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Knowledge, Perceptions, and Attitudes of People with Chronic Conditions and their Healthcare Providers on the Effects of Climate Change on People Living with Chronic Conditions

Scoping Review

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Land Acknowledgement(s)

SPOR Evidence Alliance operates from the St. Michael's Hospital, Unity Health Toronto which is located on the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island.

We are grateful to have the opportunity to work on these lands.

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Abbreviations and Definitions

Abbreviations

HCPs Healthcare professionals
CKD Chronic kidney disease
PD Peritoneal dialysis

Key Definitions:

Climate change: long-term shift in average temperatures and weather patterns of a region due to natural processes or human activities such as the burning of fossil fuels¹.

Chronic conditions: long-term (lasting over a year) illnesses requiring ongoing care or limiting daily activities, including mental conditions².



EXECUTIVE SUMMARY

Objectives: Our objective is to synthesize understanding on the knowledge, perceptions, and/or attitudes of Canadian healthcare professionals (HCPs) and people living with chronic conditions on the impact of climate change on people with chronic conditions.

Design: A scoping review was carried out to identify published studies in any language between January 2010 and June 2024.

Method: Electronic databases MEDLINE (Ovid), EMBASE (Ovid), PsycINFO (Ovid), were searched. Eligible studies included studies that reported outcomes related to the knowledge, perceptions and/or attitudes of HCPs and/or people in Canada living with a chronic condition. To qualify, the study had to link the knowledge, perceptions and/ or attitudes to climate change. Two reviewers were independently responsible for data screening and extraction.

Results: A total of 5,948 citations were screened and only 3 studies met the inclusion criteria. Two studies were international cross-sectional studies and included HCPs in Canada while a quantitative survey study was conducted in Canada only. A study examined the knowledge and attitudes of HCPs regarding the link between climate change and kidney health. Of the limited reported outcomes, the results varied. While concerns about the impact of climate change on patient health showed mixed results across studies, there was a consistent understanding that climate change negatively affects persons with chronic conditions. Knowledge of climate change among HCPs was also mixed, with two out of three studies reporting that less than half of participants felt adequately informed to support patients. None of the included studies focused on knowledge, perceptions, and attitudes of people living with a chronic condition, although one study contrasted HCPs to the general Canadian public.

Conclusion: There are clear gaps in the Canadian literature, highlighting the need for further research to better understand the knowledge, perceptions and attitudes of people with chronic conditions and HCPs in Canada.

Protocol/Topic Registration: The protocol for this review was registered with the OSF Registries (<https://doi.org/10.17605/OSF.IO/TFRWP>)



Introduction

Climate change, marked by rising temperatures, extreme weather events, and shifting disease patterns, presents significant challenges to public health and quality of life³. It has been shown to harm human health by increasing heat-related stress, acute exacerbations of asthma and chronic obstructive pulmonary disease, and increasing hospitalizations due to vector-borne disease⁴. Although some impacts of climate change are acute, there is growing evidence that people with chronic conditions are impacted to a greater degree in comparison to acute disease due to these individuals being at greater risk for other illnesses, require more consistent medication and care, may be immunocompromised, and have increased vulnerability to trauma and environmental stressors, especially people with underlying mental health conditions⁵. Climate change events can lead to direct physical and mental health impacts, as well as secondary effects by restricting access to healthcare due to infrastructure damage or safety concerns during travel⁶. In addition, environmental injustices and structural inequities disproportionately heighten exposure to these hazards and climate risk for communities of colour, low-income people, and other marginalized groups who already face health inequities^{6,7}. Chronic conditions are defined as long-term illnesses (lasting over a year) requiring ongoing care or limiting daily activities, including mental conditions². As 2023, 45.1% of Canadians were living with at least one major chronic condition, making the need to understand the impact of climate change on this population increasingly important⁸.

