, $X^2(4, N = 363) = 77.03 ***$ Significant pairwise comparisons between yes and no, $X^2(2, N = 352) = 71.67 ***$, and yes and prefer not to answer, $X^2(2, N = 45) = 9.4 **$

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Factor Analysis

SPSS factor analysis was used to determine if there were a small number of core factors underlying 22 Likert scale items on the knowledge and attitude sections of the survey of registered nurses. There were several missing values, but under the 15% threshold, and were subsequently replaced with the Series Mean when the analysis was run. Several variables were skewed but were not transformed due to the same response options being used for each variable (5-point Likert scale). There were 15 univariate outliers above 3.29 that were winsorized. There were also eight multivariate outliers above the critical value of 49.7, and these cases were deleted from the analysis. Principal components extraction was performed prior to the factor analysis to

estimate the number of factors, the presence of variable outliers, absence of multicollinearity and singularity, and factorability of the correlation matrix.

Three factors were initially extracted using the Maximum Likelihood procedure and rotated using a Varimax rotation procedure, however, there were several factors with loadings greater than 0.45 for two factors. Therefore, two factors were extracted using the Maximum Likelihood procedure and rotated using a Varimax rotation procedure. The factor loadings, shown in Table 4.16, produced two interpretable factors: Personal Preparedness (Factor 1), and Professional Preparedness (Factor 2) toward climate change and climate sensitive VBDs. Loadings above 0.45 are bolded. The personal preparedness factor accounted for 38.1% of the item variance and the professional preparedness factor accounted for 15.6% of the item variance.

Cronbach’s alpha coefficient tests were calculated to determine the reliability of the set of variables used in the factor analysis for measuring a single construct. The Cronbach alpha result was 0.922 for all 22 items extracted in the factor analysis. The Cronbach alpha result was 0.944 for the 15 items in Personal Preparedness (Factor 1), whereas the score was 0.839 for the seven items in Professional Preparedness (Factor 2). These results indicate that the set of variables demonstrated an acceptable level of internal reliability.

Table 4.16

Rotated Factor Matrix with 2 Factors

	Factor 1	Factor 2
I feel knowledgeable about climate change and subsequent health implications.	.558	.245
I feel knowledgeable about epidemiology of Lyme disease in Canada.	.776	.171
I feel knowledgeable about epidemiology of West Nile virus in Canada.	.846	.010
I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of Lyme disease in Canada.	.785	.117

I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of West Nile virus in Canada.	.824	.007
I feel knowledgeable about transmission of Lyme disease in Canada.	.636	.102
I feel knowledgeable about transmission of West Nile virus in Canada.	.618	-.066
I feel knowledgeable about diagnosis of Lyme disease in Canada.	.795	.055
I feel knowledgeable about diagnosis of West Nile virus in Canada.	.811	-.126
I feel knowledgeable about treatment of Lyme disease in Canada.	.766	.060
I feel knowledgeable about treatment of West Nile virus in Canada.	.844	-.092
I feel knowledgeable about the controversies in treatment of Lyme disease in Canada.	.647	.135
Climate change is happening.	-.082	.692
Climate change directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations in my care.	-.030	.780
As a nurse, I am concerned about the health impacts of climate-sensitive vector-borne diseases on patients/clients, families, groups, communities, and populations.	.213	.649
Nurses are positioned to help patients/clients, families, groups, communities, and populations understand the health impacts from climate-sensitive vector-borne diseases.	.098	.598
I feel well prepared to address climate-sensitive vector-borne diseases with patients/clients, families, groups, communities, and populations.	.730	.178
I feel confident counseling patients, families, groups, communities, and populations about climate change and health.	.645	.302
I feel confident counseling patients, families, groups, communities, and populations about climate-sensitive vector-borne diseases.	.777	.197
Nurses should play an active role in discussing climate-sensitive vector-borne diseases with their patients/clients, families, groups, communities, and populations.	.215	.614
Indigenous Canadians disproportionately experience negative health effects from climate change.	.015	.633

It is important for healthcare professionals to advocate for social justice by addressing socioeconomic inequities which exist among populations that are at risk of vector-borne diseases.	.053	.677
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Summary

This chapter offers a summary of the research findings of the knowledge, attitudes, and practices/experiences of registered nurses across Canada related to climate sensitive VBDs. Comparative results of knowledge, attitudes, and practices of nurses by position, education, practice area, age, years of practice, province/territory, urban/rural setting, and Indigeneity were also presented. Discussion of the significance of the research findings contrasted with current literature, along with recommendations for nursing education, research, practice, and advocacy will be presented in the next chapter.

CHAPTER FIVE: DISCUSSION, RECOMMENDATIONS, AND CONCLUSION

This chapter offers a discussion of the research findings about the knowledge, attitudes, and practices of registered nurses in Canada related to climate sensitive VBDs. Significant findings are situated within planetary health as the theoretical framework, the context of the research questions guiding this study, and compared with current literature on this topic. Recommendations for nursing education, practice, research, and advocacy are presented, followed by personal reflections, and limitations of the study. Finally, an overview of research dissemination, next steps in my research program, and a conclusion to this dissertation are included in this final chapter.

Demographic Information

As discussed in previous chapters, there were 382 survey responses included in data analysis. According to the latest statistics by the Canadian Nurses Association (CNA), in 2021, there were 312,382 RNs in Canada eligible to practice (CNA, 2024). Given the small percentage of RNs who completed the survey, caution must be taken when discussing results and it may not be appropriate to generalize study findings to the population of RNs in Canada.

Most of the respondents worked as frontline care providers, and the highest percentages of participants worked in public health, medical-surgical nursing, and educational institutions. Many specialty nursing practice areas were not listed, and therefore the “other” category also received a significant number of responses, which was a free-text box. A wide range of ages and years of practice were noted among participants. Participants were recruited from across Canada, and the greatest number of respondents were from Alberta, British Columbia, Saskatchewan, and Nova Scotia. Most participants lived in an urban setting, and there were also Indigenous, Metis, and Inuit nurses in the study.

Demographics characteristics were also obtained for Indigenous, Metis, and Inuit nurses, given the noteworthy study results pertaining to these participants. Results indicated that most worked as frontline care providers, and a significant portion were also nurse educators. Most had a baccalaureate degree, and several had a master's degree or PhD. Most nurses who declared Indigeneity worked in educational institutions, with medical-surgical nursing and home health the second-highest practice settings reported. Greatest number of Indigenous respondents were from Alberta, British Columbia, Ontario, and Quebec, and the majority lived in an urban setting.

Nurses' Knowledge and Attitudes Toward Climate Change

Several survey items addressed nurses' knowledge and attitudes on climate change. Only approximately half of the respondents in the study felt knowledgeable about climate change and subsequent health implications. Frontline staff felt less knowledgeable about climate change and health than nurse educators, as did RNs with a diploma compared to those with a PhD or master's degree. Nurses working in educational institutions reported higher knowledge compared to other nursing practice areas. Significant differences in knowledge were found between provinces, where knowledge ranked highest in Quebec, and Saskatchewan and Newfoundland and Labrador with the lowest reported knowledge of climate change and health. Significantly higher knowledge was also found among nurses who identified as Indigenous, Metis, or Inuit compared to participants who were not.

Climate Change and Indigenous Participants

Of particular importance is the significant difference in knowledge of climate change and health implications between nurses who identified as Indigenous, Metis, or Inuit compared to participants who did not declare Indigeneity. Indigenous, Metis, and Inuit nurses reported greater knowledge compared to other study respondents, and this finding is not surprising given the

expertise of Indigenous Peoples on planetary health issues. According to Redvers et al. (2023), despite historically been framed within literature through a deficit lens, with a focus on colonization, racism, and structural inequalities, Indigenous Peoples possess many strengths in addressing the global climate crisis. Indigenous Peoples have observed and adapted to changing environments since time immemorial, and intergenerational Indigenous knowledge systems allow them to continue to navigate, respond, and adapt to current climate and environmental changes (Climate Atlas of Canada, n.d.; NCCIH, 2022). Indigenous knowledge systems include observations, knowledge, and experiences that shape Indigenous Peoples' perceptions, understanding, and responses to climate change (Vodden & Cunsolo, 2021). Given that the natural environment is critical for Indigenous communities and their health, they have a strong interest in environmental justice and climate resilience (Redvers et al., 2023).

Several Indigenous nurse researchers support these findings, where First Nations, Inuit, and Metis ways of being, knowing and doing are embedded in relationships with the land. Traditional Indigenous knowledge can re-orient nursing priorities to value holistic and sustainable environmental practices (Bourque Bearskin, Kennedy, & Joseph, 2020). Furthermore, according to Sanderson et al. (2020), shared traditional ecological knowledge helps Indigenous Peoples understand climate change impacts on health. Indigenous Peoples promote knowledge sharing for climate change adaptation practices among their communities (Redvers et al., 2023). While caution must be taken in generalizations, given this literature, it is not unexpected that knowledge of climate change and health implications among nurses who identified as Indigenous, Metis, or Inuit was higher than nurses who did not declare Indigeneity on the survey.

Climate Change, Health, and Nursing Practice

While overall knowledge of climate change and health was reported as average, almost all respondents agreed that climate change is happening and directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations they care for. This finding may indicate that while nurses agree that climate change is an urgent issue in Canada, they may not be more knowledgeable on the issue than other Canadians, despite their advanced education. This finding demonstrates the need for further education for HCPs in Canada to ensure they are prepared for healthcare practice settings.

Additionally, for the item addressing climate change and the impact on the health of patients, clients, families, groups, communities, and populations, nurses in urban settings agreed with this statement to a greater extent than those in rural areas. While the study is somewhat dated, Mildenerger et al. (2016) found that strongest climate change beliefs were found in British Columbia, Nova Scotia, and Quebec, as well as in urban areas across Canada, and lowest in rural Canada and the prairie provinces. Despite these findings, climate change is affecting rural and remote communities in Canada at a disproportionate rate compared to urban centers (Vodden & Cunsolo, 2021).

Furthermore, more nurses working in public health agreed that climate change is happening and directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations, compared to nurses working in obstetrics. Given the scope of practice of public health nurses, particularly around population health issues and communicable disease control, compared to nurses working in obstetrics, this finding was expected. This finding correlates with the mandate for public health professionals in Canada, namely, to

effectively promote and protect health in a rapidly changing climate and engage in climate-health action (Public Health Agency of Canada, 2022).

The findings of this research study are consistent with several recent studies that have been published on nurses' knowledge of climate change, including the study by Kalogirou and colleagues (2020). The authors interviewed 22 frontline nurses and found that participants had varying levels of knowledge about climate change and health implications, while some participants were unable to connect climate change to health. According to Kalogirou et al. (2020), hospital contexts often challenge nurses' efforts to engage in environmentally responsible practices. Similarly in the current study, nurses with higher levels of education and those working in educational institutions reported higher levels of knowledge. Anåker et al. (2015) similarly stated that the immediate needs and demands of patient care in healthcare settings rank higher than environmental concerns, such as climate change.

Participant Views on Climate Change

Participant views on climate change were primarily influenced by media, including TV, radio, and podcasts, and secondarily influenced by professional resources, such as journals, professional associations, and governing bodies. In a recent study of nurses' experiences with climate change and climate action in Western Canada, Rempel, and colleagues (2024) found that personal and professional experiences with climate-related events, such as heat domes, droughts, and forest fires contributed to their beliefs about climate change. The increasing incidence of climate-related events in Canada in recent years may influence the perceptions of nurses in the current survey results. Additionally, Boulianne and Belland (2022) found that political ideology is a major predictor of climate change views, where right-wing ideology in both Canada and the United States influences trust in information sources that inform attitudes about climate change.

While I cannot assume political ideology of nurses from the survey results, given that it was not addressed on the survey, there is evidence to suggest that nurses often become politically active when faced with issues that affect them personally and professionally (Rempel et al., 2024). Furthermore, professional positions of leading nursing organizations in Canada toward climate change and climate action may influence nurses' views and attitudes toward climate change (CANE, 2024; CNA, 2017, 2024).

Factors Relating to Nurses' Knowledge and Attitudes Toward Climate Change Nursing Metaparadigm

Nurses' knowledge and attitudes toward climate change can be related to several factors. Firstly, while the environment is a central component of the nursing metaparadigm, theorized by Fawcett (1984), the term is often situated as the environment of individual patients, and has reduced the ability of nurses to contextualize the environment to a broader level. It can be difficult for nurses to transform the current model of nursing and health care overall, moving from illness care to planetary health care (Kurth & Potter, 2022; Martin & Kaminski, 2021). This has impeded nurses' knowledge and understanding of their professional roles in mitigating environmental health issues, including climate change (Kalogirou, Olson, & Davidson, 2020; Portela Dos Santos et al., 2023). According to Hanley and Jakubec (2019), the concept of environmental health is often marginalized, where nurses struggle to move beyond the motto to realistic applications in practice.

