

REVIEW SUMMARY

Nurses' perceptions of climate sensitive vector-borne diseases: A scoping review

Shannon Y. Vandenberg RN, MScN, CCHN(C), CCNE, CCCI¹  | Andrea Chircop RN, PhD² |
 Monique Sedgwick RN, PhD¹ | David Scott MLIS, MA³

¹University of Lethbridge, Lethbridge, Alberta, Canada

²Dalhousie University, Halifax, Nova Scotia, Canada

³University of Lethbridge Library, Lethbridge, Alberta, Canada

Correspondence

Shannon Y. Vandenberg, Nursing Instructor,
 University of Lethbridge, 4401 University
 Drive, Lethbridge, Alberta T1K 3M4
 403-359-3136, Canada.
 Email: Shannon.vandenberg@uleth.ca

Abstract

Objective: Nurses are well positioned to play an integral role in the mitigation of climate change and climate-driven vector-borne diseases, however, they lack awareness and knowledge about their role. The purpose of this scoping review was to map existing literature on nurses' perceptions, knowledge, attitudes, and experiences with vector-borne diseases, specifically Lyme disease and West Nile virus.

Design: A scoping review was conducted using Joanna Briggs Institute (JBI) scoping review methodology. CINAHL, ProQuest Nursing & Allied Health Premium, MEDLINE, APA PsycINFO, ProQuest Dissertations & Theses, and Web of Science were searched for English-language publications. The PRISMA-ScR was used. After initial screening as per study protocol, a total of 33 items were reviewed independently by four reviewers.

Results: Thirty-three articles, including seven sources from grey literature, met the criteria for this scoping review. Results were mapped according to the five domains of the *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases*.

Conclusions: Findings from the review indicate that nurses play a role in climate-related health effects and should be knowledgeable about vector-borne diseases. However, scant literature exists on nurses' knowledge, perceptions, attitudes toward vector-borne diseases, and practice readiness, signifying a need for further research on this emerging topic.

KEYWORDS

knowledge, nurses, perception, scoping review, vector-borne diseases

1 | INTRODUCTION

Climatic factors have expanded the geographical distribution of current endemic vector-borne diseases leading to increasing rates of infectious diseases. According to climatologists, researchers, and various organizations, climate change trends are expected to continue, further increasing the threat of infectious diseases for northern countries including Canada (Canadian Public Health Association [CPHA],

2021; Government of Canada, 2018; McPherson et al., 2017; Warren & Lemmen, 2014).

As one of the largest health professions, nurses are well positioned to play an integral role in the mitigation of climate-related health effects, by supporting individuals and populations at-risk for and affected by vector-borne diseases, however a lack of awareness and knowledge exists (Canadian Nurses Association [CNA], 2008, 2017; International Council of Nurses [ICN], 2018; Kalogirou et al.,

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2020; Martin & Vold, 2019). To enhance understanding of nurses' perceptions, knowledge, attitudes, and experiences of climate sensitive vector-borne diseases endemic to Canada, specifically Lyme disease and West Nile virus, the following scoping review was conducted. This scoping review is necessary, given the emerging climate change context in Canada and subsequent health effects on populations, as well as the lack of awareness and knowledge by nurses, depicted by the above-mentioned literature.

2 | BACKGROUND

Climatic factors, including increased temperatures, prolonged summer seasons, precipitation alterations, and temperature variability contribute to vector expansion and subsequent disease spread (Bouchard et al., 2019; CPHA, 2021; Ludwig et al., 2019). As the most common endemic climate sensitive vector-borne diseases in Canada, West Nile virus and Lyme disease are significant health threats, and ongoing surveillance indicates that incidence of these diseases is increasing from year to year (Bouchard et al., 2019; CPHA, 2021; Ludwig et al., 2019).

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., 2017; Government of Canada, 2021). Gasmi and colleagues (2017) reported that Lyme disease rates increased more than six-fold from 2009 until 2015 and can be found across Canada (p. 194). Range expansion of the black-legged tick is expected to escalate in the future because of climate change, further increasing Lyme disease risk, particularly in eastern Canada (Government of Canada, 2020a; Warren & Lemmen, 2014).

First detected in Ontario in 2001, West Nile virus is the most common mosquito-borne illness in Canada. It is transmitted through the bite of an infected *Culex* mosquito and is found in areas of southern Quebec and Ontario, Saskatchewan, Manitoba, Alberta, and areas of British Columbia (Government of Canada, 2015; 2016; 2020b; Warren & Lemmen, 2014). The annual incidence of West Nile virus fluctuates from year to year, ranging from 437 reported cases in 2018 to 35 reported cases in 2021, largely due to weather variations affecting mosquito reproduction. However, continued northward range expansion of West Nile virus is predicted in rural and urban regions of Canada, and incidence is expected to increase (Government of Canada, 2022; Ludwig et al., 2019).

2.1 | Nursing and climate health

Several authors have indicated that nurses may lack awareness of their role in addressing climate change and subsequent health effects (CNA, 2008; Kalogirou et al., 2020; Martin & Vold, 2019). According to Leffers et al. (2017), practicing nurses, nurse educators, and nursing students lack formal knowledge and resources to adequately prepare them for their role in mitigating vector-borne diseases and providing care to

those living with these diseases. It is necessary that nurses be educated on infectious disease threats and their potential impact on human health to fulfill their role as climate action leaders and champions of social justice (Smith, 2019; Tiitta et al., 2021).

2.2 | Guidelines for undergraduate nursing education

In 2020, the Canadian Association of Schools of Nursing (CASN) responded to the increasing risk of climate change on health in Canada, by releasing the *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases*. According to these guidelines, nurses entering practice should be well-informed with current, evidence-based knowledge on climate-driven vector-borne diseases, and subsequently use this knowledge to support individuals and populations at-risk and affected by these diseases. The CASN guidelines include 5 domains with 34 learning outcomes and were used to map the literature in this review.

3 | METHODS

Scoping reviews, unlike systematic reviews, are conducted to map the breadth of literature, outline conceptual boundaries, or determine key concepts on an emerging topic area of research (Munn et al., 2018). In (Arksey & O'Malley, 2005) published the first methodological framework for conducting scoping studies, which was extended on by Levac and colleagues in 2010 (Levac et al., 2010). Scoping reviews can provide a record of current and emerging evidence, including gaps, informing research, clinical decision making, policy development, and practice (Peters et al., 2017).