Healthcare professionals (HCPs) play a vital role in recognizing and addressing the impact of climate change and the risks it poses for their patients as they navigate the complex relationship between environmental shifts and health outcomes. HCPs must first recognize that climate change may be impacting their patients, inform their patients, and alter their own behavior to provide the best quality of care to their patient population. The Canadian Medical Association has started conversation amongst physicians on climate change and its impact on Canadian patient populations⁹. Reports such as the Extreme Heat Events Guidelines: Technical Guide for Health Care Workers have been created to support HCPs¹⁰. The Global Consortium on Climate and Health Education also has multiple environmental stewardship programs to support HCPs¹¹. There is growing recognition of the impact of climate change on chronic conditions, allowing HCPs to tailor to their patient's needs. Without sufficient recognition, there is risk of patients being under- or inadequately cared for in the context of their environmental conditions. Currently, the knowledge, perceptions, and attitudes of Canadian HCPs remains unclear. People with chronic conditions consider gaining a thorough understanding of the knowledge, perception, and attitudes of HCP's and other people living with chronic conditions as an important area of research that warrants further exploration.

Our study, co-led by patient advocacy partners, aimed to fill this gap in the literature with the following research questions: (1) What are Canadian people with chronic conditions' perceptions, knowledge, and/ or attitudes of the impacts of climate change on their conditions? (2) What are Canadian HCPs perceptions, knowledge, and/ or attitudes of the impacts of climate change on people with chronic health conditions?

This research is crucial for guiding evidence-based practices and policies to build sustainable resources. It aims to better educate Canadians on the impact of climate change on patient health and ensure equitable healthcare for all.



Methods

A scoping review was conducted following the guidance of the JBI scoping review methodology¹². The PRISMA-ScR was used to guide the reporting for the results (Supplementary 1). The protocol for this review was registered with the OSF Registries¹³.

A search strategy was developed with consultation of a scientist search specialist. The following electronic databases MEDLINE (OVID), EMBASE (OVID), and PsycINFO (OVID) were searched for studies published between 2010 and 2024. Appendix 1 contains the search strategy used with key concepts of climate change and chronic conditions being used. The current review focused on studies published within that time frame to capture the most recent knowledge, perceptions and attitudes. Given this, 2010 was chosen as the most recent important data published since it is after the development of global knowledge relating to the health impacts of climate change, such as the Lancet Commission on Planetary Health in 2015¹⁴. Grey literature, such as reports and websites, provided by the patient partners was assessed using the eligibility criteria (Appendix 2). The search was conducted on June 4, 2024.

Identifying the relevant studies

We considered articles that reported on the knowledge, perceptions and/ or attitudes of any HCP and/or any adult or pediatric patient in Canada with chronic conditions regarding climate change. Chronic conditions were defined by the following list: asthma, chronic obstructive lung disease, type 2 diabetes, heart disease, coronary disease, cardiovascular disease, ischemic heart disease, hyperlipidemia, rheumatoid arthritis, osteoporosis, osteoarthritis, cancer, kidney disease and dysfunction, hepatitis, bowel disorders such as Crohn's disease and ulcerative colitis, irritable bowel syndrome, pulmonary disease, anxiety, and depression as developed from other studies^{15,16}. HCPs could be of any type of Canadian regulated healthcare provider including physicians, pharmacists, dentists, and nurses. Articles that did not directly link climate change to chronic disease/ conditions were excluded. Additionally, articles that included climate change but did not include the knowledge (what is known about the topic or how much is known by the individual), perceptions (interpret and understand information) and/ or attitudes (feelings, beliefs, or emotional responses) of an HCP or people with chronic conditions were excluded. Editorials, case studies, abstracts, literature reviews, systematic reviews, protocols and articles without full text were excluded. There were no language restrictions. Articles in other languages were translated to English during screening to determine eligibility. No quality assessment was conducted as this was not the purpose of this scoping review.

Table 1. Inclusion and exclusion criteria for the scoping review

Inclusion criteria	Exclusion criteria
<ol style="list-style-type: none"> 1. Published between 2010 to present June 4, 2024 2. Full text available 3. Any language 	<ol style="list-style-type: none"> 1. Published prior to 2010 2. Full text unavailable 3. Editorials, case studies, abstracts, literature reviews, systematic reviews, and protocols were not included in the study



<p>4. Studies that focus on Canadian populations, but did not have to be exclusive to Canada</p> <p>5. Describes knowledge, perceptions, and attitudes of healthcare professionals and people living with chronic conditions in Canada on their views on the impact of climate change on chronic conditions.</p>	<p>4. Studies that described knowledge, perceptions and/ or attitudes towards climate change but did not focus on healthcare providers or people living with chronic conditions</p> <p>5. Studies that did not directly and explicitly link climate change to chronic disease or chronic condition(s)</p>
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Study selection