Undoubtedly, nurses have a key role in planetary health, climate change mitigation, and climate-informed health programming to reduce climate health threats, such as VBDs (Adrian, 2020; CANE, 2024; ICN, 2018). Hence, it was timely and appropriate to apply planetary health as the theoretical framework guiding this research study. Research that incorporates planetary

health is necessary to determine how nurses contextualize the environment to a broader level, and it was apparent in the current study findings that only approximately half of the respondents in the study felt knowledgeable about climate change and subsequent health implications. While this study explored a specific aspect of climate change, namely, VBDs, additional research on planetary health in nursing is necessary. The findings from this research study suggest that lack of knowledge about climate change can prevent nurses from leading change in healthcare practice and promoting a climate-resilient future.

Scope of Practice

Secondly, climate change may not be viewed as integral within a nurses' scope of practice by the public. Additionally, climate change may not be considered a priority within the nursing profession, given other critical concerns, such as the nursing shortage. According to the Canadian Federation of Nurses Unions (2023), in a 2023 survey, almost 90% of respondents felt there was a relationship between the nursing shortage and the quality of health care in Canada, where nursing care has deteriorated given insufficient staffing levels, high workloads and job stress, long wait times, burnout and fatigue, and increased demands for healthcare because of an aging population. Critical issues facing Canadian nurses included: high workload and stress (64%), burnout and fatigue (6%), and insufficient staffing (52%). Ryan and colleagues (2020) cited a lack of time in everyday practice as a significant barrier to nurses' knowledge on climate change.

Nursing Organizations

Thirdly, there may not have been enough of an emphasis on climate change and planetary health by leading national and provincial/territorial nursing organizations and health authorities in Canada, until recently. The lack of original research on planetary health and climate-related

issues within nursing may have contributed to the lack of action by leading nursing organizations. Hence, this research study was timely, given that it incorporated planetary health as a theoretical framework for nursing research. These views are consistent with opinions by Gaudreau et al. (2024) who affirmed that nurses' role in climate change issues has received little attention from nursing organizations, apart from environmental associations, such as the Canadian Association of Nurses for the Environment (CANE). However, recent developments by leading national nursing organizations are promising.

The CNA (2017) position statement on climate change and nurses' roles in addressing climate change in practice was retired in May 2024. This document was replaced with a new position statement on planetary health, released on Earth Day 2024, where the CNA offers guidance for nursing practice, education, research, and leadership. This position statement was created in partnership with CANE (2024), an organization of Canadian nurses who strive to improve planetary health across nursing practice, policy, research, and education. Additionally, in 2022, the CNA partnered with the Canadian Medical Association and the Canadian Public Health Association to produce *The Lancet Countdown on Health and Climate Change: Policy Brief for Canada* (Pétrin-Desrosiers et al., 2022). Finally, the Canadian Federation of Nurses Unions published their discussion paper titled *Climate Change and Health: It's Time for Nurses to Act* in 2019 that includes 26 recommendations for nurses to combat climate change (Martin & Vold, 2019).

Nursing Practice Standards

Fourthly, little progress has been made to integrate climate change concepts into nursing practice standards in Canada, limiting nurses' knowledge and attitudes, apart from Quebec. The Ordre des infirmières et infirmiers du Québec recognized the importance of the impacts of

climate change on nursing practice and published their position paper (2019) titled: *The impacts of climate change on population health and nursing practice*. The purpose of this document was to raise awareness and make members aware of their role in the context of climate change and may contribute to nurses in Quebec demonstrating greater knowledge on climate change in the current survey compared to nurses in other provinces and territories. Therefore, climate change concepts should be integrated into practice requirements and standards of practice by nursing regulatory bodies (Dossey et al., 2019; Gaudreau et al., 2024). One of the survey questions asked respondents how they heard about the survey, and most respondents indicated it was through their professional association. This finding speaks to the fact that nurses engage with information provided by regulatory bodies and professional associations, and these organizations should elevate leadership and action on current nursing issues, such as climate change.

Nurses' Limited Knowledge of VBDs

Almost 95% percent of respondents were aware that VBDs are caused by viruses, bacteria, or parasites that are transmitted to humans from animals or insects, while 78% of respondents knew that Lyme disease and WNV are the two most prevalent VBDs in Canada. While a large percentage of study participants indicated they did not see patients, only 21% of respondents indicated they often or always considered that climate change played a role in causing or exacerbating Lyme disease, and only 16% similarly responded for WNV.

Overall Knowledge and Attitudes

Overall mean knowledge scores among RNs of the two most prevalent climate sensitive VBDs in Canada, namely Lyme disease and WNV, was 36.75 ($SD = 11.296$) out of 64. Given this data, I can conclude that the overall knowledge of RNs who participated in the study was limited. Overall knowledge of VBDs was higher for nurse managers compared to frontline care

providers, as well as among nurses working in educational institutions compared to other practice areas. Indigenous, Metis, and Inuit nurses reported higher overall knowledge compared to those participants who did not declare Indigeneity, and of note is that 31.4% of nurses who declared Indigeneity were employed in educational institutions. Additionally, nurses in Quebec and New Brunswick had significantly higher overall knowledge than nurses in British Columbia, Alberta, Newfoundland and Labrador, Saskatchewan, and Nunavut and the Territories.

Similar to knowledge, the total attitude mean score among participants was considered average (22.26/45), and significant differences were noted, where nurses with a master's degree and PhD reported higher mean scores than nurses with a diploma, baccalaureate degree, and those who marked their education as "other". Scores were also higher among nurses in educational institutions, and nurses in Quebec, Ontario, and Nova Scotia had significantly higher overall attitude scores than nurses in other provinces, with significant differences noted in Saskatchewan and Newfoundland and Labrador.

These findings align with the results of the scoping review completed by Vandenberg and colleagues (2023), who found that nurses lack knowledge and confidence regarding climate change and VBDs. The lack of knowledge among nurses may contribute to a lack of practice preparedness in addressing VBDs in the practice setting. These findings are concerning given that nurses, as trusted HCPs, will be sought out for guidance and support in mitigating climate-driven threats, and their expertise in climate-related health outcomes is desirable (Leffers et al., 2017; Liu, Potter, & Zahmer, 2020). Additionally, the lack of knowledge and preparedness in addressing climate-related health implications limits nurses' ability to engage in and advance planetary health, which speaks to the importance of situating this research study within planetary health as the theoretical framework.

Overall Knowledge of Lyme Disease

Overall mean knowledge of Lyme disease epidemiology, prevention, transmission, diagnosis, and treatment was 14.54 ($SD = 5.23$) out of 25. Given these findings, I can conclude that the overall knowledge of RNs on Lyme disease was limited. Overall knowledge of Lyme disease was highest for PHNs, and among nurses in Quebec, Nova Scotia, Ontario, and New Brunswick than nurses in other provinces and territories, particularly Saskatchewan and Nunavut and the Territories. Additionally, Indigenous, Metis, and Inuit nurses reported greater knowledge compared to participants who did not identify with these groups.

Overall Knowledge of West Nile Virus

Overall mean knowledge of WNV epidemiology, prevention, transmission, diagnosis, and treatment was 12.57 ($SD = 5.26$) out of 25, which also demonstrates limited knowledge of WNV. Overall knowledge of WNV was higher for nurse managers and nurse educators compared to frontline care providers, and higher for nurses practicing in educational institutions. Greater knowledge scores were found for Indigenous, Metis, and Inuit nurses compared to those who were not members of these groups or who preferred not to answer. Additionally, nurses in Quebec, New Brunswick, and Manitoba had significantly higher overall WNV knowledge than nurses in other provinces and territories, particularly Saskatchewan, Newfoundland & Labrador, and Nunavut and the Territories.

Factors Relating to Knowledge

Prevalence of Lyme Disease and WNV in Canada

When the means were compared for each disease, participants reported higher overall knowledge of Lyme disease compared to WNV. These results can be attributed to the fact that Lyme disease is more prevalent in Canada compared to WNV. Preliminary data indicates that

there were 2,544 reported human Lyme disease cases in Canada in 2023 (Government of Canada, 2024a), compared to only 47 human cases of WNV in Canada in 2022 (Government of Canada, 2024b).

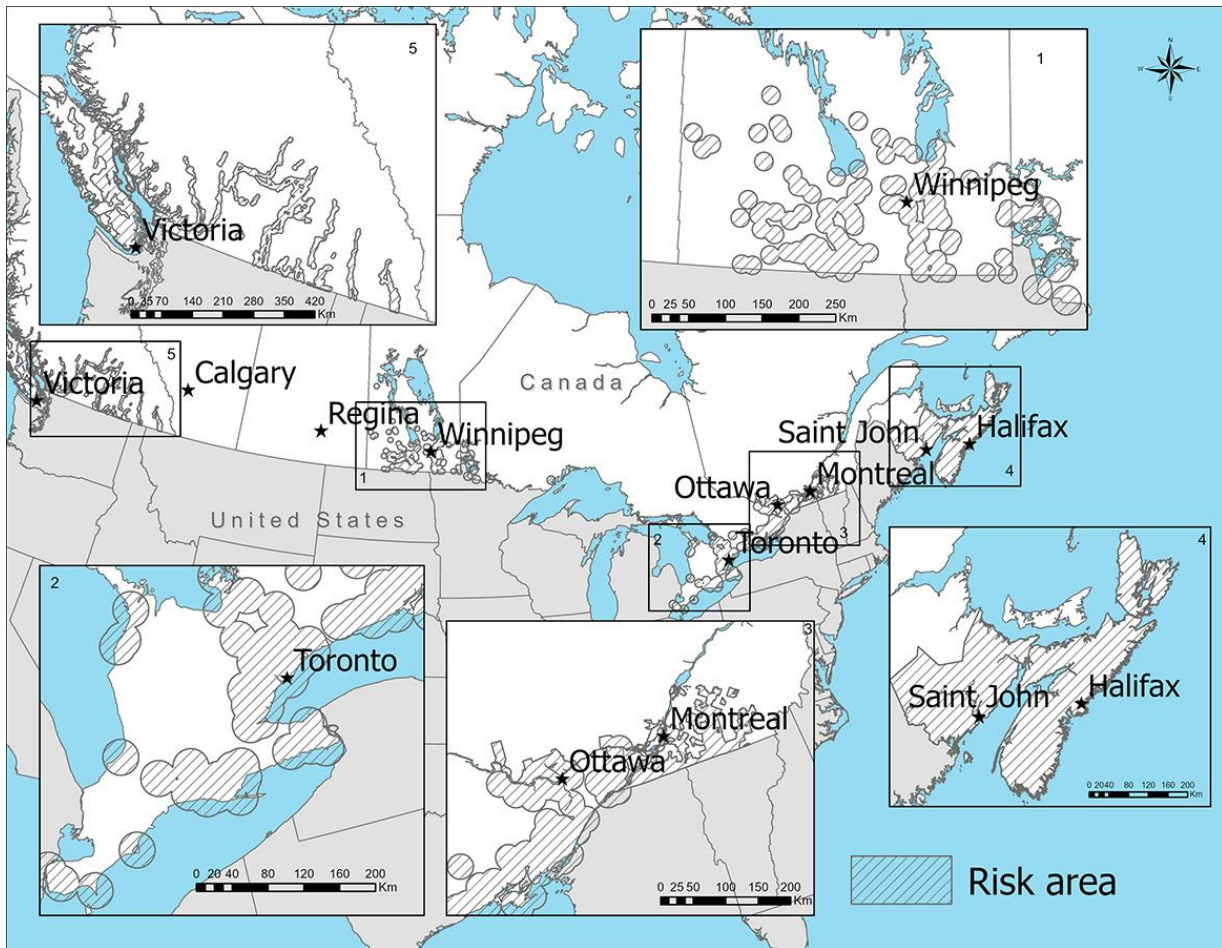
The discussion in the section above on the study findings illustrates the significant knowledge and attitude differences among nurses across Canada. Overall, nurses in New Brunswick, Nova Scotia, Quebec, and Ontario were more knowledgeable about VBDs than nurses working in other geographical areas in Canada. Cameron and colleagues (2021) conducted a research study to understand public risk perceptions of climate change and Lyme disease in Manitoba, Canada. They found that a range of knowledge and risk perceptions on climate change and Lyme disease existed, where participants in both higher risk areas and in high climate concern groups had greater knowledge and higher perceptions of risk than those in low concern groups and low concern geographical areas. Aenishaenslin et al. (2022) found high levels of awareness of Lyme disease, however, low levels of adoption of preventative behaviors in a highly endemic Lyme disease region in Canada. Similarly, Logan et al. (2024) discovered that 60% of residents of Ottawa, Ontario had high knowledge of Lyme disease, which is considered an emerging Lyme disease risk region in Canada.

Nurses in New Brunswick, Nova Scotia, Manitoba, and Ontario also indicated that increasing knowledge of VBDs was a priority for them, compared to nurses in other provinces and territories. These findings correspond to the current incidence rates of VBDs, where Lyme disease incidence is highest in Ontario, Nova Scotia, Quebec, New Brunswick, and Manitoba (Public Health Agency of Canada, 2023a), and WNV incidence among human cases is highest in Ontario and Quebec (Public Health Agency of Canada, 2023b). Additionally, according to the

most current VBDs risk maps, both Lyme disease and WNV are more prevalent in these provinces, as per the figures below.