Joanna Briggs Institute scoping methodology review, based on the work of Aromataris and Munn (2020) and Peters et al. (2017), was used to review literature pertaining to nurses' perceptions toward climate sensitive vector-borne diseases. The specific questions that guided this review included:

1. What is nurses' knowledge, perceptions, attitudes, and experiences toward climate sensitive vector-borne diseases, specifically concerning Lyme disease and West Nile virus?
2. How does published literature support requirements of the CASN (2020) *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases*?

3.1 | Inclusion criteria and search strategy

To be included in the review, articles and grey literature must have included the following criteria: 1) a focus on vector-borne diseases, including West Nile virus and/or Lyme disease, 2) pertain to nurses and/or nurse practitioners, and 3) address nurses' perceptions, knowledge, attitude, and experiences with vector-borne diseases. Grey

MEDLINE Search Strategy for Scoping Review

1. exp Nurses/ [MeSH]
2. (nurse* or nursing).mp.
3. or/1-2
4. exp Lyme Disease/ [MeSH]
5. exp Borrelia/ [MeSH]
6. (borrelia).tw.
7. (lyme).mp.
8. (erythema migrans).mp.
9. (erythema chronicum migrans).mp.
10. West Nile virus/ [MeSH]
11. West Nile Fever/ [MeSH]
12. (west nile adj (virus or fever)).mp.
13. or/4-12
14. 3 and 13
15. Limit 14 to english language

Note: MeSH = medical subject heading; exp = used with a MeSH term to include all narrower MeSH terms; .mp, .tw = field codes for multi-purpose and text word, respectively; adj = search for records with terms adjacent to each other; * after keyword indicates truncation (e.g., nurse* will retrieve "nurse" and "nurses")

FIGURE 1 MEDLINE search strategy for scoping review.

literature was included in the review to determine if there were advocacy groups and nursing organizations involved in climate change and environmental health which support the *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases*. According to Paez (2017), grey literature can make important contributions to reviews by increasing the comprehensiveness of the review and presenting a balanced overview of available evidence.

CINAHL, ProQuest Nursing and Allied Health Premium, MEDLINE, APA PsycINFO, Web of Science, and ProQuest Dissertations and Theses were searched on October 8, 2021, by a Health Sciences professional librarian. Search terms were identified through consultations among the research team, a scan of the titles and subject headings of preliminary search results, and a review of the titles and abstracts of preliminary articles gathered by the lead researcher. The search strategy was first developed for MEDLINE (Figure 1) and then adapted for the other five databases.

When possible, subject headings from controlled vocabularies (e.g., MeSH, CINAHL subject headings) were used in the search. To increase sensitivity, search terms were also entered in the search string as keywords, with truncation (e.g., nurse*) and proximity operators (e.g., west Nile adj virus) used when appropriate. Boolean operators connected subject headings and keywords, as shown in Figure 1. No publication date filter was applied.

Search parameters for this scoping review consisted of existing English peer-reviewed articles, including, but not limited to, original research studies, literature reviews, case reports, reviews, editorials, and evidence-based practice articles that could be retrieved by electronic database searching. The search was limited to full-text articles available electronically; articles without an abstract and/or full-text were excluded. Targeted online, grey literature searches included advocacy groups and nursing organizations involved in

climate change and environmental health and were retrievable by using the Google Chrome search engine. The PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extensions for Scoping Reviews) was used (Figure 2) as was the PRISMA-ScR checklist (Table 1) to document relevant terms, core concepts and key reporting items to ensure transparency (Tricco et al., 2018).

3.2 | Extraction of results

Bibliographic information (e.g., title, abstract, authors, publication information, subject headings) for each search result was imported into EndNote X8 for deduplication and review. A total of 636 results were returned from the six database searches. After removing duplicates, 468 records were reviewed independently by the first author and an initial reviewer, resulting in the removal of 273 items that did not meet the inclusion criteria, and 195 items to be included in the second, full text review. After review by the first author and initial reviewer, a further 157 items were removed as an explicit nursing perspective was not apparent, resulting in 38 items remaining. Of the 38 items, 29 were similarly considered by the initial two reviewers for inclusion, and the remaining 9 sources were included by only one reviewer. The 38 included items from both initial reviewers were subsequently reviewed independently by the second and third authors, as agreement on article inclusion between the initial reviewers differed.

Consensus among the authors resulted in twelve additional items being removed. Rationale for excluding these items include literature without explicit/exclusive inclusion of a nursing perspective, the nursing role was not clear or there was merely one sentence addressing this role ($n = 7$). Articles, such as original research studies, with a