Studies were imported into Covidence where duplicates were removed, and two stages of screening were conducted. The first level of screening was title and abstract reviews by five reviewers (JR, ZA, JC, KW, MT). Pilot screening exercise was conducted using five studies. Following piloting, screening was performed in duplicate. The second level of screening was full-text review by three reviewers (JR, ZA, MT) and a pilot screening exercise conducted using five studies. Following piloting, screening was performed in duplicate. During both stages, disagreements between reviewers were settled through discussion or consensus involving a third reviewer.

Data extraction and charting the data

The data extraction spreadsheet was designed by JR in collaboration with JLR and KL, using MS Excel. Data from the first of the three articles were piloted between JK and ZA to validate the extraction form and JR and ZA extracted the remaining. The information that was extracted was (a) study characteristics (title, author, year of publication, study design, aim, geographical region, tool of assessment (i.e. survey, checklist), study population and type, chronic disease type if applicable, (b) patient characteristics tracked using PROGRESS Plus¹⁷, allowing a health equity lens to be applied by extracting and analyzing the data, (c) reported outcomes of interest (knowledge, perceptions, attitudes), (d) any other applicable information (how/ why they received their knowledge from, future recommendations of study).

Results

In total, 9,476 articles were identified through the literature search, with 5,137 from Embase, 3,697 from MEDLINE, and 606 from PsycINFO (Figure 1). After removing the 3,528 duplicates, 5,958 were included for title and abstract screening. After title and abstract screening, which included grey literature screening, 38 articles remained and after full-text screening, three articles remained for data analysis¹⁸⁻²⁰ None of the grey literature met the inclusion criteria.