Figure 5.1

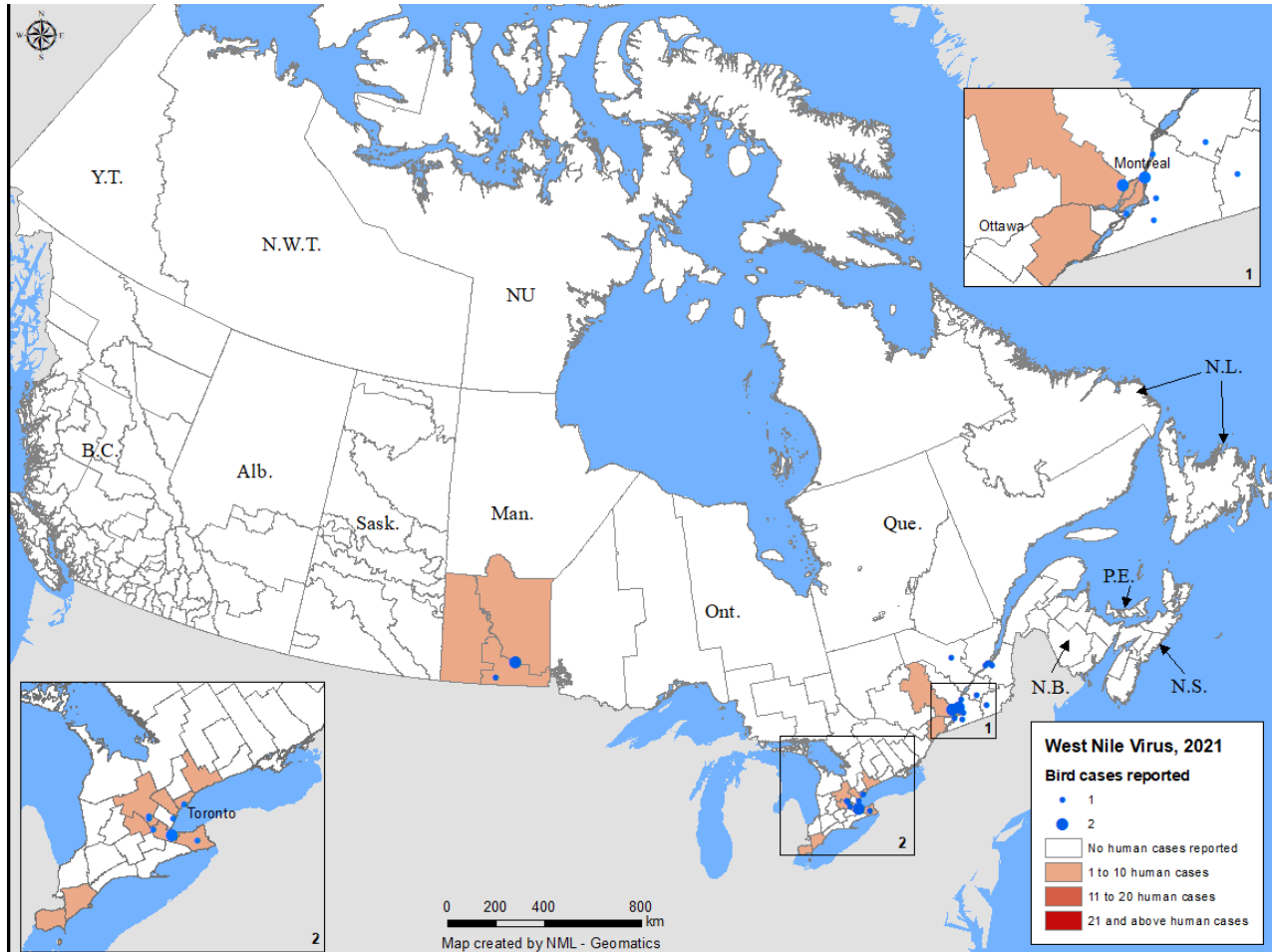
Lyme Disease Risk Map, 2023



(Government of Canada, 2024).

Figure 5.2

West Nile Virus Risk Map, 2021



(Government of Canada, 2024).

Variations by Practice Area & Position

Knowledge and attitude variations were also found across practice areas and position. PHNs and nurses working in educational institutions reported higher knowledge and attitude scores than nurses working in other practice areas. These findings are consistent with the scope of practice of nurses in these areas, as well as the recent calls to action on climate change and subsequent health implications for nurse educators. While the document is somewhat dated, CASN (2014) published their *Entry-to-Practice Public Health Nursing Competencies for Undergraduate Nursing Education*, which outline core competencies for PHNs and provides direction for nurse educators teaching public health curricular content. Several competencies in this document highlight the importance of knowledge in health promotion and protection, communicable and non-communicable disease prevention, and ability to recognize trends in epidemiological data (CASN, 2014).

Furthermore, the Community Health Nurses of Canada (CHNC) outline the role of community health nurses in their standards of practice, where PHNs are called to promote, protect, and preserve the health of populations, participate in surveillance and communicable disease control and management, recognize trends in epidemiological data, and use appropriate prevention approaches in managing communicable diseases and protection of the environment (CHNC, 2019). Therefore, it is to be expected that nurses working as PHNs would exhibit advanced knowledge of VBDs than nurses working in other practice areas.

Nurses with a master's degree or PhD displayed the highest scores for attitudes toward VBDs, while nurses working in educational institutions demonstrated greater knowledge than nurses working in other practice areas. These findings are linked, given that most nurses working in educational institutions hold a master's degree or a PhD (CASN, 2022). While nurse educators

are aware of climate change and VBDs, recent literature also demonstrates that nurse educators are keen to improve their knowledge on climate change and subsequent health implications (Field et al., 2020; Lal et al., 2021). However, there are several challenges which prevent them from integrating this content into educational curriculums, including lack of emphasis on climate change by curriculum regulators, lack of resources for curriculum development, full curriculums, and a lack of involvement in climate change by nurses (Diallo et al., 2023; McDermott-Levy et al., 2019; Neal-Boylan, Breakey, & Nicholas, 2019).

Higher knowledge of VBDs was reported by nurse managers compared to frontline staff. This finding is concerning because frontline care providers are directly responsible for patient care, and lack of knowledge of VBDs can hinder best practice and positive patient outcomes. This finding also highlights the necessity of nurse managers to share relevant information and resources with their staff. According to Coderre-Ball and colleagues (2021), HCPs, including nurses, require consistent, current, evidence-based education on VBDs to reduce knowledge gaps, and continuing education can improve performance, leading to enhanced patient outcomes. Furthermore, Howard et al. (2022) in their KAP study on HCPs, found that training and experience of frontline providers were associated with greater knowledge of tick-borne illnesses.

Variations by Indigeneity

Overall knowledge of Indigenous, Metis, and Inuit nurses for both Lyme disease and WNV was significantly higher compared to those who were not members of these groups or who preferred not to answer. Additionally, a significant number of respondents who declared Indigeneity reported their primary position as a nurse educator and were employed in educational institutions (31.4%). This may correlate with the finding that nurses working in educational

institutions reported higher knowledge and attitude scores than nurses working in other practice areas, discussed above.

According to Redvers et al. (2023), Indigenous Peoples experience many climate-related health impacts, namely rising temperatures that create favorable conditions for the increase in infectious diseases, including VBDs. Similarly, the National Collaborating Centre for Indigenous Health (2022) affirmed that health impacts of climate change increase First Nations, Inuit, and Metis peoples' risk for and exposure to disease-causing organisms, such as VBDs. Therefore, the enhanced knowledge of Indigenous, Metis, and Inuit nurses on VBDs may be attributed to their increased risk and exposure, as well as intergenerational knowledge transfer among Indigenous Peoples, which has provided them with the knowledge to observe, respond, and adapt to climate change and environmental concerns (NCCIH, 2022).

This increased knowledge may translate into their roles in practice, where a significant number of respondents who declared Indigeneity worked as nurse educators in educational institutions. As educators, Indigenous, Metis, and Inuit nurses can share their personal, cultural, and professional knowledge and expertise on climate change and climate-related health impacts with future nurses, providing a rich and meaningful educational experience for nursing students. This study finding demonstrates the importance of decolonizing nursing education and valuing Indigenous perspectives on current planetary health challenges (Jones et al., 2022). Indigenous nurse educators can situate their perspectives and knowledge on climate change and VBDs and lead discussions on holism, sustainability, climate justice, stewardship, relationality, and reciprocity (Bourque-Bearskin et al., 2020; Van Bewer et al., 2020).

Personal Practice Preparedness

Personal Experience with VBDs

Nurses' knowledge and attitudes towards climate driven VBDs influence personal practice preparedness. 130 (34%) respondents had personal experience with VBDs outside of their work/clinical setting. Significant results for this survey item were noted between nurse managers, who reported significantly more personal experiences with VBDs compared to nurse educators, frontline nurses, and nurses who marked their position as "other". Additionally, nurses who declared Indigeneity reported significantly greater personal experience with VBDs compared to participants who did not declare Indigeneity. This finding can be attributed to First Nations, Inuit, and Metis peoples' increased exposure to VBDs (NCCIH, 2022). Additionally, Ford et al. (2020) acknowledge that Indigenous Peoples' relationship with place is important, as it provides a foundation for identity and knowledge through which environmental changes are experienced and understood. Furthermore, Indigenous Peoples' traditional, collective ways of knowing and living are passed down through generations, enabling them to observe, respond, and adapt to climate change and climate-related infectious diseases (NCCIH, 2022).

According to Ciotti (2023), HCPs are often effectively able to separate personal experiences from professional practice; however, these experiences can positively intersect with and shape both personal and professional perspectives. One of the foundational theorists in nursing practice, Carper (1978), believed that theoretical reasoning for nursing practice is founded in four quadrants of knowledge: empirical, esthetic, personal, and moral. Therefore, personal knowledge and experiences can influence ways of knowing. Literature, such as the integrative review by Stewart et al. (2018), confirmed that both professional experience and scientific evidence is important for evidence-based practice. Additionally, Jakubec and Astle

(2021) affirm that personal knowledge is shaped by life experiences, culture, values, and beliefs, and this knowledge forms the foundation for professional interactions. HCPs require multiple types of knowledge to become effective, reflective, and receptive in practice (Jakubec & Astle, 2021). Therefore, it is to be expected that personal experience with VBDs would influence knowledge and attitudes on the topic.

Encounters in Practice

Indigenous, Metis, and Inuit nurses encountered patients more often in practice compared to participants who did not declare Indigeneity; however, most participants never or rarely (1-5 times) encountered patients with VBDs in the clinical setting. Nurses aged 20-25 and those with less than five years of experience encountered patients' fewer times than those in other age groups or those with more experience. This finding can be attributed to the fact that VBDs are an emerging issue in Canada and nurses who are younger and have less experience have had fewer opportunities to encounter patients with VBDs in practice. Cuzmenco (2024) confirmed that younger nurses are making up an increasing proportion of the nursing profession, enlarging the number of inexperienced RNs in practice settings.

Most respondents indicated they do not discuss the impacts of climate change or VBDs on health with patients or clients. This finding is concerning, given that most nurses are at the frontline of care, and therefore are well-positioned to address the impact of climate on health (Brenndorfer, 2020). A larger number of nurses in Quebec discussed climate change and health with patients compared to nurses in British Columbia Saskatchewan, Alberta, and Newfoundland, while a larger number of Indigenous, Metis, and Inuit nurses reported that they discussed climate change and health with patients compared to participants who did not declare Indigeneity. Indigenous Peoples' knowledge about climate change enables them to provide

important teaching about environmental and planetary stewardship to reduce climate change effects (NCCIH, 2022).

Barriers in Practice

The most common barriers preventing discussions with patients about VBDs included lack of knowledge, lack of time, and lack of patient interest, while the greatest barriers to accessing resources on VBDs included lack of time, lack of knowledge where to locate reliable information, and lack of motivation. These findings were certainly not surprising, given the current context within nursing, where nurses are facing greater workloads and higher patient acuity levels. Additionally, participants' limited knowledge of VBDs, discussed earlier in this chapter, directly relates to the perceived barriers. The perceived barriers were also identified in the literature, where Tiitta et al. (2021) found that the nurses in their qualitative study lacked professional preparation to address climate-related health effects with their patients and provide guidance on the topic. Similarly, Adams et al. (2021) affirmed that nurses' lack of awareness and knowledge can impede diagnosis and treatment of Lyme disease.

Views on VBDs

Participant views on VBDs were influenced primarily by professional resources. Most participants were concerned about the health impacts of VBDs on patients and agreed that nurses are in an opportune position to play an active role in helping patients, families, groups, communities, and populations understand the health impacts associated with VBDs. However, given the lack of emphasis on planetary health and climate change by leading nursing organizations and regulatory bodies in position statements, calls to action, practice standards, and practice competencies, participants may not necessarily have sensed the urgency of the issue in nursing practice. Additionally, while participants may have agreed that nurses are in an

opportune position to play an active role in preventing and addressing VBDs in practice, they lack the knowledge and preparedness to do so.

Nurses in Nova Scotia reported feeling greater concern about the health impacts of VBDs compared to nurses in Saskatchewan. This finding can be attributed to higher rates of VBDs in Eastern Canada, depicted earlier in Figure 5.1 and 5.2. While the study was not conducted with nurses, but rather with Canadians in general, Casson et al. (2023) found that survey respondents were more concerned about climate-related health impacts on water, food, and air quality, compared to infectious diseases, such as VBDs. Differences were also found among sociodemographic groups, where Canadians who were more highly educated and those on the political left expressed greater concern compared to others (Casson et al., 2023). Given the findings of Casson et al. (2023), a low survey response by RNs in Canada in the current study may be the result of a lack of interest in VBDs, where other climate-related effects may be of greater concern or interest to them.