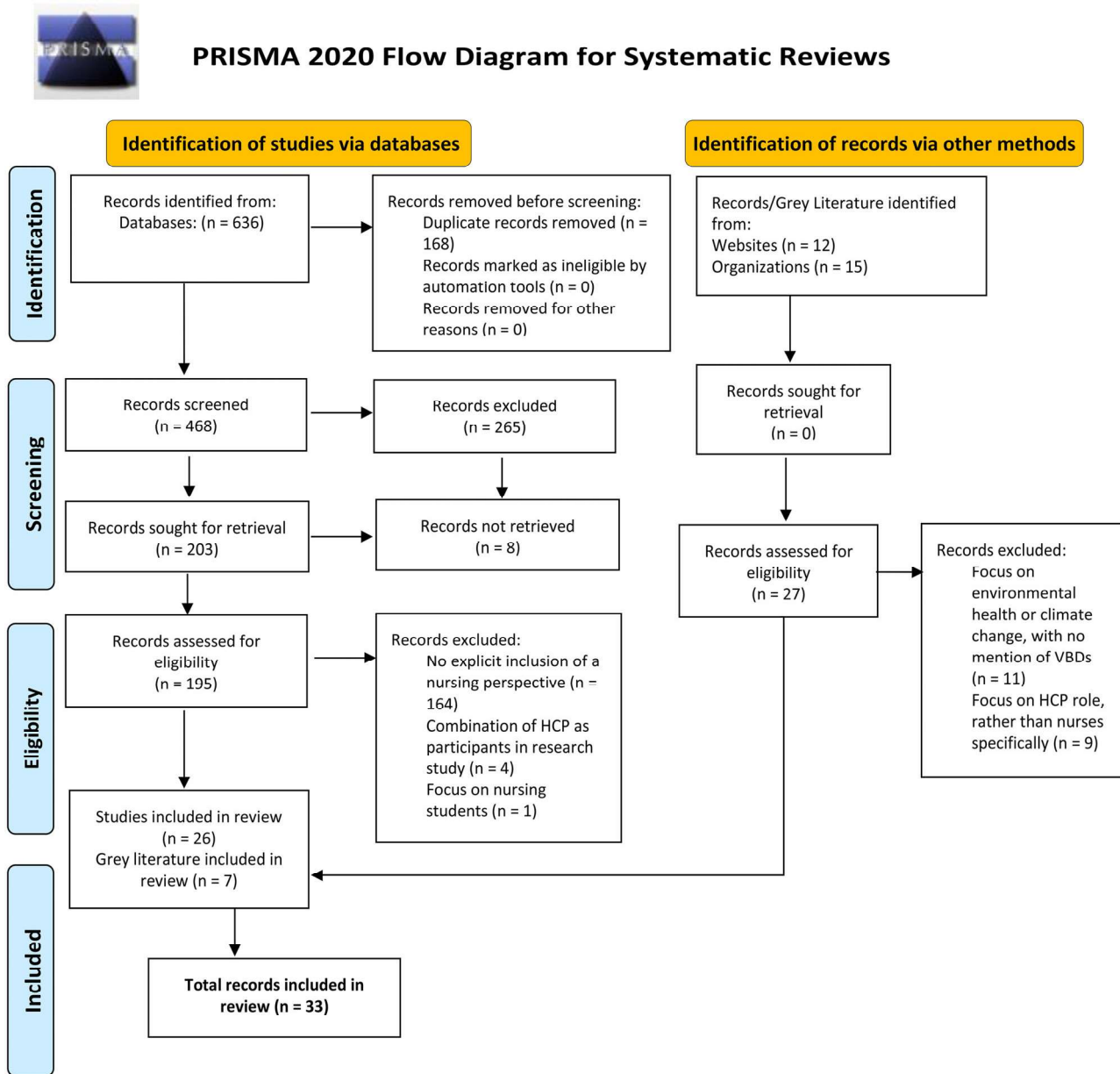


FIGURE 2 PRISMA 2020 flow diagram for systematic reviews.

variety/combination of health care providers as participants, were also excluded from the results ($n = 4$). One additional item was excluded, as the sample comprised of nursing students, rather than practicing nurses. This resulted in 26 items from the database search for inclusion in the scoping review.

Records from government websites, advocacy groups, and nursing organizations ($n = 27$) were reviewed by the first author to determine if the grey literature met inclusion criteria for the scoping review. Nineteen records were excluded by the first author because the emphasis was either on environmental health or climate change, with no discussion of vector-borne diseases, or because the focus was on health care professionals rather than nurses specifically. The remaining eight sources were independently reviewed by the initial reviewer, and subsequently reviewed by the second and third authors. Following a

discussion among authors on the use of terminology in the grey literature sources (i.e., health care professionals rather than nurses), one additional item was excluded from the search results. This resulted in including seven items from the grey literature for a total of 33 items in this scoping review. See Figure 2 for a flow diagram of the review process.

4 | RESULTS

4.1 | Descriptive statistics

A summary of included literature is presented in Table 2. Descriptors for each item include author(s), year of publication, country

TABLE 1 Preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) checklist

Section	Item	PRISMA-ScR checklist item	REPORTED on page #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	2–4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4,5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5,6
Information sources ^a	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5,6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Figure 1
Selection of sources of evidence ^b	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6,7
Data charting process ^c	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Table 2
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	7,8
Critical appraisal of individual sources of evidence ^d	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7,8
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 2
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Table 2
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A

(Continues)

TABLE 1 (Continued)

Section	Item	PRISMA-ScR checklist item	REPORTED on page #
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 2
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	8–13
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	13–17
Limitations	20	Discuss the limitations of the scoping review process.	17
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	17
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	None

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: 10.7326/M18-0850.

Abbreviations: JBI, Joanna Briggs Institute; PRISMA-ScR, Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

^aWhere *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

^bA more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

^cThe frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

^dThe process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

of origin, study aim(s)/purpose, study population and sample size, design and methods, study outcomes, and key findings (Peters et al., 2017). Blank spaces in the summary table indicate either a lack of available information for the descriptor or the absence of original research.

Thirty-three items published between 1990 and 2021 were included in this scoping review. Twenty items were evidence-based, clinical, or continuing education articles, as categorized by the publishing journal. Of the remaining items, four were editorials, three were original research studies, and seven were discussion papers, position statements, guidelines, or articles from grey literature. Of the original research studies, two were quantitative studies, while one was qualitative in nature.

Twenty-three papers were published in the USA, six in Canada, three in the United Kingdom, and one in Switzerland. The search was limited to English-language articles, which may have influenced the results. Eighteen items dealt primarily with Lyme disease, while nine articles focused on West Nile virus. The remaining six items addressed vector-borne diseases in general, including Lyme disease and West Nile virus.

Most of the literature addressed nurses in general, however, three items specifically focused on the role of the nurse practitioners in rela-

tion to vector-borne diseases (Denman & Hart, 2015; Harrison, 2002; Nichols & Windemuth, 2013). Practice settings of nurses varied significantly across the literature, and included: community health, home health, public health, occupational health, schools, camps, perioperative nursing, primary care, physician's offices, outpatient clinics, and emergency departments.

4.2 | Nurses' knowledge, perceptions, attitudes, and experiences

To address knowledge gaps among nursing graduates, the CASN (2020) created the *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases* and accompanying E-Resource on vector-borne diseases and the effects on population health in Canada. The goal for this resource was to support the integration of this information into undergraduate nursing programs. Similarly, the CNA (2008) suggests that including climate change and vector-borne diseases in nursing curricula is important to ensure nurses are prepared to address health impacts on Canadians. For further analysis, the results of the scoping review were mapped according to the five domains of the CASN (2020) guidelines.