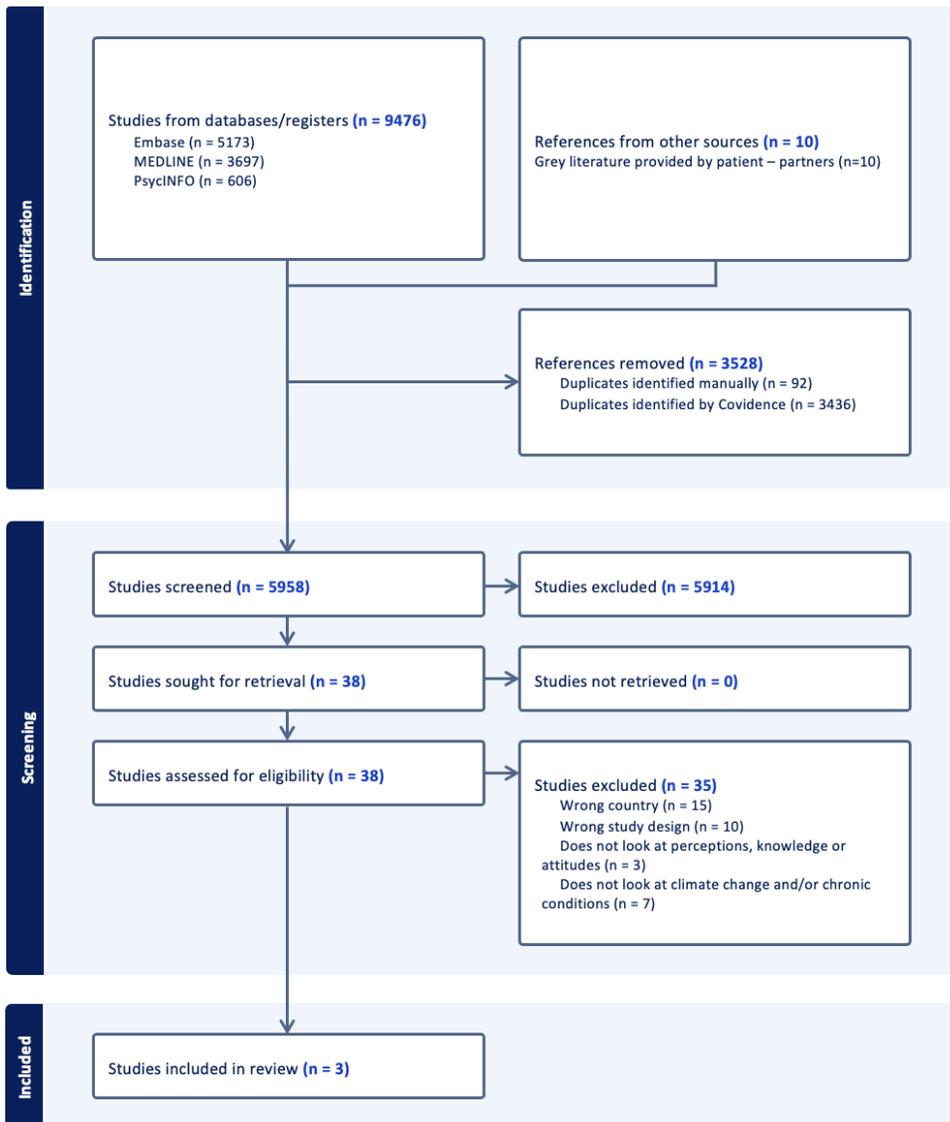


Figure 1. PRISMA for Included Studies

Table 2 details the characteristics of the studies included. The three studies¹⁸⁻²⁰ were conducted in 2012, 2016, and 2024. Two were cross-sectional studies that were multi-national, and the other was a quantitative survey study conducted only in Canada.



Table 2. Characteristics of included studies (n=3)

Study	Aim	Study Type	Country	Assessment Tool
Sandal et al. (2024) ¹⁸	Aimed to ascertain the knowledge, attitude, and practice of HCPs on the interconnectedness of climate change, kidney health, and kidney care and compare responses by the income level of the participant's country.	Cross-sectional study	108 countries (Canada n=88, 9%)	Multinational survey Non-validated questionnaire
Sarfaty et al. (2016) ¹⁹	The American Thoracic Society surveyed international members of the society to assess perceptions, clinical experiences, and preferred policy responses related to global climate change.	Cross-sectional study	68 countries (n=489 with Canada and Mexico 18%)	Survey approved by the George Mason University Institutional Review Board (Project 624642-2)
Krewski et al. (2012) ²⁰	Assess changes in expert risk perception over time, investigate perceptions of new or emerging health risks, and compare results to the 2004 general risk perception survey conducted among members of the Canadian public.	Quantitative survey study	Canada (n=125)	Survey designed as a follow-up to the 1993 survey of members of the Society of Toxicology of Canada Pre-tested with volunteers

Table 3 highlights the characteristics and demographics of the study populations. All three studies provided insights of HCPs; however, Sandal et al. (2024)¹⁸ surveyed a range of HCPs from nephrologists (62%) to pharmacists (1%). Sandal et al. (2024)¹⁸ and Sarfaty et al. (2016)¹⁹ looked at specific outcomes related to high-income countries. Sandal et al.¹⁸ stratified the results by a country's income level, with Canada being considered high-income along with Australia, United States, United Kingdom, Italy, Hong Kong, Ireland, Singapore, and Saudi Arabia. 64% of the countries included in the study were identified as lower-to-middle-income countries.



Table 3. Characteristics and Demographics of Reported Population (n=3)

Study	Participant Type	Age of Participants	Sex	Socioeconomic Status	Profession
Sandal et al. (2024) ¹⁸	Health care provider	<25: 0% 25-34: 16% 35-44: 32% 45-54: 29% 55-65: 12% >65: 9%	Male (46%) Female (53%) Prefer not to say (1%)	64% lower-to-middle income countries	Nephrologist (62%) Nurse (17%) Another physician/doctor (9%) Scientist (2%) Manager (2%) Trainee (2%) Other (2%) Pharmacist (1%) Dietician (1%) Technician (1%) Social worker (0%)
Sarfaty et al. (2016) ¹⁹	Health care provider	18-30: 7.2% 31-50: 49.3% 51-65: 33.9% >65: 9.6%	Male (64%) Female (23%)	High income	Physicians with MD or equivalent degree (70%) PhD (34%) Nondoctoral clinical degree (1%)
Krewski et al. (2012) ²⁰	Health care provider	18-34: 19.2% 35-43: 39.2% >55: 41.6%	Male (66.4%) Female (33.6%)	N/A	Graduate school (81.6%)