Practice Preparedness & Confidence

Despite feelings of concern about health impacts of VBDs, over half of participants felt unprepared to address VBDs with patients, and significant differences existed by geographical area, where nurses in Quebec felt more prepared than nurses in British Columbia, Alberta, Saskatchewan, and Newfoundland and Labrador. Additionally, nurses who declared Indigeneity reported greater preparedness compared to those who did not declare or preferred not to answer. According to Sanderson et al. (2020), Indigenous Peoples have solutions to climate-related health challenges and our healthcare system must be more inclusive of Indigenous knowledge on climate change adaptation. Therefore, given this finding, it is not surprising that Indigenous, Metis, and Inuit nurses felt more prepared to address VBDs with patients in the practice setting.

Nurses also lacked confidence counselling patients, clients, families, groups, communities, and populations about climate change and subsequent health implications, such as VBDs. Nurses working in educational facilities and public health reported greater confidence compared to other practice areas, which can relate to their role or scope of practice in addressing VBDs, while nurses in Quebec reported higher confidence compared to other provinces and territories. Given the higher rates of both Lyme disease and WNV in Quebec, as depicted in Figure 5.1 and 5.2, it is not unexpected that nurses in Quebec feel more prepared and confident addressing climate change and VBDs with patients compared to nurses in other provinces. Greater confidence was also felt by Indigenous, Metis, and Inuit nurses compared to other survey respondents, and this can be attributed to the risk of exposure and practice setting, discussed earlier in this chapter.

These findings are consistent with Kircher and colleagues' (2022) study, where they found that while most HCPs recognized the health impacts of climate change, they reported feeling uncomfortable discussing climate change with patients. Additionally, in an autoethnographic research study, Ciotti (2023) asserted that relationships with HCPs have a significant impact on patients' healthcare experiences, and HCPs should engage in reflexive practice to improve their responsiveness toward patients' needs and experiences to minimize pre-existing power relations in healthcare practice.

Education on VBDs

Approximately 85% of participants reported that they have not completed any continuing education or formal education on VBDs, which correlates with the limited knowledge scores and lack of confidence by study participants. Significant differences were found for nurses who declared Indigeneity on the survey compared to nurses who did not declare Indigeneity, where

Indigenous, Metis, and Inuit nurses had completed formal education on climate sensitive VBDs. Not surprisingly, there were also significant differences in knowledge among Indigenous, Metis, and Inuit nurses, and I can infer that formal education and the fact that a significant number of Indigenous respondents were nurse educators may have influenced knowledge on the survey. Additionally, intergenerational knowledge transfer among Indigenous Peoples may have provided them with the knowledge to observe, respond, and adapt to climate change (NCCIH, 2022).

Information in Practice

Most participants had never received information on VBDs for their practice setting. A statistically greater number of nurses working in public health reported receiving information about VBDs compared to nurses working in medical/surgical practice, and a statistically significant result was also obtained between nurses working in educational institutions compared to medical/surgical practice. Additionally, more nurses between the ages of 36-40 reported receiving specific information on VBDs compared to those ages 20-25 as did nurses who declared Indigeneity compared to non-Indigenous nurses.

Given that VBDs relate to communicable disease prevention and control, it is not surprising that PHNs have received information in their practice setting compared to working in acute care settings. Additionally, nurses in educational institutions may be more familiar with resources, such as the CASN (2020) E-Resource on VBDs, which is aimed at undergraduate nursing education. According to study findings, 42.9% of nurses who worked in educational institutions were aware of the CASN E-Resource on VBDs, which was significantly higher than any other practice area.

Younger nurses typically have less experience than nurses who are older in age, and therefore, the finding that nurses ages 20-25 reported receiving information on VBDs to a lesser extent than older nurses is also not unexpected. According to Tiita et al. (2021), continuing education for practicing nurses can be effective in preparation to address the health impacts of climate change. Additionally, Ryan et al. (2020) advocated for improved education for health professionals on climate-related issues.

Given that VBDs are an emerging issue in Canada, it is concerning that most participants have not received information in the practice setting. Lyme disease is ranked second on a prioritization tool for endemic diseases in Canada, which confirms that Lyme disease is significant in Canada (Otten et al., 2020); however, Boudreau et al. (2018) and CPHA (2021) establish that VBDs are not given priority within Canada's healthcare system, confirming the finding in the current survey that most nurses have not received continuing education or information on VBDs in the practice setting. This lack of priority by the healthcare system in Canada may also contribute to nurses' reduced capacity to move beyond the patient to planetary health care.

Continuing Education on VBDs

Participants indicated that they would consider continuing education opportunities, research articles, patient educational materials, case studies or best practice approaches, and treatment or assessment options to be helpful resources on VBDs. These findings are consistent with an integrative review by Fossum et al. (2022), who found that greater access to digital resources in the last decade has enhanced nurses' ability to access evidence-based information; however, peer nurses were the most common source of information in clinical practice. Additionally, reference materials, nursing journals, continuing education, and supervisors were

considered important sources of information for nurses in practice. Furthermore, Cuzmenco (2024) advocated for workplaces that support and value scholarly inquiry, where current research and practice guidelines for clinical decision-making are promoted to achieve evidence-based practice, given that evidence-based practice is associated with improved patient outcomes, enhanced patient safety, and lower health care costs (Opperman et al., 2022).

Most participants were interested in an open access continuing education course or online modules about VBDs if available. This finding is consistent with literature that continuing professional development opportunities are important for nurses' lifelong learning and are a vital aspect for keeping nurses' knowledge and skills current (Mlambo, Silen, & McGrath, 2021). Self-motivation, relevance to practice, strong leadership, and a positive workplace culture are all factors that enhance the impact of continuing education for nurses (King et al., 2021). Furthermore, according to Song and Park (2021), e-learning should be meaningful, where educators or course developers plan, apply, and evaluate appropriate online activities by considering pedagogical perspectives, educational objectives, and outcomes, learning styles, and the educational environment. Integrating new technologies into e-learning modules or education courses, such as game-based learning and social media, will enhance learning (Song & Park, 2021).

Despite interest in continuing education, very few participants were aware of the CASN E-Resource on VBDs. Nurse educators and nurse managers reported significantly greater awareness of the CASN guidelines compared to frontline staff, while agreement with this statement was significantly higher for nurses with a PhD or a master's degree, compared to nurses with a baccalaureate degree. Significant differences also existed across practice areas, where more nurses in educational institutions were significantly more aware of the CASN

guidelines compared to nurses working in critical care, public health, medical/surgical, geriatrics, pediatrics, emergency departments, operating room, obstetrics, and occupational health.

Significant differences were noted across provinces, with significant differences between nurses in Quebec compared to British Columbia, Alberta, Saskatchewan, Nova Scotia, and Newfoundland, with nurses in Quebec perceiving greater awareness of the CASN guidelines. Finally, more Indigenous, Metis, and Inuit nurses were aware of the CASN guidelines compared to participants who did not declare Indigeneity or who preferred not to answer. This lack of awareness is concerning and highlights the importance of knowledge translation, where knowledge is communicated and shared in an effective manner to assist in making informed practice decisions and improve overall patient health outcomes (Olson & Oudshoorn, 2019).

Nurses' Professional Role with Equity-Denied Populations

Most of the nurses in the study agreed that Indigenous Canadians disproportionately experience negative health effects from climate change. Nurses in urban settings agreed with this statement to a greater extent than nurses in rural settings, and nurses who declared Indigeneity compared to those who preferred not to answer. According to Brand et al. (2023), CASN (2020), and Martin and Kaminski (2021), nurses must acknowledge the knowledge and expertise of Indigenous Peoples on climate change and planetary health, and respect and honor the holistic relationship Indigenous Peoples have in relation to the land (Brand et al., 2023; CASN, 2020; Martin & Kaminski, 2021). This understanding will promote knowledge of how the social determinants of health, historical injustices, public policies, and circumstances impact VBDs vulnerability and subsequent health effects for equity-denied populations, such as Indigenous Peoples (CASN, 2020).

According to Bourque Bearskin et al., (2020) and Van Bewer et al. (2020), nursing education and practice often marginalizes Indigenous ways of being, knowing and doing, and nurses are called to advocate for the integration of Indigenous traditional knowledge into nursing education and healthcare practice. Additionally, nurses have a responsibility to reveal barriers to including Indigenous perspectives into policies and practices. Furthermore, Sanderson et al. (2020) stated that action is required to address inequities and systemic racism faced by Indigenous Peoples, and within Indigenous health nursing, Indigenous and non-Indigenous nurses should work together to protect and promote Indigenous Peoples' health and human rights.

Most study participants also agreed that nurses must advocate for social justice by addressing socioeconomic inequities which exist among equity-denied populations that are at risk of VBDs. Nurses with a master's degree placed higher value on advocacy than nurses with a diploma or baccalaureate degree, which can be attributed to greater knowledge in this subject area given their advanced education. Additionally, Indigenous, Metis, and Inuit nurses agreed with this survey item more than nurses who did not declare Indigeneity. Nicholas and Breakey (2017) believed that nurses have a commitment to social justice, where they are obligated to recognize and act on the complex impacts of climate change on health, such as VBDs. Similarly, Smith (2019) and Tiita et al. (2021) established that nurses should be prepared to address VBDs in practice to fulfil their role as champions of social justice. Sanderson et al. (2020) stated that nurses must understand climate change as a foundation for meaningful response for social justice and environmental health, while Martin and Kaminski (2021) believed that nurses should be strong advocates for health equity.

Recommendations

The following section includes recommendations for education, practice, advocacy, and research, based on the study findings, current context, and discussion above.

Recommendations for Education

Given the limited knowledge of nurses on climate change and VBDs revealed in the current study, planetary health, climate change and VBDs content must be better integrated into nursing curriculums across Canada to better prepare nurses to address planetary and climate health challenges, such as VBDs, in practice. Both current and future nurses have an integral role in mitigating climate-related health effects, and therefore must be knowledgeable about these issues. Curricular modifications are recommended using planetary health framework to guide curriculum development. Myer's (2017) schematic on planetary health (see Figure 3.1) and the Planetary Health Education Framework (see Figure 2.1) are appropriate frameworks that align with nursing education and can be readily adapted into nursing curricula to ensure students are prepared for future practice, where an understanding of planetary health, climate change, and VBDs is essential.

Nurse educators should attempt to decolonize nursing curricula and situate the topics of planetary health, climate change, and VBDs in Indigenous perspectives. According to Chinn (2022), decolonization refers to the “recognizing the cultural hegemonies—the constitutive frameworks of power that control thought, naming them, and putting labels on them. In our current contexts, the dominant cultural hegemonies derive from white, Euro-centric thought” (p. 1).

A broader understanding of planetary health is necessary, where Indigenous values and knowledge are acknowledged rather than silenced (Jones et al., 2022). Indigenous perspectives

and knowledge on climate change and related health effects provide numerous opportunities for nursing education, including discussions around holism, sustainability, climate justice, stewardship, relationality, and reciprocity (Bourque-Bearskin et al., 2020; Van Bower et al., 2020). Although dated, the Aboriginal Nurses Association of Canada (2009) outlined competencies for nursing education in Canada, where students are called to “demonstrate ways to acknowledge and value Indigenous knowledge with respect to the health and wellness of First Nation, Inuit, and Metis clients, families, and communities” (p. 13).

Integration of Indigenous knowledge and practices into nursing curricula is necessary to ensure future nurses can respond and adapt to environmental changes in Canada. In addition to a focus on the SDOH in nursing curricula, I recommend that the determinants of planetary health from an Indigenous perspective should take priority. These determinants provide a means to practically lead sustainable health for both humans and the planet (Redvers et al., 2022). Incorporating the determinants of planetary health from an Indigenous perspective into nursing education will allow students to appreciate the interconnectedness of human and planetary health and appreciate both Indigenous and Western ways of knowing in planetary health action (Jones et al., 2022).

Furthermore, the *Two-Eyed Seeing* approach would be a valuable addition to nursing curricula, where the strengths of Indigenous knowledge are appreciated through one eye, while recognizing the strengths of Western knowledge and ways of knowing with the other eye (Guzman & Potter, 2021; Martin, 2012; Redvers et al., 2022). This approach would allow students to appreciate culturally safe, trauma-informed care and understand how colonization and historical injustices may place Indigenous populations at greater risk of climate-related health effects.

It is recommended that content on planetary health, climate change, and VBDs be integrated throughout nursing programs, instead of within singular courses, as this approach would promote holistic student thinking about planetary health and subsequent challenges using a levelled approach. Furthermore, it is recommended that curricular initiatives meet the educational needs of students, considering learning styles, new technologies, such as simulation and digital technologies.

These recommendations are supported by Hanley & Jakubec (2019), who advocate for early integration of environmental health concepts in nursing curriculum, promoting opportunities for nursing students to prepare for their expanded role in planetary health. Additionally, Bernhardt et al. (2023) instituted a climate center, where efforts on curriculum development, integration, and evaluation in both theory and clinical courses, as well as supporting courses such as ethics, health policy, and professional issues, addressed population health issues related to climate change. Furthermore, Butterfield et al. (2021) advocated for a national nursing education curriculum on topics such as planetary health, social determinants of health, climate change, and health equity, as well as the inclusion of climate change content into accreditation requirements.