TABLE 2 Summary of literature included in scoping review

Author(s), year, country	Article/document type	Study aim(s)/ purpose	Study population & sample size	Design and methods	Study outcomes/ recommendations	Key findings
Adams et al., 2021 USA	Continuing education article	N/A	N/A	N/A	<ul style="list-style-type: none"> Case study on Lyme disease with overview of LD, prevention, diagnosis, and treatment. 	<ul style="list-style-type: none"> Nurses should be aware of the vague nature of symptoms and quickly work toward a diagnosis to prevent further complications of LD. Nurses should educate patients on common places for tick exposure as well as primary preventative measures.
Alliance of Nurses for Healthy Environments, 2021 USA	Organization website	N/A	N/A	N/A	N/A	<ul style="list-style-type: none"> Nurses have a professional obligation to address climate change and associated health risks, including VBDs through research, education, advocacy, and practice.
Audain & Maher, 2017 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Overview of mosquito-borne illnesses, including WNV, which are becoming more prevalent in the US, and how nurses can engage in prevention and control about these diseases. 	<ul style="list-style-type: none"> Nurses are excellent health and community educators, and critical partners to teach about prevention and control of mosquito-borne illnesses, including vector ecology, transmission, and clinical characteristics, in ways that are understandable by different populations.
Bender & Thompson, 2003 USA	Continuing education article	N/A	N/A	N/A	<ul style="list-style-type: none"> Presents a review of transmission, clinical presentation, and prevention of WNV. 	<ul style="list-style-type: none"> Nurses must provide good nursing care and contribute to community-level education in transmission control and prevention, policy development, and advocacy.
Campbell and Drehr, 2002 USA	Continuous education article	N/A	N/A	N/A	<ul style="list-style-type: none"> West Nile virus has increased in the US since 1999, and no specific treatment has been identified. Work continues on vaccine development. Nurses in the Northeast and Southeastern United States are likely to see more cases of West Nile virus. 	<ul style="list-style-type: none"> Early identification and reporting of symptoms is critical to prevent disease complications. Thorough patient histories should be taken. Nurses should educate patients in high-risk areas, of insect bite risks and provide preventative strategies. Nurses should assess for neurological changes.
Canadian Association of Schools of Nursing, 2020 Canada	Guidelines for undergraduate nursing education on climate-driven vector-borne diseases & E-resource	N/A	N/A	N/A	N/A	<ul style="list-style-type: none"> Goal of project is to increase the knowledge of the effects of climate-driven vector-borne infectious diseases on population health in Canada amongst nurse educators, and to foster the integration of this knowledge into Canadian nursing education programs.

(Continues)

TABLE 2 (Continued)

Author(s), year, country	Article/document type	Study aim(s)/ purpose	Study population & sample size	Design and methods	Study outcomes/ recommendations	Key findings
Canadian Nurses Association, 2008 Canada	Workbook— “Role of the Nurses in Addressing Climate Change”	N/A	N/A	N/A	N/A	<ul style="list-style-type: none"> Including climate change and health in nursing curricula is important, as climate change affects vector borne disease, which can affect the health of Canadians.
Canadian Nurses Association, 2017 Canada	Position statement— “Nurses and Environmental Health”	N/A	N/A	N/A	<ul style="list-style-type: none"> Climate change has affected the health of Canadians through longer seasons for vector-borne diseases (e.g., West Nile virus and Lyme disease). 	<ul style="list-style-type: none"> Role of the nurse in environmental health includes: Assessing and communicating risks of environmental hazards to individuals, families and communities, Educating patients, families and communities about environmental health Showing leadership in personal practices Collaborating with interdisciplinary partners Advocating for policies that protect health Producing nursing science and research on environmental health issues Promoting development of natural and built environments
Canadian Nurses Association, 2019 Canada	Article— “Climate Change and Health in your Nursing Practice”	N/A	N/A	N/A	<ul style="list-style-type: none"> 104% Increase in Lyme disease cases 	<ul style="list-style-type: none"> Nurses should: Improve eco-literacy, educate patients, prevent or mitigate environmental health hazards, create nursing knowledge on environmental health issues, and advocate for climate change mitigation.
Canadian Federation of Nurse Unions, 2019 Canada	Discussion paper	N/A	N/A	N/A	<ul style="list-style-type: none"> Climate change health impacts include an acceleration in the spread of Lyme disease and WNV. 	<ul style="list-style-type: none"> Nurses must be equipped to educate patients and clients about the health risks of climate change and work upstream to prevent health crises before they occur.
Capps et al., 1999 USA	Original research study	To determine general knowledge and professional practices (symptoms, case definition, treatment, and personal protection) about Lyme disease among local health department nurses.	226 out of 428 nurses (56%) practicing in 80 health departments in Indiana, USA	Quantitative— Self-administered questionnaire with 30 questions; analyzed by independent group t test	<ul style="list-style-type: none"> Nurses are most knowledgeable about personal protection against Lyme disease and least knowledgeable about symptoms, case definition, and reporting criteria. Non-baccalaureate degree nurses scored higher on questions about Lyme disease than those with a baccalaureate or master’s degree. Nurses who defined their role as “public health” were no more knowledgeable than other nurses in the study. 	<ul style="list-style-type: none"> Better dissemination of Lyme disease information among public health nurses through an established system, such as the CDC website, monthly newsletters, or in-service programs to enhance knowledge about LD and other tick-borne diseases. Nurses should be aware of surveillance, incidence, and prevalence of LD in their communities and geographic locations.