All studies reported an outcome related to perceptions and attitudes of HCPs (Table 4a -c). Sandal et al. (2024)¹⁸ focused on how concerned participants were regarding climate change and stratified their results by patients' disease type specifically for kidney disease. Stratification classes were people on dialysis, those on peritoneal dialysis (PD), individuals with chronic kidney disease (CKD) not on dialysis, and kidney transplant recipients, as well as the general population. The level of concern was consistently high for all disease types. In comparison to high-income countries, concerns surrounding the impact of climate change on patient health was higher among lower-to-middle-income countries for all population types, except those on PD.

Sarfaty et al. (2016)¹⁹ reported a range of perceptions and attitudes of physicians, individuals with PhD's and nondoctoral clinical degree health providers. 41% of individuals think that climate change is affecting the health of their patients a moderate amount while 28% think climate change is affecting the health of your patients a great deal. 88% believe that climate change is currently impacting their patients in regard to air pollution relating to increases in severity of illness for asthma, chronic obstructive pulmonary disease, pneumonia, and cardiovascular disease. A majority of HCPs (89%) believe climate change will impact their patients in 10-20 years from now (being time of survey). 76% of HCP's believe that the people with chronic disease (76%) are most likely to be impacted by climate change followed by the poor and working poor (64%), young children ages 0 to 4 years old (71%) and elderly individuals over the age of 60 (70%), as defined by the study. Additionally, 80% of HCPs felt that physicians should bring health effects of climate change to the patient's attention and 79% felt that physicians should bring health effects of climate change to the public's attention.



Krewski et al. (2012)²⁰ compared the perceptions of experts and the public on climate change and health risks. Experts considered climate change the second greatest health risk in Canada after motor vehicles, but they scored lower than the public on several factors related to the extent of the risk, personal health impact, and acceptability of the risk. The only exception was the level of uncertainty, which was higher among experts. While the public expressed more concern about climate change risks, the difference in worry between the two groups was not statistically significant.

Table 4a. Reported Outcomes of Perceptions and Attitudes of Canadian Health Care Providers

Study	Outcome	Population	Outcome Statistic
Sandal et al. (2024) ¹⁸	% selecting scores of 4 or 5 when participants were asked "On a scale of 1–5, where 1 is not concerned at all and 5 is very concerned, how concerned are you that climate change will harm the health of?"	People on dialysis	68%
		People on PD	63%
		People with CKD (not on dialysis)	64%
		People with kidney transplant	64%
		Kidney health of the general population	67%
		High-Income Country vs. lower-to-middle incomes countries for people on hemodialysis:	70% vs. 70%
		High-Income Country vs. lower-to-middle incomes countries for people on PD	66% vs. 62%
		High-Income Country vs. lower-to-middle incomes countries for people with CKD (not on dialysis)	62% vs. 68%
		High-Income Country vs. lower-to-middle incomes countries for people with kidney transplant	62% vs. 67%
		High-Income Country vs. lower-to-middle incomes countries for kidney health of the general population	66% vs. 70%

CKD: Chronic kidney disease; PD: peritoneal dialysis.

Table 4b. Reported Outcomes of Perceptions and Attitudes of Canadian Health Care Providers

Study	Outcome	Population	Outcome Statistic
Sarfaty et al. (2016) ¹⁹	How much do you think climate change is affecting the health of your patients?	N/A	A moderate amount = 41% A great deal = 28% Only a little = 14% I don't see patients = 9% Don't know = 5% Not at all = 3%



	n (%) responding "yes" to "In which of the following ways, if any, do you think your patients are currently being affected by climate change, or might be affected in the next 10-20 years?" for air pollution related increases in severity of illness for asthma, chronic obstructive pulmonary disease, pneumonia, and cardiovascular disease.	N/A	Now: Yes: 88% No: 7% Don't Know 6%
			10-20 years from now: Yes: 89% No: 4% Don't know: 6%
	% who will be affected	People with chronic disease	76%
		Poor and working poor	64%
		Young children (0-4years)	71%
		Adults over 60	70%
	% trusted sources of information	N/A	Trusted/strongly trusted: 50% Did not know: 22%
	% responding to climate change	N/A	Physicians should have significant advocacy role in relation to climate change and health: 85% Personal and/or professional life can contribute to action on climate change: 76% Physicians should bring health effects of climate change to patient attention: 80% Physicians should bring health effects of climate change to public attention: 79%