Given the findings that nurses with a baccalaureate degree possess lower levels of knowledge than nurses with a master's degree or PhD, nursing education programs across Canada must take action to ensure nursing graduates are knowledgeable in these concepts upon entry to practice. As the leading organization for nursing education in Canada, CASN released the *National Nursing Education Framework* in 2022, and a specific learning outcome for undergraduate nursing graduates is the ability to “describe global and planetary health issues and their effects on health” (p. 10), which may urge nursing education programs across Canada to

integrate planetary health issues, such as VBDs, into nursing curricula. While the National Nursing Education Framework is an excellent starting point for the inclusion of planetary health in nursing curricula in Canada, it is recommended that additional learning outcomes specific to climate change and VBDs are included in future revisions of the framework. Furthermore, CASN is encouraged to enhance educational initiatives and activities on climate driven VBDs and promote their E-Resource on VBDs more widely, given the fact that few study participants were aware of their E-Resource.

Recommendations for Practice

Nurses, particularly those involved in frontline care, are well positioned to address climate-related health implications; however, study findings revealed that nurses lack knowledge and confidence in the practice setting, and therefore are unprepared to address VBDs with their patients. Most nurses did not receive any formal education on VBDs, and therefore do not discuss climate change or VBDs with patients in the practice setting. Additionally, most nurses in the current study had never received any information in the practice setting on VBDs, which is concerning. In a recently released position statement on planetary health, the CNA (2024) calls on nurses to promote both human and planetary health. Furthermore, nurses must provide nursing care in a manner that supports planetary health by addressing the triple threat, namely climate change, biodiversity loss, and pollution (CNA, 2024).

Therefore, it is recommended that nursing regulatory bodies and associations in Canada revise the entry-to-practice competencies and nursing standards of practice to include planetary health, climate change and related health implications, such as VBDs, to ensure practicing nurses in Canada are prepared to effectively care for patients. Greater attention must be placed on VBDs

in geographic regions in Canada that are not currently considered highly endemic, such as Northern and Western regions, to enhance practice preparedness of nurses in these areas.

Climate driven VBDs should be prioritized in all nursing practice areas, and Indigenous nurses are encouraged to lead the nursing profession to a decolonization of nursing knowledge. According to Chinn (2022), nurses should engage in decolonization to question dominant views of health and to attain social justice. Nurses in practice should collaborate with the Canadian Indigenous Nurses Association (2019) “to work with communities, health professionals and government institutions on Indigenous Health Nursing issues and practices within the Canadian health system that address particular interest and concern in Indigenous communities with a view to benefiting Indigenous Peoples of Canada by improving their health and well-being” (para 6).

Healthcare and nursing entities in Canada are advised to enhance continuing education for HCPs on planetary health, climate change, and VBDs, which will create a more informed and appropriately skilled health workforce that is better equipped to use evidence to foster change. Skills in communication and advocacy are necessary to facilitate multisectoral partnerships and planetary health and climate-related policy development. Greater effort must be taken to provide nurses and other HCPs with evidence-based information that is readily available, accessible, and reliable. For instance, learning modules, instructive resources, or education programs are advised for nurses to improve patient care and knowledge in planetary health, as well as climate change and VBDs mitigation and advocacy.

These recommendations for practice are consistent with current literature, where Coderre-Ball et al. (2021) asserted that consistent education for HCPs is an important step to reduce knowledge gaps, as it improves performance to effectively treat patients, leading to better patient health outcomes. Butterfield et al. (2021) similarly believed that climate change and

related health issues must be included in clinical practice requirements and national licensing councils. According to Bernhardt et al. (2023), health organizations must better prepare nurses, particularly those on the frontlines, as these organizations are large contributors to climate change and greenhouse gas emissions.

Recommendations for Advocacy

It is recommended that nurses in Canada prioritize planetary health issues and subsequent health concerns, such as VBDs, within both their personal and professional lives. I recommend that the nursing profession acknowledge the value of Indigenous nurse leaders on planetary health issues. Decolonization of nursing knowledge, and a focus on health equity and social justice is necessary, particularly with equity-denied populations, such as Indigenous Peoples. This recommendation is supported by Martin and Kaminski (2021), who believed that nurses should advocate for health equity. Similarly, Butterfield et al. (2021) affirmed that nurses must strengthen commitment to Indigenous practices and knowledge and elevate health equity, justice, and morality. Furthermore, nurses are advised to consider the privilege they hold within Canadian society and employ their professional positions to enhance public awareness and risk perceptions of climate driven VBDs.

Furthermore, I recommend that the legislated scope of RNs increases to allow for expanded roles in planetary health and climate action policy advocacy and development, given that the scope of other HCPs, such as licensed practical nurses (LPNs) has increased in recent years. For instance, in Alberta, the LPN scope of practice recently increased to include administration of blood and blood products and administering medication by an invasive procedure, such as a central venous line (College of Licensed Practical Nurses of Alberta, 2023). Advocating for advanced practice roles among RNs in planetary health and climate action would

promote better health outcomes for individuals and populations. This recommendation is supported by Butterfield and colleagues (2021) who advocate for advancing nurses into leadership roles and paying for nurses' climate change work.

Bernhardt et al. (2023) stated that policy and advocacy efforts among nurses are needed to advance climate change efforts, and nursing students and nurses in clinical practice and education can address climate change on a local, state, and national level to decrease the health risks associated with climate change. Chinta (2023) advocated for nurses to become climate leaders through innovative strategies, such as effective social media use, while Rosa and Upvall (2019) suggested that nurses can facilitate partnerships with multidisciplinary leaders beyond the traditional healthcare system, ensuring a holistic nursing lens and a planetary health approach.

Advocacy within the Canadian Context

Nurses are encouraged to assume greater leadership by advocating to and engaging with nursing organizations, regulatory bodies, healthcare organizations, legislators, and governments across Canada to act on these issues to advance population and planetary health. Nurses can encourage researchers, policy developers, and practitioners to take a multi-disciplinary and multi-sectoral perspective to develop climate-sensitive policies, given the challenges with the complexities of climate change and VBDs. According to Myers (2017), factors, including good governance and financial resources, can mediate the effects of planetary health challenges, such as climate change, on health.

Despite the importance of good governance and financial resources, outlined by Myers (2017), it can be argued that climate change and VBDs are not considered priority public health issues in Canada (CPHA, 2021), and sound governance and adequate public health funding is not occurring. Prior to the COVID-19 pandemic, only 6% of health funding was allocated to public

health (Duong & Vogel, 2022), and recent statistics on public health funding were not located. The COVID-19 pandemic contributed to a further devaluing of public health, not only in Canada but globally. According to Samet and Brownson (2024), the COVID-19 pandemic, and other ongoing public health concerns have highlighted challenges for public health systems. An erosion of trust in the public health system has occurred, leading to ongoing concerns around vaccine hesitancy and the science behind public health policies, as well as the political nature of public health (Carrieri et al., 2023; Samet & Brownson, 2024).

Positioning planetary and human health within economics and a socio-political context has created disconnect and a lack of urgency (CPHA, 2021). The reluctance of governments, healthcare organizations, and policy developers in Canada to allocate funding to planetary health issues, such as climate change and VBDs, diminishes the ability of HCPs to engage in mitigation and advocacy initiatives (CPHA, 2021). Therefore, policy advocacy by nurses on planetary health issues is challenging

Recommendations for Research

This research area is emerging, particularly within nursing literature. According to Vandenberg et al. (2023), original research on this topic is lacking, and while there is an abundance of literature that recommends nurses should be knowledgeable about VBDs, research on nurses' perceived knowledge, and an evaluation of their practice readiness is absent. This research study contributes significantly to the current body of knowledge, by providing an analysis of the knowledge, attitudes, perceptions, and practices of RNs, rather than articulate a list of competencies required for practice, addressing a gap in existing literature. This research study provides baseline data on knowledge, attitudes, beliefs, and behaviors of RNs toward climate driven VBDs; however, there is a need for further research to evaluate RN workforce and

practice readiness in meeting the challenges of planetary health and VBDs, which will promote improved practice competence.

Research with other groups of HCPs may be necessary to compare perceptions of RNs with other HCPs or members of the multidisciplinary team. Furthermore, research on curricular integration of planetary health, climate change, and VBDs across Canada is warranted. Exploring student knowledge, attitudes, beliefs, and behaviors toward climate driven VBDs may provide additional information on educational preparation of the future nursing workforce. According to Bernhardt et al. (2023), scholarly engagement to address climate change and health implications requires urgent leadership by nurses, nurse educators, and nurse researchers.

Planetary Health Research

Planetary Health can be considered a pragmatic theoretical framework, suitable to guide research on anthropogenic changes on both human and planetary health. Hence, it was chosen to guide nursing this research study on the KAP of RNs toward climate sensitive VBDs in Canada. While the research study did not explicitly explore planetary health among practicing RNs in Canada, the research aligned with components of Myer's (2017) schematic illustration of anthropogenic change on human health where climate change is the ecological driver and causes exposure to infectious disease and subsequent health effects, such as VBDs. Mediating factors, such as good governance, financial resources, philanthropy, appropriate uses of technology, and cultural considerations can mitigate the overall health effects (Myers, 2017).

While the survey items were specifically focused on VBDs, namely Lyme disease and WNV knowledge, attitudes, and practices, they all fall under the planetary health umbrella and demonstrate how closely aligned environmental issues and climate change are with planetary health. Indigenous-led and focused nursing research using the determinants of planetary health

from an Indigenous perspective (Redvers et al., 2022) is recommended to decolonize nursing research. Similarly, Chinn (2022) calls on decolonization of nursing knowledge “by creating new knowledge by using the terms of the people, the frames of reference, and knowledge patterns that come from other countries and cultures and then attempt to develop research, practice, and education that flow from those philosophies” (p. 1).

Given the current planetary health challenges and emerging climate-related health threats in Canada and around the globe, it is necessary for nurses to be prepared for climate change mitigation and advocacy roles. However, according to Kurth and Potter (2022) and Martin and Kaminski (2022), it is challenging for the nursing profession to integrate planetary health care into nursing practice. Therefore, nursing research in this area is recommended as evidence for action to preserve human and planetary health and situate nurses as leaders, both within healthcare practice, as well as within overall planetary health.

While the term *planetary health* has exploded in nursing literature in recent years, upon review of the minimal published literature, there did not appear to be any published original research that incorporated planetary health as a theoretical framework. Therefore, to my knowledge, this is the first research study to do so. Myers (2017) planetary health framework was an innovative and effective way to situate the overall research topic and questions, where aspects of planetary health, namely climate change and VBDs, were examined with practicing Canadian RNs. Hence, it is timely to advocate for planetary health as a theoretical framework to guide nursing research, education, and practice to ensure nurses are prepared for their roles as exemplary planetary health communicators, collaborators, educators, facilitators, advocates, and leaders in advocating for and promoting sustainable and equitable health care.

Limitations

While efforts were taken to ensure this study followed research and ethical guidelines, there are several limitations to report. First, the findings of this study are specific to one group of HCPs in one country. Although the study was conducted with RNs in Canada, the perceptions of other HCPs may be similar to that of nurses and the topic of climate driven VBDs is internationally relevant. Second, the sample size was small, where only a small percentage of eligible RNs in Canada participated in the research study, despite significant efforts to recruit study participants through various methods. While not a specific limitation to this research study, but rather of the nursing profession as a whole, as discussed throughout this chapter, there may be a general lack of interest by practicing nurses in climate change research, and specifically research on VBDs, contributing to the small sample size in this study.

Thirdly, limitations exist in the findings for the comparative statistics between province/territory, age, and practice area, given that a larger sample size was recommended to conduct a one-way ANOVA with greater than six groups according to G*Power. Therefore, the findings of this research must be interpreted with caution and may not be generalizable to the population of RNs in Canada. While it is recommended that this emerging issue should be explored more broadly, this study is an important beginning to inquiry of climate driven VBDs among nurses in Canada.

Research Dissemination

Scholarship comprises three key elements, namely, documentation, peer review, and public dissemination (CASN, 2013). In alignment with the principles of knowledge translation, research findings will be broadly disseminated in a manner that supports meaningful integration into practice and subsequent action. Resources, such as infographics, workshops, online

webinars, and online courses may be considered to promote knowledge of VBDs among nurses and other HCPs. Research findings and recommendations will be shared with nurses and nursing organizations across Canada, as well as through conference presentations. Additionally, I will attempt to share research findings with government officials and healthcare organizations across Canada, with the hope that climate-related health concerns, such as VBDs, will become a greater priority within the healthcare system in Canada. In alignment with the CASN (2013) elements of scholarship listed above, it is my intent to document and disseminate findings through peer-reviewed publications and presentations to promote greater understanding of this issue. This emerging topic provides an appropriate evolution into a program of research in this area.