(Continues)

TABLE 2 (Continued)

Author(s), year, country	Article/document type	Study aim(s)/ purpose	Study population & sample size	Design and methods	Study outcomes/ recommendations	Key findings
Cavendish, 2003 USA	Evidence-based article	Case study of school-aged child with Lyme disease	Case Study on School-Aged Child with Lyme Disease based on experience of a school nurse in northern New Jersey.	N/A	<ul style="list-style-type: none"> Nursing knowledge of epidemiology was instrumental in making an accurate assessment and referral for appropriate treatment for child, using an individualized health care plan. Family was made aware of preventative measures when engaging in outdoor activities in the region. 	<ul style="list-style-type: none"> School nurses need to be aware of growing threat of Lyme disease to ensure they are committed to life-long learning and providing expert care to school-aged children.
Dean, 2020 United Kingdom	Editorial	N/A	N/A	N/A	<ul style="list-style-type: none"> Lyme disease risk increases with warm weather and people spending more time outdoors, particularly in wooded or grassy areas. Lyme disease cases are on the rise. The NUCE guidelines are raising awareness among nurses 	<ul style="list-style-type: none"> Nurses have a key role in advising and educating members of the public on what Lyme disease is and how they can reduce their risk. Nurses, especially those in primary care and emergency departments should use a holistic approach and be alert to the signs of infected tick bites, especially the rash and ensure prompt antibiotic treatment is offered.
Denman & Hart, 2015 USA	Clinical article	N/A	N/A	N/A	<ul style="list-style-type: none"> During warm months, nurse practitioners may see West Nile virus cases in their practice area. A thorough understanding of WNV disease presentation and prevention is essential for accurate diagnosis, treatment, and patient education. 	<ul style="list-style-type: none"> Nurse Practitioners should educate patients and public, particularly those who are vulnerable, on prevention measures, as well as support local public health surveillance measures and advocate for attention to these health hazards.
Drew & Hewitt, 2006 USA	Original research study	Explore the lived experience of becoming diagnosed with Lyme disease.	10 participants diagnosed with Lyme disease	Qualitative, Phenomenological Study	<ul style="list-style-type: none"> Participants expressed frustration with long road to diagnosis, financial stress, and the need for self-advocacy, and a sense of hopefulness for the future. 	<ul style="list-style-type: none"> Nurses must form trusting relationships with patients and provide effective support and referrals to appropriate community resources. Understanding the lived experience of those with Lyme disease will help nurses prioritize health care interventions and strategize ways to implement quality improvement measures in the health care setting.
Fletcher, 2003 Canada	Editorial	N/A	N/A	N/A	<ul style="list-style-type: none"> Camp Nurses need to be prepared for SARS and WNV, and whatever arrives at their doorstep in order to protect themselves, according to the Canadian Nurses Protective Society (CNPS) 	<ul style="list-style-type: none"> Camp Nurses should be knowledgeable about SARS and WNV, including knowing what to look for, where to locate information, and how to treat symptoms or handle an emergency.
Force, 1999 USA	Clinical practice article	N/A	N/A	N/A	<ul style="list-style-type: none"> Occurrence of Lyme disease is increasing in the United States. Through a case study, article summarizes clinical manifestations of Lyme disease. Lyme disease is a clinical diagnosis, based on thorough history and risk of tick exposure. 	<ul style="list-style-type: none"> Nurses are often unfamiliar with Lyme disease and lack accurate clinical information to provide comprehensive nursing care to patients. Nurses must provide comprehensive education about disease and treatment.

(Continues)



TABLE 2 (Continued)

Author(s), year, country	Article/document type	Study aim(s)/ purpose	Study population & sample size	Design and methods	Study outcomes/ recommendations	Key findings
Franklin et al., 1997 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Occupational health nurses have a focus on prevention of work-related diseases and injuries, including zoonotic diseases (Lyme disease). The role of the occupational health nurse in preventing zoonotic infections includes education, disease prevention, and surveillance to maintain a healthy work environment for employees. 	<ul style="list-style-type: none"> Occupational health nurses play a crucial role in the prevention of zoonotic diseases (LD) in workers. Awareness of workplace environments, active assessment of risks, and education of employees and community health professionals are all components of this role. Nurses should keep abreast of changes in prevention and treatment and know what resources are available in the area.
Gagnon-Dorsa, 1990 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Overview of Lyme disease stages, diagnosis, treatment, and prevention for occupational health nurses. 	<ul style="list-style-type: none"> Occupational health nurses need to be aware of the signs and symptoms and what to teach employees about LD. Prevention is key to decreasing the incidence of LD. The nurse's role should be case finder, health educator, and resource person.
Gillespie, 2021 USA	Original research study	Describe the QOL among CLD patients living in Maine, which is endemic for LD.	60 participant responses were analyzed	Flanagan Quality of Life (QOL) Instrument	<ul style="list-style-type: none"> Majority of patients were not satisfied with being physically fit, socializing and meeting people, and actively participating in recreation. Lyme disease needs to be included in classroom discussions at the high school and university level in Maine, the most endemic state in the country for Lyme. Public health nurses can track the incidence of Lyme across the state and report prevalence to appropriate authorities and the public and collaborate with nurses in a variety of practice settings for education and support. 	<ul style="list-style-type: none"> Nurses working in home health, walk-in clinics, public health, physicians' offices, outpatient clinics, emergency rooms and other areas need to be aware of the signs and symptoms of Lyme disease for prompt diagnosis and treatment. Nurses need to offer support and education as well as evaluate patients' QOL in order to develop a care plan conducive to providing health maintenance.
Girard, 2004 USA	Editorial	N/A	N/A	N/A	<ul style="list-style-type: none"> Perioperative nurses should be asking about diagnosis of WNV and alert health care professionals to potential problems with patients who have had WNV, as they may be more susceptible to postoperative viral infections. They should also be alert to possibility of WNV in patients receiving blood products and report problems to appropriate authorities. 	<ul style="list-style-type: none"> Perioperative nurses should be knowledgeable about WNV as they are experts in debugging systems. Awareness will benefit both professional and personal lives.
Hamlen & Kilman, 2009 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Offers tips for school nurses on Lyme disease infection incidence, risks, signs and symptoms, and role of the nurse. 	<ul style="list-style-type: none"> School nurses must have a basic awareness and understanding of Lyme disease and recognize the impaired behavior caused by this illness.