Table 4c. Reported Outcomes of Perceptions and Attitudes of Canadian Health Care Providers

Study	Outcome	Population	Outcome Statistic
Krewski et al. (2012) ²⁰	To what extent is climate change a risk to the health of Canadians?	Mean perception of the public (SD) vs. experts (SD) (0 to 5 scale)	2.77 (0.92), 2.41 (0.85)**
	How much do you worry about climate change risks?	Mean perception of the public (SD) vs. experts (SD) (0 to 5 scale)	2.17 (1.08), 2.01 (0.89)
	What level of uncertainty do you think there is, in general, about climate change risks?	Mean perception of the public (SD) vs. experts (SD) (0 to 5 scale)	2.75 (0.92), 3.15 (0.89)**
	What level of risk from climate change do you think is acceptable?	Mean perception of the public (SD) vs. experts (SD) (0 to 5 scale)	2.14 (0.84), 1.92 (0.62)**
	How much personal control do you feel you have over climate change risks?	Mean perception of the public (SD) vs. experts (SD) (0 to 5 scale)	1.80 (1.00), 1.59 (0.78)**
	To what extent is climate change a risk to your health?	Mean perception of the public (SD) vs. experts (SD) (0 to 5 scale)	2.36 (1.01), 1.97 (0.78)**

**indicates statistical significance

Table 5 presents the results for knowledge of HCPs on the health impacts of climate change on chronic disease. Less than half of the participants in the Sandal et al. (2024)¹⁸ study indicated sufficient knowledge on the health effects of climate change. Participants from high-income countries rated their knowledge to be lower than HCPs in upper-middle-income countries, lower-to-middle-income countries, and low-income countries. These results were significant for patients on hemodialysis (P=0.02), CKD (P=0.004), kidney transplant (P= 0.006), and kidney health of the general population (P<0.001). Sarfaty et al. (2016)¹⁹ showed similar results, with half of the HCPs being modestly or very knowledgeable about the association between climate change and health (54%). Forty-five percent of participants indicated a "lack of knowledge about how to address the issue with their patients" as a barrier to addressing climate changes issues with their patients. When comparing public knowledge of climate change risks to experts, the public has similar knowledge. Krewski et al. (2012)²⁰ found an insignificant difference between public and experts for the question knowledge on climate change risks.

Table 5. Reported Outcomes of Knowledge for Canadian Healthcare Providers (n=3)

Study	Outcome	Population	Outcome Statistics
Sandal et al. (2024) ¹⁸	% responding "yes" to "Do you think you possess sufficient knowledge on the health	People on dialysis	47%
		People on PD	42%
		People with CKD (not on dialysis)	49%



	effects of climate change for?"	People with kidney transplant	41%
		Kidney health of the general population	40%
Sarfaty et al.(2016) ¹⁹	% overall knowledge about association between climate change and health	N/A	Moderately or very knowledgeable: 54% Modestly knowledgeable: 39% Not at all knowledgeable: 6%
	Identify barriers to addressing climate change– related health issues with patients	N/A	45% indicated lack of knowledge about how to address the issue with their patients.
Krewski et al. (2012) ²⁰	How much knowledge do you feel you have about climate change risks?	Mean perception of public (SD) vs. experts (SD) (0 to 5 scale)	2.70 (0.89) vs. 2.65(0.79)

CKD: Chronic kidney disease; PD: peritoneal dialysis.



Discussion

This paper examines the literature to synthesize understanding on the knowledge, perceptions, and attitudes of Canadian HCPs and people with chronic conditions on the impact of climate change on people living with chronic conditions. Only three studies¹⁸⁻²⁰ were included in the paper that focused on HCPs knowledge, perceptions, and attitudes of the impact of climate change on chronic conditions, while no studies highlighted the perspective of people with chronic conditions. Of the limited studies, there was generally a high level of concern among HCPs that climate change is impacting their patient populations, but the results remain inconsistent as several perspectives were assessed with varying results. Similarly, all studies reported generally low knowledge of the general impacts of climate change on patient populations. There is an evident need to do more research in this space as there is insufficient evidence to draw any conclusions at this time. In addition to understanding more on the HCPs, future research may focus on learning more about the knowledge, perceptions, and attitudes of Canadian people living with chronic conditions on the impact of climate change on their health.