Program of Research

A program of research should be an area of interest, passion, and commitment to the person describing it (Holzemer, 2009). Additionally, a program of research should address a significant public health issue that contributes to improved health care outcomes (Holzemer, 2009). Building a program of research involves scholarship. According to CASN (2013), nurses in academia are responsible for engaging in scholarship and advancing nursing knowledge. CASN (2013) defines scholarship as “a full range of intellectual and creative activities that include the generation, validation, synthesis, and/or application of knowledge to advance science, teaching, and practice” (p. 2).

This research study provided baseline data on the KAP of RNs in Canada toward climate sensitive VBDs. While this study was important and timely, additional research is needed on this topic, given that planetary health issues are of significant public health importance. Therefore, my anticipated program of research will be focused on planetary health broadly, with a special interest in addressing climate-related issues, such as VBDs, outlined below.

My anticipated research will be centered on planetary health, with a focus on nursing calls to action and preparedness to address these calls to action in nursing education, practice, and advocacy. Given the lack of original research in planetary health in nursing, there is a need for research to understand how nurses perceive their role in planetary health, and the competencies required for practicing nurses to become effective planetary health leaders. Research on planetary health in nursing education is necessary, through the examination of current curricular content, preparedness of nurse educators in teaching this content, and readiness of students entering nursing practice. This research will hopefully inform the development of entry-to-practice competencies for undergraduate nursing education on planetary health. Furthermore, it is anticipated that the knowledge gained through research will promote effective knowledge translation activities and action by leading nursing organizations and nursing regulatory bodies to ensure nurses are prepared for planetary health leadership roles.

Additionally, there is a need for further research to evaluate RN workforce and practice readiness in meeting the challenges of planetary health, climate change, and VBDS, which will promote improved practice competence. I plan to address the gaps in competencies around climate change and subsequent health outcomes, such as VBDS, for nursing practice. The CASN (2020) *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases* situate necessary knowledge and skills within nursing education in Canada; however, competencies for entry-level nursing practice have not yet been developed. Through research and meaningful knowledge translation, it is my hope that nurses will advance their knowledge on these important issues, and thereby assume a greater role in advocating for climate action, including action on mitigation of climate sensitive VBDS, reduction of social inequities, and strengthened public health infrastructure.

Furthermore, research on curricular integration of climate change and VBDs is warranted. Evaluative research on the integration and effectiveness of the CASN (2020) *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases* is timely, given that the guidelines were released four years ago. I plan to explore student knowledge, attitudes, beliefs, and behaviors toward climate driven VBDs, which will provide information on educational preparation of the future nursing workforce. Research in this area will hopefully promote curricular changes, where planetary health becomes a central feature in nursing education programs.

Finally, given the challenges people living with VBDs face in Canada, particularly those with Lyme disease, I believe nurses must do more to provide appropriate patient-centered care and treatment. Hence, I plan to engage in participatory action research in my research program, where patient perceptions, attitudes, and experiences associated with climate sensitive VBDs in Canada are explored. Additionally, research on the intersection of nurses and patients with VBDs within the healthcare system is warranted. It is expected that research will uncover strengths, challenges, barriers, and opportunities for nurses and patients, which will lead to a greater understanding of the issues within our healthcare system. Additionally, through effective integrative research, I am hopeful that changes to policies and guidelines on VBDs, including the treatment of Lyme disease in Canada, are made. Opportunities for collaboration between HCPs and patients with lived experience of VBDs will be explored, promoting patient-centered care and overall health and well-being of people living with VBDs.

My anticipated program of research relates closely to significant public health concerns nationally and globally. Therefore, it is to be expected that funding initiatives in this research area will be available, through Tri-Council funding and other sources of funding. I plan to

continually assess my goals and research program in relation to the current health care and nursing context to stay informed of developments, research opportunities, and funding announcements, and capitalize on available opportunities. I plan to utilize strategic approaches to form strong research teams of like-minded researchers, clinical partners, patient partners, and students to promote success in funding applications and research projects. Additionally, I will ensure strategies are in place to support and sustain research success, which may include mentorship, partnerships, and the necessary personal, professional, and institutional supports.

To build a research career, one must engage in scholarship. Scholarship includes four domains: scholarship of discovery, scholarship of teaching, scholarship of application, and scholarship of integration (Boyer, 1990; CASN, 2013). In my anticipated program of research, I aim to engage in all forms of scholarship, where I create new knowledge, support nursing pedagogy, advance knowledge in the practice setting, and develop new insights through integration with other disciplines. According to Clark and Souza (2018), nurse academics are often called extreme knowledge workers, who “create, distribute, and apply knowledge” (p. 12). Therefore, in my program of research I will aim to influence change, improve the lives of patients and populations, promote social and climate justice, and answer questions and create knowledge in areas I am passionate about (Clark & Sousa, 2018).

Personal Reflections

I have had the privilege of being employed at the University of Lethbridge since 2009, and one building on campus always attracts my attention. On one of the cornerstones of the University of Lethbridge library entrance is a quote by Michelangelo: “I am still learning.” Every time I walk past this quote, it serves as both a reminder of the importance of, as well as an inspiration to pursue life-long learning. My teaching philosophy revolves around this concept,

and I attempt to inspire my students by stressing that the conclusion of formal education should not mean the end of their learning journey. Part of inspiring students to engage in lifelong learning is by “walking the talk” and being a role model for my students, and the quote by Michelangelo above has become my personal and professional motto. This is in part, why I chose to pursue further education through the Population Studies in Health (PhD).

I completed my Master of Science in Nursing degree in 2013, and my supervisor at that time, Dr. Judith Kulig, tried to persuade me to pursue a PhD immediately following completion of my MSc. I was at a crossroads in my life and beginning a new family, and the timing did not seem right then. However, after ongoing discussions about furthering my education with a close friend and colleague in 2020, in 2021 I decided I was ready to embark on the journey. My intent to pursue a PhD was driven by my love of learning and interest in further research activity. Since the start of my career, I have demonstrated my love of learning and knowledge acquisition through the countless courses and modules I have completed, numerous certifications I earned, and projects I have been involved in. I have successfully managed to engage in these learning opportunities while maintaining competence in my role as a nurse educator in the Faculty of Health Sciences at the University of Lethbridge, as well as raising a young family. My strong organizational abilities, initiative, motivation, and determination for success has enabled me to effectively manage the commitments I pursue.

In 2020, I was hired by the Canadian Association of Schools of Nursing (CASN) as a content expert for the project titled: *Empowering the next generation of health care professionals with knowledge, skills, tools, and supports to address infectious diseases related to climate change in Canada*. A colleague and I developed three out of the five modules in the *Climate-Driven Vector-Borne Diseases and Nursing E-Resource*. The goal of this project was to increase

the knowledge of the effects of climate driven infectious diseases on population health in Canada amongst nurse educators, and to foster the integration of this knowledge into Canadian nursing education programs. This project sparked an interest in this novel area of research, particularly because while we were engaged in this project, we learned that HCPs may not always provide competent care for patients with VBDs in Canada, due to a lack of knowledge and awareness on the topic. Engaging in this work fueled my interest in contributing to knowledge generation by means of research and provided the foundational ideas for this PhD dissertation.

Evolution as a Researcher

Recently, my family and I visited the Kennedy Space Center in Florida, and the experience was awe-inspiring to say the least. One aspect of the visit that resonated with my children, but also with myself, was President John F. Kennedy's speech, where he persuaded the American people to support the Apollo space program. He spoke these words on September 12, 1962:

The greater our knowledge increases, the greater our ignorance unfolds...But why some say the moon? Why choose this as our goal? And they may well ask, why climb the highest mountain? Why 35 years ago fly the Atlantic? We choose to go to the moon. We chose to go to the moon. We choose to go to the moon in this decade and do the other things not because they are easy, but because they are hard. Because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we're willing to accept. (John F. Kennedy Presidential Library and Museum, video transcript)

President Kennedy's words caused me to reflect on my PhD journey, and I can attest that I chose this journey not because it would be easy, but because it would test my skill and my

determination, and because the completion of this degree opens doors that were previously closed. Obtaining a PhD will provide greater opportunities for knowledge generation, translation, and evaluation, allow me to share my love of learning and research with students at both undergraduate and graduate levels, advance the nursing profession, and promote the facilitation of change to advance positive healthcare outcomes.

Therefore, while this PhD journey has been filled with roadblocks, potholes, and sharp curves, the view has been rewarding and the destination is in sight. Through the delicate blend of both failures and successes, I now have a clearer understanding of my existence and my position in the world, and these experiences influence how I approach professional practice and my position as a novice researcher. I experienced many challenges along the way, particularly early in the program where I struggled with the coursework and feelings of intense guilt given the burdens and demands of the program on my personal and family life. Toiling through manuscripts and experiencing rejection from publishers creates discouragement, but I persevered and carried on. The successes and failures have allowed me to experience growth, and I believe I have evolved into a well-rounded scholar. Furthermore, I have experienced unwavering support of family, friends, colleagues, my supervisor, and committee members along the journey, and have met many wonderful individuals with similar research interests. These connections have developed into working relationships, where I am involved in several projects in my area of research to date. My journey relates to a quote by Mackey and Bassendowski (2017), who eloquently state: “Never consider ourselves finished nurses; we must be learning all of our lives” (p. 52).

Evolving Topic of Research

One particular challenge I faced as I completed this degree is the evolving nature of my topic of research. The landscape of climate driven VBDs has changed significantly in the past few years, with new research continually being published. Additionally, the concept of planetary health has gained considerable traction in recent years, particularly in nursing literature. As a novice researcher, I had the time to continually review literature to ensure the work I was completing was current, which was a significant benefit as this allowed me to strengthen my knowledge of the current literature on this topic. Overall, these challenges can be viewed positively, where these issues are more widely known and a greater priority for Canadians than when I began PhD studies.

Research in a Digital Age

Given the current nursing landscape in Canada, discussed earlier in this dissertation, I experienced challenges with recruitment. A small percentage of eligible RNs in Canada completed the survey, despite considerable efforts to recruit nurses to the study. Barriers to recruitment of nurses include survey fatigue and organizational structures that limit access to participants (Bethel, Rainbow, & Dudding, 2021). Upon reflection on recruitment strategies, I ponder whether there are more effective ways to recruit nurses to participate in research. Social media is certainly an advantageous and promising method of survey recruitment. Bethel et al. (2021) found that social media is an accessible, cost-effective, high-yield recruitment strategy of nurses for survey research. While I utilized social media for this research project, I question whether there are additional approaches to reach nurses through social media successfully, and Bethel et al. (2021) provide several recommendations that I will consider for subsequent survey research.

However, as I experienced in this study, there are certainly risks to using online surveys in a digital age. With online surveys, there is an increased risk that survey data will be hacked or infiltrated by bots, as strategies used to hack surveys have become increasingly sophisticated (Reagan et al., 2019; Simone, 2019). I experienced this risk with data collection, where my online Qualtrics™ survey was hacked early on, and approximately 400 additional survey responses had to be deleted, as the “bot detection” and CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart) options were not enabled in Qualtrics™. One strategy to combat bots is frequent data checking, and as a novice researcher, I engaged in this practice which allowed me to detect and attend to the issue immediately after it occurred. Foolishly, I assumed that a reliable program such as Qualtrics™ would automatically enable those features in their survey development, however I was mistaken. Therefore, when utilizing Qualtrics™ in the future, I will ensure these features are enabled, as well as consider the recommendations by Bethel et al. (2021), namely including more open-ended survey responses, and asking similar questions at different points in the survey to detect inconsistencies.

Conclusion

Climate driven VBDs are an emerging issue in Canada, affecting overall population health. Given the integral role that RNs have in supporting individuals and populations affected by various climate-related health challenges, exploring nurses’ knowledge, attitudes, and perceptions toward climate-sensitive VBDs was warranted. The purpose of this quantitative, cross-sectional research study was to investigate the knowledge, attitudes, and practice of RNs in Canada related to climate sensitive VBDs, using Planetary Health as the guiding theoretical framework. An online national survey was distributed via Qualtrics™ to practicing RNs across

Canada, through contact with nursing organizations and regulatory bodies, as well as social media.

Research findings indicate that overall, nurses' knowledge on climate change and VBDs was limited, specifically among frontline nurses and those in Western and Northern regions of Canada. Greater knowledge of Lyme disease compared to WNV was perceived, particularly among nurses working in highly endemic areas and Indigenous, Metis, and Inuit nurses. RNs do not often consider VBDs in practice and demonstrated a lack of confidence and preparedness in addressing VBDs in the practice setting. Barriers to discussing VBDs in practice exist, with lack of knowledge and time reported most frequently. Most study participants never received training or education on VBDs, and information on VBDs for nurses in the practice setting is absent. Most nurse participants believed they have a role in health equity and social justice, particularly for equity-denied populations, such as Indigenous Peoples. A greater understanding of nurses' knowledge, attitudes, and practices of climate driven VBDs has been achieved through the meaningful data obtained from study participants. The goal of this research is that nurses are better prepared to address VBDs in the practice setting and assume a greater role in leading change to advocate for a climate-resilient future.

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APPENDIX A: KAP SURVEY TOOL

Part 1: Demographics

This section contains questions that provide descriptive information about you and the setting in which you work.