(Continues)

TABLE 2 (Continued)

Author(s), year, country	Article/document type	Study aim(s)/ purpose	Study population & sample size	Design and methods	Study outcomes/ recommendations	Key findings
Harrison, 2002 USA	Clinical article	N/A	N/A	N/A	<ul style="list-style-type: none"> West Nile Virus Encephalitis pathophysiology, vector transmission, clinical manifestations and laboratory findings are discussed. 	<ul style="list-style-type: none"> Nurse Practitioners can play a critical role in recognizing and diagnosing WNV encephalitis, as well as providing anticipatory guidance on the prevention of outbreaks.
Healy, 2000 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Overview of Lyme disease and risks for children, including etiology, epidemiology, pathophysiology, diagnosis, and manifestations. Nurses should use nursing process when dealing with LD in the school setting to create an individualized healthcare plan for the student. 	<ul style="list-style-type: none"> School nurses should become familiar with pathophysiology of LD, be cognizant of the environments known to have high distribution of LD and look for opportunities to educate communities and engage in political action/advocacy to bring awareness to this disease.
International Council of Nurses, 2018 Switzerland	Position statement	N/A	N/A	N/A	<ul style="list-style-type: none"> The relationship between climate change and health is complex. The resulting impact on health and well-being includes increased food- and water-borne infections; increased vector-borne diseases. 	<ul style="list-style-type: none"> Nurses should be involved in mitigating climate change and take action to develop climate-informed health programs for emerging infectious and communicable diseases. The ICN works with governments to reduce infectious and vector-borne diseases. Nurses must engage in national and multisectoral measures to mitigate the impact of climate change on the population with a focus on vulnerable groups and those more exposed to disease and injury.
Laudenslager & Hartung, 2019 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> School nurses are often frontline providers of care to children presenting with early and late symptoms of Lyme disease (LD). Many children and families are unaware of tick bites; therefore, the school nurse needs to know how to detect tickborne illness such as Lyme arthritis (LA) and encourage and assist families to seek treatment and implement the treatment plan while the child is attending school. 	<ul style="list-style-type: none"> It is imperative that school nurses become familiar with vector-borne diseases, including LD and LA. Nurses should be aware of the signs of LD and LA, and be able to educate the family and child and school staff on LD and LA, and putting a plan in place to assist and meet student needs in school while achieving academic success.
Marchese & Primer, 2013 USA	Continuous education article	N/A	N/A	N/A	<ul style="list-style-type: none"> Lyme disease is most common VBD in the US. Overview of LD transmission, clinical manifestations, diagnosis, prevention, and treatment. 	<ul style="list-style-type: none"> Nurses have an important role in recognizing the signs and symptoms of LD and understanding how to address them. Nurses should stay current on LD research and attend professional development programs when available. Nurses should educate community on preventing LD by health fairs, pamphlets, and newsletters, and are in an optimal role in educate patients and communities.

(Continues)



TABLE 2 (Continued)

Author(s), year, country	Article/document type	Study aim(s)/ purpose	Study population & sample size	Design and methods	Study outcomes/ recommendations	Key findings
McGhee et al., 2018 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Increase in Lyme disease cases in emergency departments over the past 10 years. Overview of LD and provides emergency nurses with information about the disease. 	<ul style="list-style-type: none"> Emergency nurses must be aware of the signs of LD, and must be sensitive to the psychological stress associated with LD. People should be taught simple preventative measures to avoid exposure to ticks.
Network to Reduce Lyme Disease in School-Aged Children, Washington, DC., 2010 USA	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Overview of Lyme disease, tick biology, symptoms of LD, prevention in school-aged children. 	<ul style="list-style-type: none"> School nurses can make a significant difference in a child's life by preventing Lyme disease in schools. Early detection and education of staff and students is important.
Nichols & Winde-muth, 2013 USA	Clinical article	N/A	N/A	N/A	<ul style="list-style-type: none"> Lyme disease has become an epidemic in the USA in the past years. Overview of LD is presented. Early diagnosis and treatment are necessary to prevent complications. 	<ul style="list-style-type: none"> Nurse practitioners are in a key position to educate patients about risk exposure to tick-borne illnesses. NPs must be aware of the signs and symptoms of LD, interpretation of test results, and treatment recommendations. NPs must understand evidence-based practices related to chronic LD syndrome to ensure patients receive accurate information.
O'Connor, 2003 United Kingdom	Editorial	N/A	N/A	N/A	<ul style="list-style-type: none"> Emerging infections, such as WNV, should be of concern to nurses and the people who train them. Constant vigilance is needed against the risk of new and re-emerging diseases. 	<ul style="list-style-type: none"> British nurses are not sufficiently aware of the threats posed by emerging diseases. Training of nurses needs to evolve to include this information.
Pallares & Winokur, 2017 USA	Continuing education article	N/A	N/A	N/A	<ul style="list-style-type: none"> Prevalence and significance of WNV, the signs and symptoms of WNV, and primary prevention of WNV among patients seeking care in emergency departments. 	<ul style="list-style-type: none"> Emergency Nurses should understand prevalence and significance of VBDs, such as WNV. They should perform accurate nursing assessments, ensure prevention methods are shared with patients in the ED, provide education, support, and case management referral for patients with limited support.
Pearson, 2014 United Kingdom	Evidence-based article	N/A	N/A	N/A	<ul style="list-style-type: none"> Ticks are endemic in the UK, and Lyme disease is the most common tick-borne disease in the northern hemisphere. Overview of Lyme disease, symptoms, prevention, diagnosis, and treatment. 	<ul style="list-style-type: none"> The nurse has an important role in raising awareness, giving advice on prevention and correct tick removal, and recognizing signs of Lyme disease.

4.3 | Domain 1: Public health—Vector-borne infectious diseases

According to CASN (2020), nursing graduates must understand climate change causes, driving factors, mitigation efforts, as well as discuss epidemiology and etiology of climate sensitive vector-borne diseases in Canada. Furthermore, CASN asserts that understanding health-equity frameworks and Indigenous knowledge and expertise on climate change are necessary for practice.

Evidence retrieved from the grey literature, including the Alliance of Nurses for Healthy Environments (2021), suggests that nurses have a professional obligation to address climate change and ensuing health risks, including vector-borne diseases, through research, education, advocacy, and practice. This view was shared by the ICN (2018), who promote nurses' role in climate change mitigation and climate-informed health programming to reduce vector-borne diseases.

The evidence from the scoping review suggests nurses are excellent health educators on ecology, transmission, surveillance, incidence, prevalence, and clinical characteristics of vector-borne diseases (Audain & Maher, 2017; Capps et al., 1999). Consequently, nurses' awareness and knowledge of the pathophysiology of vector-borne diseases is critical (Girard, 2004; Hamlen & Kilman, 2009; Healy, 2000; Laudenslager & Hartung, 2019; Network to Reduce Lyme Disease in School-Aged Children, Washington, DC, 2010). Force (1999) and O'Connor (2003) though, found nurses were not sufficiently aware of the threats posed by emerging vector-borne diseases and concluded that nursing education should evolve to include this information.