Considering that reported concerns of HCPs were generally high, the subsequent reported knowledge of HCPs did not mirror these concerns. One study included in our study revealed that almost 50% of their participants lacked knowledge to address climate change with their patients¹⁹. Other studies, not specific to chronic disease, have found HCPs to have generally high levels of concern such as registered dietitians in the United States of America²¹. A systematic review conducted in 2018 found a similar pattern where HCPs in Canada recognized that climate change was impacting people with health concerns, but they lacked the knowledge on the topic²². In understanding that HCPs have a relatively high concern, but not enough knowledge to supplement their concern or act on it, future resources can be implemented into healthcare settings to decrease this gap and make better-quality care accessible to patients.

Sandal et al. (2024)¹⁸ specifically investigated perspectives, knowledge, and attitudes of HCPs for kidney disease and was stratified by patient type. This indicated that the type of chronic condition and disease characteristics are imperative to the levels of concerns. This is due to different diseases requiring various levels of resources that might cause the HCP to have a higher level of concern in comparison to other specialties that require less resources to support patient health (i.e. the concern of a general practitioner varies from that of an oncologist). Although the included studies did not directly compare Canada to other countries, the data was stratified by country income levels when considering patients with various kidney diseases. The results show lower-income countries to have higher concern and significantly more knowledge¹⁸. This could be due to climate change impacting these countries to a greater degree and this concern is magnified for patients with kidney disease as they require more resources in their care that may be at risk²³. Further research on specific HCPs knowledge, perceptions, and attitudes would be important to providing specific resources to better support patient care and health. Future studies should capture additional information regarding the resources available to lower-income countries and specific disease characteristics.

Krewski et al. (2012)²⁰ reported on the sources of which the Canadian experts received their information regarding health risks. They found that most experts received their information from university scientists and scientific journals, followed by medical doctors, government, health brochures and pamphlets, news media, public interest/ environmental groups, industry, or friends and relatives. The public is significantly different as they generally consulted news, media platforms, friends and relatives, and health brochures and pamphlets more often than experts and had greater confidence in



these sources than experts. This may indicate how to expand HCP and public knowledge on the health impacts of climate change on chronic conditions when integrating resources into the healthcare system.

Amongst the study characteristics reported, PROGRESS-Plus was used as the driving tool for tracking¹⁷. While one study examined country income difference, it is important to note that individual demographics were not analyzed beyond basic categories such as sex, age, and profession (i.e. PhD, MD). The results were not stratified by profession and specialty within the profession, leaving a gap in understanding on which specific HCPs would benefit the most from additional knowledge, resources, and education. Reporting education/ profession level is beneficial to understanding how different backgrounds may emphasize learning of climate change within their learning curriculums or current work environments (i.e. clinical, community, research). It could also indicate how different HCP specialists view climate change. Specialist HCPs may be more informed or hold differing opinions. There is also a lack of data on intersectionality and factors that may put patients at disproportionate risk of climate change impacts, such as structural inequities and environmental injustices. Without researchers and HCPs considering these factors, it is difficult to have a comprehensive understanding of the type of support patients need to improve care and address health inequities. Future research should seek a complete understanding of HCPs professional profile and people's perspectives and contexts based on various factors such as sociodemographic, geographic location, type of chronic condition, number of chronic conditions, and specific climate change hazards or impacts to tailor to patient needs.

Strengths

This study has many strengths. Firstly, this is the first study of this nature that specifically looks at Canadian HCPs and people with chronic conditions regarding their knowledge, perceptions, and attitudes on the impact of climate change on chronic conditions. Secondly, a comprehensive search was completed, allowing for a wide range of literature to be captured. Given the rapid growth of this global movement, it is important to highlight how relevant it is in current scientific research. This review contributes to the increasingly urgent call to address gaps in research and also highlights the importance of scaling comprehensive understanding of climate change risk, appropriate clinical practices, and equitable supports for people living with chronic conditions that are proportional to the climate crisis we are facing.