1. What best describes your current primary position?
 - a. Frontline care provider/staff nurse
 - b. Nurse educator
 - c. Nurse manager
 - d. Other

2. What is your highest level of education?
 - a. Diploma
 - b. Baccalaureate Degree
 - c. Master's Degree
 - d. PhD
 - e. Other

3. What is your current primary practice area?
 - a. Critical Care
 - b. Educational Institution
 - c. Emergency department
 - d. Geriatrics
 - e. Home Health
 - f. Hospice care
 - g. Medical-Surgical nursing
 - h. Mental Health
 - i. Neonatal care
 - j. Obstetrics
 - k. Occupational Health
 - l. Oncology
 - m. Operating Room
 - n. Orthopedic nursing
 - o. Pediatrics
 - p. Primary Care
 - q. Public Health
 - r. School Nurse
 - s. Travel nursing
 - t. Other _____

4. What is your age? _____
- a. 20-25
 - b. 26-30
 - c. 31-35
 - d. 36-40
 - e. 41-45
 - f. 46-50
 - g. 51-55
 - h. 56-60
 - i. 61-65
 - j. 66+
5. How many years have you practiced as a Registered Nurse?
- a. Less than 5
 - b. 5-10
 - c. 11-20
 - d. 21-30
 - e. 31-40
 - f. 41 or more
6. What province or territory do you currently hold registration and practice in?
- a. British Columbia
 - b. Alberta
 - c. Saskatchewan
 - d. Manitoba
 - e. Ontario
 - f. Quebec
 - g. Nova Scotia
 - h. Prince Edward Island
 - i. New Brunswick
 - j. Newfoundland & Labrador
 - k. Nunavut
 - l. Northwest Territories
 - m. Yukon Territory
7. Where do you live?
- a. Urban setting
 - b. Rural setting
 - c. Unsure
8. Are you Indigenous, Metis, or Inuit?
- a. Yes

- b. No
- c. Prefer not to answer

Part 2: Knowledge of Climate-Driven Vector-Borne Diseases

This section contains questions to assess your current knowledge of the most common climate-sensitive vector-borne diseases (VBDs) in Canada.

- 9. Vector-borne diseases are caused by viruses, bacteria, or parasites that are transmitted to humans from animals or insects.
 - a. True
 - b. False
 - c. Unsure

- 10. Lyme disease and West Nile virus are the two most prevalent vector-borne diseases in Canada.
 - a. True
 - b. False
 - c. Unsure

- 11. When you care for patients or clients with Lyme disease, how often do you consider that climate change is playing a role in causing or exacerbating the condition?
 - a. Never
 - b. Rarely
 - c. Sometimes
 - d. Often
 - e. Always
 - f. I don't know
 - g. I don't see patients/clients with Lyme disease

- 12. When you care for patients or clients with West Nile virus, how often do you consider that climate change is playing a role in causing or exacerbating the condition?
 - a. Never
 - b. Rarely
 - c. Sometimes
 - d. Often
 - e. Always
 - f. I don't know
 - g. I don't see patients/clients with West Nile virus

Please indicate the extent to which you agree or disagree with the following statements about climate change and vector-borne diseases.

	Strongly Agree (5)	Agree (4)	Neither Agree nor Disagree (3)	Disagree (2)	Strongly Disagree (1)
I feel knowledgeable about climate change and subsequent health implications.					
I feel knowledgeable about epidemiology of Lyme disease in Canada.					
I feel knowledgeable about epidemiology of West Nile virus in Canada.					
I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of Lyme disease in Canada.					
I feel knowledgeable about primordial, primary, secondary, tertiary, and quaternary prevention of West Nile virus in Canada.					
I feel knowledgeable about transmission of Lyme disease in Canada.					
I feel knowledgeable about transmission of West Nile virus in Canada.					
I feel knowledgeable about diagnosis of Lyme disease in Canada.					
I feel knowledgeable about diagnosis of West Nile virus in Canada.					
I feel knowledgeable about treatment of Lyme disease in Canada.					
I feel knowledgeable about treatment of West Nile virus in Canada.					
I feel knowledgeable about the controversies in treatment of Lyme disease in Canada.					

25. Have you completed any continuing education or formal education on climate-sensitive vector-borne diseases?

- a. Yes
- b. No
- c. Unsure

Part 3: Attitudes toward Vector-Borne Diseases

This section contains questions to assess your perception of risk for climate-sensitive vector-borne diseases in Canada and your degree of confidence in addressing concerns related to these diseases.

Please indicate the extent to which you agree or disagree with the following statements about climate change and vector-borne diseases.

	Strongly Agree (5)	Agree (4)	Neither Agree nor Disagree (3)	Disagree (2)	Strongly Disagree (1)
26. Climate change is happening.					
27. Climate change directly or indirectly impacts the health of patients, clients, families, groups, communities, and populations in my care.					
28. As a nurse, I am concerned about the health impacts of climate-sensitive vector-borne diseases on patients/clients, families, groups, communities, and populations.					
29. Nurses are positioned to help patients/clients, families, groups, communities, and populations understand the health impacts from climate-sensitive vector-borne diseases.					
30. I feel well prepared to address climate-sensitive vector-borne diseases with patients/clients, families, groups, communities, and populations.					
31. I feel confident counseling patients, families, groups, communities, and populations about climate change and health.					
32. I feel confident counseling patients, families, groups, communities, and populations about climate-sensitive vector-borne diseases.					
33. Nurses should play an active role in discussing climate-sensitive vector-borne diseases with their patients/clients, families, groups, communities, and populations.					
34. Indigenous Canadians disproportionately experience negative health effects from climate change.					
35. It is important for healthcare professionals to advocate for social justice by addressing socioeconomic inequities which exist among populations that are at risk of vector-borne diseases.					

36. My views on climate change are influenced primarily by (select largest influence):
- Media - TV, Radio, podcast
 - Social Media - Twitter, Instagram, Facebook
 - Through current employment
 - Professional resources- ex. Journals, Professional associations, Governing bodies
 - Personal connections
 - Continuing education
37. My views on vector-borne diseases are influenced primarily by (select largest influence):
- Media - TV, Radio, podcast
 - Social Media - Twitter, Instagram, Facebook
 - Through current employment
 - Professional resources- ex. Journals, Professional associations, Governing bodies
 - Personal connections
 - Continuing education

Part 4: Practices, Experiences, and Resources

This section contains questions about your experiences and practices in your practice area related to vector-borne diseases, as well as accessing resources on vector-borne diseases.

38. What proportion of your patients or clients do you discuss the impact of climate change on their health?
- All
 - Most
 - Some
 - A few
 - None
39. What proportion of your patients or clients do you discuss the impact of climate-sensitive vector-borne diseases on their health?
- All
 - Most
 - Some
 - A few
 - None
40. How many times have you encountered a client with a climate-sensitive vector-borne disease in your practice setting?
- Never
 - 1-5 times
 - 6-15 times
 - 16-30 times

- e. 31-50 times
 - f. More than 50 times
 - g. Unsure
41. Have you ever received specific information about climate-sensitive vector-borne diseases for your practice setting?
- a. Yes
 - b. No
 - c. Unsure
42. Increasing my knowledge of climate-sensitive vector-borne diseases is a priority for me.
- a. Strongly Agree (5)
 - b. Agree (4)
 - c. Neutral (3)
 - d. Disagree (2)
 - e. Strongly Disagree (1)
43. Which of the following barriers prevent you from discussing climate-sensitive vector-borne diseases with patients or clients? (Check all that apply)
- a. Lack of time
 - b. Lack of knowledge regarding how to approach this issue with my patients or clients
 - c. My patients or clients would not be interested
 - d. My patients or clients would not be knowledgeable enough about climate-sensitive vector-borne diseases to discuss this issue
 - e. Discussing this issue with my patients or clients will not make much difference in their overall health
 - f. Climate change is not occurring
 - g. Not applicable – I don't face barriers discussing climate-sensitive vector-borne diseases with patients or clients
 - h. Other – please specify _____
44. Which of the following barriers prevent you from accessing resources on climate-sensitive vector-borne diseases? (Check all that apply)
- a. Lack of time
 - b. Financial constraints
 - c. Family obligations
 - d. Lack of motivation
 - e. Doesn't interest me
 - f. I don't know where to access reliable information about climate-sensitive vector borne diseases

- g. Not applicable – I don't face barriers accessing resources on climate-sensitive vector-borne diseases
 - h. Other – please specify _____
45. Which of the following resources related to climate-sensitive vector-borne diseases, if any, would be helpful for you? (Check all that apply)
- a. Research articles demonstrating the link between climate change and vector-borne diseases
 - b. Treatment or assessment options
 - c. Continuing education course on climate change and health (including vector-borne diseases)
 - d. Patient or client education materials
 - e. Case studies or clinical care examples demonstrating best practices for discussing climate change and health with patients or clients
 - f. I don't need any resources
 - g. I am not interested in this topic
 - h. Other – please specify _____
46. If a continuing education course or online modules on climate-sensitive vector-borne diseases were available to you, would you be interested?
- a. Yes
 - b. No
 - c. Unsure
47. If you are interested in a continuing education course, what format would you prefer?
- a. Open access (free complete course which is available for use)
 - b. Virtual synchronous (students log in and participate in class at a specific time)
 - c. Asynchronous (course content is available at any time)
 - d. Unsure
 - e. I am not interested
48. Have you had personal experience with vector-borne diseases outside of your clinical/work setting?
- a. Yes
 - b. No
 - c. Unsure
49. Are you aware of the Canadian Association Schools of Nursing E-Resource on vector-borne diseases?
- a. Yes
 - b. No
 - c. Unsure

50. How did you hear about this survey?

- a. Professional association
- b. Nursing interest group
- c. Social media
- d. Friend/colleague
- e. Place of employment

Thank-you for your time!

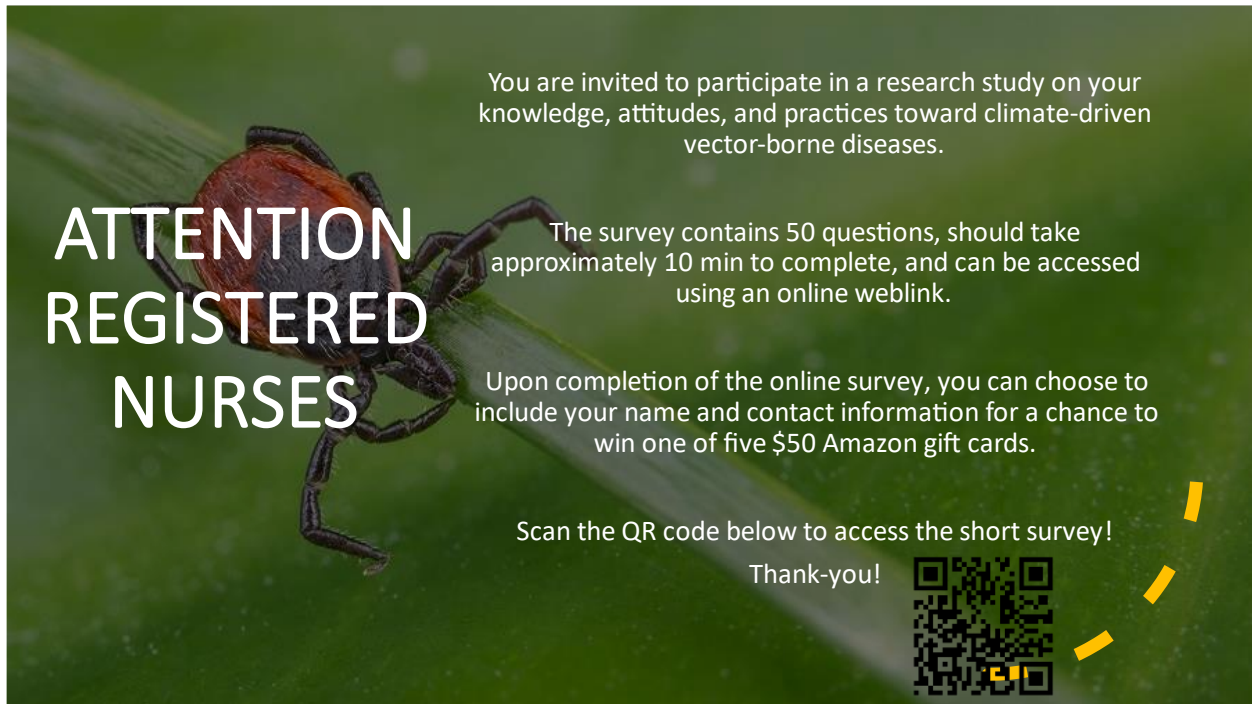
Survey adapted with permission from:

Kircher, M., Doheny, B. M., Raab, K., Onello, E., Gingerich, S., & Potter T. (2022).

Understanding the knowledge, attitudes, and practices of healthcare professionals toward climate change and health in Minnesota. *Challenges*, 13(57), 1-17.

<https://doi.org/10.3390/challe13020057>

APPENDIX B: RECRUITMENT POSTER & LETTER OF INITIAL CONTACT



**ATTENTION
REGISTERED
NURSES**


You are invited to participate in a research study on your knowledge, attitudes, and practices toward climate-driven vector-borne diseases.

The survey contains 50 questions, should take approximately 10 min to complete, and can be accessed using an online weblink.

Upon completion of the online survey, you can choose to include your name and contact information for a chance to win one of five \$50 Amazon gift cards.

Scan the QR code below to access the short survey!