4.4 | Domain 2: Populations exposed to potential risks

Nursing graduates should respect the perspective of those with lived experience of vector-borne diseases and be able to identify how the social determinants of health, historical injustices, public policies, and circumstances/context impact individuals' and populations' vulnerability to vector-borne diseases and their adverse effects (CASN, 2020).

Consistent with this guideline, evidence from this review suggests that identifying at-risk populations is a key priority for nurses. The ICN (2018) suggests that nurses must mitigate impacts of climate change on populations with a focus on priority groups. Ensuring priority populations in high-risk areas are educated on the risks of vector-borne diseases is important, as well as how they can reduce their risks to promote capacity building and community empowerment (Campbell and Drehr, 2002; Dean, 2020; Denman & Hart, 2015).

Drew and Hewitt (2006) found that nurses need to form trusting relationships with patients who have Lyme disease and provide effective support and referrals to appropriate community resources. According to these researchers, understanding the lived experience of those with Lyme disease enables nurses to prioritize health care interventions and implement quality improvement measures. Similarly,

Gillespie (2021) suggests nurses should offer support to patients with chronic Lyme disease and develop a care plan conducive to health.

4.5 | Domain 3: Prevention

Identifying key preventative measures to control vector-borne diseases, as well as explaining primary and secondary prevention and protection strategies to individuals, families, communities, and populations, is necessary for nursing graduates. Furthermore, recognizing the holistic relationship Indigenous peoples have in relation to the land is important when considering prevention strategies for vector-borne diseases (CASN, 2020).

Nurses' role in patient education and primary prevention was well-documented in the literature. Adams et al. (2021); Bender and Thompson (2003); Dean (2020); Franklin et al. (1997); Gagnon-Dorsa (1990); Harrison (2002); Marchese and Primer (2013); McGhee et al. (2018); Network to Reduce Lyme Disease in School-Aged Children, Washington, DC (2010); Nichols and Windemuth (2013); Pallares and Winokur (2017), and Pearson (2014) all mention that nurses and/or nurse practitioners should educate patients on vector-borne disease exposure and primary preventative measures.

Additionally, Capps et al. (1999) found that nurses are most knowledgeable about personal protection against Lyme disease and should be aware of surveillance, incidence, and prevalence of Lyme disease in their communities. Franklin et al. (1997) and Gagnon-Dorsa (1990) stress that occupational health nurses play a crucial role in the prevention of zoonotic diseases, such as Lyme disease, through active assessments. Likewise, school nurses can work to prevent Lyme disease through early detection in both staff and students (Network to Reduce Lyme Disease in School-Aged Children, Washington, DC, 2010).

4.6 | Domain 4: Treatment

Nursing graduates should engage in person-centered nursing care strategies and current treatment approaches for vector-borne diseases and assist affected individuals, families, communities, and populations in navigating the health care system to improve prognosis and quality of life. An awareness of the inequities and impact of colonization on accessing health care treatment and resources for Indigenous people is also imperative (CASN, 2020).

The literature in this scoping review suggests that nurses and/or nurse practitioners working in a variety of practice settings should be aware of the threat and signs and symptoms of vector-borne diseases to ensure prompt diagnosis and treatment and ensure expert care is provided to patients (Adams et al., 2021; Campbell & Drehr, 2002; Cavendish, 2003; Dean, 2020; Fletcher, 2003; Force, 1999; Gillespie, 2021; Harrison, 2002; Marchese & Primer, 2013; McGhee et al., 2018; Nichols & Windemuth, 2013; Pallares & Winokur, 2017; Pearson, 2014). However, no literature in this review studied the impact of colonization on health care treatment for Indigenous people.



4.7 | Domain 5: Advocacy

It is important that nursing graduates can describe strategies to address health inequities faced by individuals and populations living with vector-borne diseases, identify culturally appropriate advocacy strategies to promote equitable access to care, engage in culturally safe partnerships with patients, and reflect on public policies related to vector-borne diseases (CASN, 2020). Nursing graduates should be competent in different advocacy strategies that shape climate change and vector-borne disease policy, demonstrate an awareness of various position statements, policies, guidelines, and practice standards to advocate for best care, and in influencing governments to address climate change and adverse health effects (CASN, 2020).

The literature reviewed by the research team demonstrates that nurses have an important role in policy development and advocacy to address vector-borne diseases and quality improvement measures within the health care setting to promote appropriate and equitable access to care for those experiencing vector-borne diseases (Bender & Thompson, 2003; Drew & Hewitt, 2006; Healy, 2000). Nurses are leaders in assessing and communicating environmental risks to patients, collaborating with interdisciplinary partners, advocating for policies that address climate change mitigation and health protection, and producing research on environmental health issues (CNA, 2017, 2019), in addition to advocating for climate change action and working upstream to avoid health crises (Canadian Federation of Nurse Unions, 2019). Literature from this scoping review is congruent with the five domains of the CASN guidelines, with nurses' involvement in mitigation, prevention, and advocacy of climate sensitive vector-borne diseases, focusing on priority populations and those with lived experience of vector-borne diseases. However, literature including Indigenous perspectives was absent.

5 | DISCUSSION

This scoping review determined the extent to which published and grey literature exists on nurse's knowledge and perceptions of vector-borne diseases, and how this literature falls within the *CASN Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases*. Gaining awareness of nurses' knowledge and perceptions of vector-borne diseases is important to determine the current levels of understanding and feelings of competence. Once nurses' perceptions and knowledge, skills, and attitudes are better understood, practice implications, such as patient care and advocacy, can be addressed.

The first domain in the CASN (2020) guidelines highlights the need for nursing graduates to understand climate change and climate sensitive vector-borne diseases. Lack of awareness on climate-driven diseases among nurses is perhaps not surprising since the overall incidence of Lyme disease and West Nile virus, although endemic to Canada, has increased only in recent years and thus is an emerging issue. Boudreau et al. (2018) assert

that vector-borne diseases are not priority issues within Canada's healthcare system, which may contribute to the lack of knowledge among nurses.