Thank-you!





Are you a practicing Registered Nurse in Canada?

You are invited to participate in a research study on your knowledge, attitudes, and practices toward climate-driven vector-borne diseases in Canada.

I am a PhD student and am conducting a national study on the knowledge, attitudes, and practices of Registered Nurses in Canada toward climate-driven vector-borne diseases. The title of the study is: **An analysis of the knowledge, attitudes, and practices of registered nurses toward climate-driven vector-borne diseases.**

There is abundant evidence that climate change is contributing to increasing rates of vector-borne diseases, which affects the health of Canadians. Registered Nurses are central to a highly performing health care system and play an integral role in supporting individuals and populations affected by various health challenges, and thus exploring nurses' knowledge, attitudes, and perceptions toward climate-sensitive vector-borne diseases is warranted.

Practicing Registered Nurses across Canada who hold valid registration with a designated provincial or territorial professional licensing body and can read English are invited to participate in this study. The study consists of an online anonymous Qualtrics survey, which will take approximately 10-15 min to complete, and can be accessed using an online weblink.

Upon completion of the online survey, you can choose to include your name and contact information for a chance to win one of five \$50 Amazon gift cards.

Scan the QR code below to access the short survey! Thank-you!

If you have any questions or require more information about the study, please contact the Principal Investigator:

Shannon Vandenberg
RN, PhD(c), CCHN(C), CCNE, CCCI
PhD Student, University of Lethbridge; Lethbridge AB
403-359-3136

Shannon.vandenberg@uleth.ca

You may also reach out to my Supervisor, Dr. Tracy Oosterbroek, for additional information
(tracy.oosterbroek@uleth.ca)



University of Alberta Ethics ID: Pro00131179

APPENDIX C

Checklist for Reporting Of Survey Studies (CROSS) (Sharma et al., 2021)

Section/topic	Item	Item description	Reported on page #
Title and abstract			iv
Title and abstract	1a	State the word “survey” along with a commonly used term in title or abstract to introduce the study’s design.	iv
	1b	Provide an informative summary in the abstract, covering background, objectives, methods, findings/results, interpretation/discussion, and conclusions.	iv
Introduction			1
Background	2	Provide a background about the rationale of study, what has been previously done, and why this survey is needed.	1
Purpose/aim	3	Identify specific purposes, aims, goals, or objectives of the study.	3
Methods			56
Study design	4	Specify the study design in the methods section with a commonly used term (e.g., cross-sectional or longitudinal).	61
	5a	Describe the questionnaire (e.g., number of sections, number of questions, number and names of instruments used).	68
Data collection methods	5b	Describe all questionnaire instruments that were used in the survey to measure particular concepts. Report target population, reported validity and reliability information, scoring/classification procedure, and reference links (if any).	82,88
	5c	Provide information on pretesting of the questionnaire, if performed (in the article or in an online supplement). Report the method of pretesting, number of times questionnaire was pre-tested, number and demographics of participants used for pretesting, and the level of similarity of demographics between pre-testing participants and sample population.	88-91
	5d	Questionnaire if possible, should be fully provided (in the article, or as appendices or as an online supplement).	221
Sample characteristics	6a	Describe the study population (i.e., background, locations, eligibility criteria for participant inclusion in survey, exclusion criteria).	77-78
	6b	Describe the sampling techniques used (e.g., single stage or multistage sampling, simple random sampling, stratified sampling, cluster sampling, convenience sampling). Specify the locations of sample participants whenever clustered sampling was applied.	77-78
	6c	Provide information on sample size, along with details of sample size calculation.	77,96

	6d	Describe how representative the sample is of the study population (or target population if possible), particularly for population-based surveys.	96
	7a	Provide information on modes of questionnaire administration, including the type and number of contacts, the location where the survey was conducted (e.g., outpatient room or by use of online tools, such as SurveyMonkey).	82
	7b	Provide information of survey's time frame, such as periods of recruitment, exposure, and follow-up days.	82
Survey administration		Provide information on the entry process: →For non-web-based surveys, provide approaches to minimize human error in data entry.	
	7c	→For web-based surveys, provide approaches to prevent "multiple participation" of participants.	
Study preparation	8	Describe any preparation process before conducting the survey (e.g., interviewers' training process, advertising the survey).	68,78
Ethical considerations	9a	Provide information on ethical approval for the survey if obtained, including informed consent, institutional review board [IRB] approval, Helsinki declaration, and good clinical practice [GCP] declaration (as appropriate).	94
	9b	Provide information about survey anonymity and confidentiality and describe what mechanisms were used to protect unauthorized access.	85
	10a	Describe statistical methods and analytical approach. Report the statistical software that was used for data analysis.	85
	10b	Report any modification of variables used in the analysis, along with reference (if available).	85,93
Statistical analysis	10c	Report details about how missing data was handled. Include rate of missing items, missing data mechanism (i.e., missing completely at random [MCAR], missing at random [MAR] or missing not at random [MNAR]) and methods used to deal with missing data (e.g., multiple imputation).	85
	10d	State how non-response error was addressed.	85
	10e	For longitudinal surveys, state how loss to follow-up was addressed.	
	10f	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for non-representativeness of the sample.	
	10g	Describe any sensitivity analysis conducted.	85

Results

Respondent characteristics	11a	Report numbers of individuals at each stage of the study. Consider using a flow diagram, if possible.	96
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	11b	Provide reasons for non-participation at each stage, if possible.	
	11c	Report response rate, present the definition of response rate or the formula used to calculate response rate.	96
	11d	Provide information to define how unique visitors are determined. Report number of unique visitors along with relevant proportions (e.g., view proportion, participation proportion, completion proportion).	96
Descriptive results	12	Provide characteristics of study participants, as well as information on potential confounders and assessed outcomes.	96,126
	13a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates along with 95% confidence intervals and p-values.	
Main findings	13b	For multivariable analysis, provide information on the model building process, model fit statistics, and model assumptions (as appropriate).	
	13c	Provide details about any sensitivity analysis performed. If there are considerable amount of missing data, report sensitivity analyses comparing the results of complete cases with that of the imputed dataset (if possible).	96
<hr/>			
Discussion			
<hr/>			
Limitations	14	Discuss the limitations of the study, considering sources of potential biases and imprecisions, such as non-representativeness of sample, study design, important uncontrolled confounders.	182
Interpretations	15	Give a cautious overall interpretation of results, based on potential biases and imprecisions and suggest areas for future research.	172
Generalizability	16	Discuss the external validity of the results.	89
<hr/>			
Other sections			
<hr/>			
Role of funding source	17	State whether any funding organization has had any roles in the survey's design, implementation, and analysis.	
Conflict of interest	18	Declare any potential conflict of interest.	
Acknowledgements	19	Provide names of organizations/persons that are acknowledged along with their contribution to the research.	vii
<hr/>			

APPENDIX D: LETTER OF CONSENT



4401 University Drive
Lethbridge, Alberta, Canada
T1K 3M4

Phone 403.329.2699
Fax 403.329.2668

<http://www.uleth.ca/hlsc>

Please read the following letter of information carefully before beginning the survey:

Title of the study: An analysis of the knowledge, attitudes, and practices of registered nurses toward climate-driven vector-borne diseases

Principal Investigator:

Shannon Vandenberg, RN, PhD(c), CCHN(C), CCNE, CCCI
Instructor
Faculty of Health Sciences
University of Lethbridge
Lethbridge, AB
(403) 359-3136
shannon.vandenberg@uleth.ca

Supervisor:

Tracy Oosterbroek PhD, RN
Assistant Professor
Faculty of Health Sciences
University of Lethbridge
Lethbridge, AB
(403) 317-5067
tracy.oosterbroek@uleth.ca

Invitation to Participate: You are invited to participate in this research study on your knowledge, attitudes, and practices toward climate-driven vector-borne diseases. You are receiving this invitation because you are a practicing registered nurse in Canada.

Purpose of the Study: There is abundant evidence that climate change is contributing to increasing rates of vector-borne diseases, which affects the health of Canadians. Registered nurses are central to a highly performing health care system and play an integral role in supporting individuals and populations affected by various health challenges, and thus exploring nurses' knowledge, attitudes, and perceptions toward climate-sensitive vector-borne diseases is warranted, given the emerging nature of these diseases in Canada. A national survey will be distributed via Qualtrics to practicing nurses in Canada, with the goal being that nurses assume a greater role in leading healthcare practice and advocating for a climate-resistant future.

Inclusion Criteria: To be eligible to participate in the study, you must be a practicing registered nurse in Canada, and hold valid registration with your designated provincial or territorial licensing body. Participants must also be 18 years of age and above and must be able to read English.

Study Procedures: You are invited to participate in a cross-sectional, web-based survey, which will be distributed to you using Qualtrics. Advantages to online survey tools, such as Qualtrics, are that it ensures anonymity, it is cost-effective, participants can complete the survey at a convenient time, and many participants can be accessed.

Aggregated results will be shared through published research in academic journals and nursing-related conference presentations.

Participation: The survey contains 50 questions and should take approximately 10-15 min to complete and can be accessed using the Qualtrics weblink.

Benefits: You will likely not benefit from the study. Study results may reveal gaps in knowledge, attitudes, and practices of nurses on this topic. This knowledge could be used to drive future practice and policy change.

Risks: There are no anticipated risks to participating in this study.

Confidentiality and Anonymity: The information that you will share will remain strictly confidential and will be used solely for the purposes of this research. The only people who will have access to the research data are the principal investigator and supervisory committee. Participation is voluntary and your responses will not be identified with you personally as the survey collects no identifying information; however, as with any online survey, neither anonymity nor confidentiality can be completely guaranteed. The survey is being hosted on Qualtrics and their privacy policy can be accessed at: <https://www.qualtrics.com/privacy-statement/>. To minimize the risk of security breaches and to help ensure your confidentiality we recommend that you use standard safety measures such as closing your browser and locking your screen or device when you are no longer using them / when you have completed the study. Results will be published in pooled (aggregate) format.

Data Storage: Data will be transferred from the survey software database and saved securely on the principal investigator's password-protected computer onto a drive that is only accessible by members of the research team consistent with the University of Lethbridge data storage

guidelines. The study data will be anonymous and will never include any personal information that could identify you. All research data generated from this project will be kept for a minimum of five years in accordance with the University of Lethbridge policies but may be kept longer for future research. Your name will never be associated with any electronic data. Your data may be linked to other data for research purposes only to increase the usefulness of the data. Any researcher who wants to use this data in the future must have the new project reviewed by an ethics board.

Compensation (or Reimbursement): Upon completion of the online survey, participants can choose to include their name and contact information in a secondary survey for a chance to win one of five \$50 Amazon gift cards. Odds of winning a prize are 1 in 42 chances of winning. Under federal law, it is necessary that you answer a skill-testing question successfully in order to qualify for a chance to win the prize. If you wish to be considered for this prize, you must answer the skill-testing question.

Voluntary Participation: Your participation is completely voluntary. You may withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled by simply closing your browser before you submit your responses and they will not be included. If you choose to discontinue participation after you have submitted your responses, it will not be possible to withdraw your responses because they will not have identifying information linked to them.

Information about the Study Results: Please indicate your interest in receiving the research findings to the research team by emailing the primary investigator (shannon.vandenberg@uleth.ca).

Contact Information: If you have any questions or require more information about the study itself, you may contact Shannon Vandenberg, using the information mentioned herein.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta (**University of Alberta Ethics ID: Pro00131179**). If you have any questions regarding your rights as a research participant or how the research is being conducted, you may contact the Research Ethics Office at reoffice@ualberta.ca.

Consent Statement

I have read this form, and the research study has been explained to me. I have been given the opportunity to ask questions, and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form.

Completion and submission of the survey means your consent to participate.

If you wish to participate in the survey, please proceed to the survey.

APPENDIX E: RESEARCH STUDY APPROVAL

8/25/23, 3:02 PM

arise.ualberta.ca/ARISE/sd/Doc/0/GTSJFBI3F88UT859AM9A4LIG00/fromString.html

Notification of Approval

Date: Friday, August 25, 2023
Study ID: Pro00131179
Principal Investigator: Shannon Vandenberg
Study Supervisor: Tracy Oosterbroek
Study Title: AN ANALYSIS OF THE KNOWLEDGE, ATTITUDES, AND PRACTICES OF REGISTERED NURSES TOWARD CLIMATE-DRIVEN VECTOR BORNE DISEASES
Approval Expiry Date: Friday, August 23, 2024

Thank you for submitting the above study to the Research Ethics Board 2. Your application has been reviewed and approved on behalf of the committee.

Approved Documents:

Letter of Initial Contact

[Letter of Initial Contact](#)

Consent Forms

[Letter of Consent Revised Aug 2](#)

Questionnaires, Cover Letters, Surveys, Tests, Interview Scripts, etc.

[Survey -Final](#)

Protocol/Research Proposal

[Research Proposal](#)

Any proposed changes to the study must be submitted to the REB for approval prior to implementation. A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the REB does not constitute authorization to initiate the conduct of this research. The Principal Investigator is responsible for ensuring required approvals from other involved organizations (e.g., University of Lethbridge, community organizations, school boards) are obtained, before the research begins.

Sincerely,

Ubaka Ogbogu, LLB, BL, LLM, SJD
Chair, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).