It is not surprising then, that this scoping review reveals a lack of knowledge and confidence among nurses regarding climate change and vector-borne diseases. Research by Leffers et al. (2017) confirms that nurses are inadequately prepared for their role in mitigation and prevention of climate related health effects, as well as providing patient-centered nursing care for those affected. Similarly, Kirk (2002) suggests that nurses are poorly prepared to understand the impact of climate change on health, while Barna et al. (2012) argue that nurses require a greater depth of evidence-based knowledge on this topic. These findings demonstrate the importance of incorporating CASN's (2020) guidelines into nursing education programs.

The second domain of the CASN (2020) guidelines address nursing graduates' competencies in respecting and acknowledging populations at risk of vector-borne diseases, those living with vector-borne diseases, and recognizing diverse ways of knowing in relation to vector-borne diseases. This includes the recognition of Indigenous knowledge and expertise on climate change, the effects on health and the environment, and their close and holistic relationship to the land (Leffers et al., 2017; Warren & Lemmen, 2014).

Included literature did not address the recognition of Indigenous knowledge related to climate sensitive vector-borne diseases prevention strategies. An approach called *Two-Eyed Seeing* would be a beneficial approach for nurses to consider, which involves learning to appreciate the strengths of Indigenous knowledge through one eye, while recognizing the strength of Western knowledge and ways of knowing from the other eye (Institute for Integrative Science & Health, n.d.). This approach would allow nurses to demonstrate culturally safe, trauma-informed care and understand how colonization and historical injustices may place Indigenous populations at greater risk of vector-borne diseases and impact access of treatment for vector-borne diseases.

The absence of Indigenous perspectives in current literature is concerning and highlights the need for involvement of Indigenous peoples in future research. Additional research should also include greater participation of populations at-risk for vector-borne diseases to ensure nurses acknowledge and respect the perspectives of those considered at-risk for vector-borne diseases in Canada.

The third and fourth domains in the CASN (2020) guidelines address prevention of and treatment for vector-borne diseases by nursing graduates in practice. The literature retrieved in this scoping review cites the fact that nurses *should* be knowledgeable about vector-borne diseases but literature on whether nurses *actually feel* prepared is lacking. A lack of nursing knowledge on vector-borne diseases may relate to a lack of confidence and feelings of unpreparedness in the practice setting, which may impact patient care. This gap in literature was not unexpected given the emerging nature of this topic and demonstrates a need for further research to evaluate practice readiness. Future studies on workforce readiness in meeting the challenges of vector-borne diseases would be applicable.

Overall, there is a lack of original research on this topic. Only three research studies were located and as such included in this review (Capps et al., 1999; Drew & Hewitt, 2006; Gillespie, 2021). Moreover, all were completed in the USA. Capps et al. focused on general knowledge of Lyme disease of practicing nurses, while Drew and Hewitt and Gillespie studied participants with Lyme disease and the nurses' role in supporting these patients.

Absence of a nursing perspective was also present in the grey literature. Government websites and advocacy organizations spoke of the role of health care professionals in addressing vector-borne diseases; however, a specific focus on nurses was lacking (Can Lyme, 2021; CPHA, 2021; Government of Canada, 2015; 2021). As the largest group of regulated health care professionals in Canada, nurses are central to a high-performing health care system and play an integral role in supporting individuals and populations affected by various health challenges, and thus a specific focus on nurses' knowledge is warranted in future research.

The final domain in the CASN (2020) guidelines is nursing advocacy from the micro to macro levels. An awareness and understanding of policies, guidelines, practice standards, and processes is needed to effectively advocate for quality vector-borne disease care (CASN, 2020). Therefore, exploration of nurses' knowledge, attitudes, and perceptions of vector-borne diseases will provide greater understanding of preparedness toward advocacy roles.

As no research exists on addressing vector-borne diseases in nursing curricula in Canada, additional research is needed to explore the current curriculum context to provide a more accurate picture of the preparedness of nurses in practice. Future research on the integration and effectiveness of the CASN *E-Resource for Nursing Education on Climate-Driven Vector Borne Diseases* in nursing programs is warranted. Additionally, an analysis of learning outcomes for nursing graduates in the CASN guidelines compared to actual practice readiness among novice nurses is crucial.

CASN, as an accrediting body, shows vigilance and preparedness regarding emerging population health threats by developing these guidelines. The challenge now lies with a) curriculum follow up and nurse educators using the guidelines, b) nurse researchers engaging in original research studies to generate evidence for nursing practice, and c) practicing nurses to critically engage with and respond to climate change related health implications.

5.1 | Limitations

A range of literature was retrieved, including original research studies, editorials, evidence-based articles, and grey literature. Although multiple databases were included in the search, all available data on this topic may not be included in this review (Sucharew & Macaluso, 2019), as several promising items were included in the search results, however, efforts to locate full text of the item failed. Additionally, grey literature from Indigenous sources was not included in this scoping review.

6 | CONCLUSIONS

A comprehensive understanding of the perceptions, attitudes, knowledge, and experiences of nurses related to climate sensitive vector-borne diseases is necessary, given the emerging climate change context in Canada and subsequent health effects on populations. Using the *Guidelines for Undergraduate Nursing Education on Climate-Driven Vector-Borne Diseases*, this scoping review revealed that both dated and current literature exists that recommends nurses *should* be knowledgeable about vector-borne diseases, however literature on whether nurses *actually feel* prepared, and an evaluation of their practice readiness is absent. Further research is necessary to address practice readiness among nurses, and the efficacy of content on vector-borne diseases in nursing curricula warrants further exploration. Additional research, as well as improved educational and practice preparation for nurses, is required to further understand perceptions of nurses toward vector-borne diseases to promote improved overall health and wellbeing of Canadians.

AUTHOR CONTRIBUTION

Shannon Vandenberg: conceptualization, methodology, validation, investigation, writing—original draft; writing—review & editing, visualization, project administration. **Andrea Chircop:** methodology, validation, investigation, writing—review & editing, supervision. **Monique Sedgwick:** methodology, validation, investigation, writing—review & editing, supervision. **David Scott:** software, formal analysis, investigation, resources, data curation.

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CONFLICTS OF INTEREST

None to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Shannon Y. Vandenberg RN, MScN, CCHN(C), CCNE, CCCI  <https://orcid.org/0000-0002-6735-2161>

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