Limitations

There are some limitations of this study. Firstly, the surveys used to assess perceptions, attitudes, and/or knowledge were generated internally within the institute or team and were not published. They may have led to biases as there is a lack of validation in the assessment tool. Secondly, limited studies are published in this area, possibly due to the research being conducted early in this field. For the studies that were included, the studies do not capture characteristics specific to patient and HCP demographics. This is a limitation to understanding the burden of chronic disease. Additionally, the studies had limitations, such as lacking country-to-country comparison, leaving a gap in the literature to assess Canada-specific outcomes that are of interest to us.

Conclusion

This paper reviews existing literature to understand the knowledge, perceptions, and attitudes of Canadian HCPs and people living with chronic conditions regarding the impacts of climate change on people living with chronic conditions. Our findings are from two international cross-sectional studies and



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one national cross-sectional study that looked at HCPs' knowledge, perceptions, and attitudes. There was a range of perceptions and attitudes among participants that demonstrated mixed results. Knowledge of HCPs on the impacts of climate change seemed insufficient among all three studies despite the negative perspectives of climate change's impact on patient populations. There are evident gaps in Canadian literature with the current lack of literature on the topic. Future research can be conducted to assess people living with chronic conditions' knowledge, perceptions, and attitudes on climate change and its impact on chronic conditions in order for HCPs to gain a greater understanding of how to more effectively support the people they care for.



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Appendix 1: Search Strategy

Overview

Interface: Ovid

Databases

- MEDLINE All (1946-present)
- Embase (1974-present)
- PsycINFO

Note: Subject headings and search fields have been customized for each database. Duplicates between databases were removed in Covidence.

Date of search: June 4, 2024

Ovid MEDLINE

- 1 (climate adj3 change*).ti,ab,kf.
- 2 (global adj3 warming).ti,ab,kf.
- 3 (greenhouse adj3 effect).ti,ab,kf.
- 4 (environmental adj3 change*).ti,ab,kf.
- 5 Global Warming/ or Greenhouse Effect/ or Climate Change/
- 6 1 or 2 or 3 or 4 or 5
- 7 (chronic adj3 (illness* or disease* or condition*)).ti,ab,kf.
- 8 (long-term adj4 (illness* or disease* or condition*)).ti,ab,kf.
- 9 chronic health condition*.ti,ab,kf.
- 10 long-term health condition*.ti,ab,kf.
- 11 non-communicable disease*.ti,ab,kf.
- 12 asthma.ti,ab,kf.
- 13 chronic obstructive lung disease.ti,ab,kf.
- 14 (diabetes adj3 mellitus).ti,ab,kf.
- 15 type 2 diabetes.ti,ab,kf.
- 16 heart disease*.ti,ab,kf.
- 17 coronary disease*.ti,ab,kf.
- 18 cardiovascular disease*.ti,ab,kf.
- 19 (ischemic adj2 heart adj2 disease*).ti,ab,kf.
- 20 Hyperlipidemia.ti,ab,kf.
- 21 rheumatoid arthritis.ti,ab,kf.
- 22 osteoporosis.ti,ab,kf.
- 23 osteoarthritis.ti,ab,kf.
- 24 cancer*.ti,ab,kf.
- 25 (kidney adj2 disease*).ti,ab,kf.
- 26 (chronic adj2 kidney adj2 disease*).ti,ab,kf.
- 27 kidney dysfunction.ti,ab,kf.
- 28 hepatitis.ti,ab,kf.
- 29 (bowel adj2 disorder*).ti,ab,kf.
- 30 Crohn's disease.ti,ab,kf.
- 31 ulcerative colitis.ti,ab,kf.
- 32 irritable bowel syndrome.ti,ab,kf.
- 33 Chronic Disease/



- 34 pulmonary disease*.ti,ab,kf.
- 35 anxiety.ti,ab,kf.
- 36 depression.ti,ab,kf.
- 37 multiple morbidit*.ti,ab,kf.
- 38 comorbidit*.ti,ab,kf.
- 39 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38
- 40 6 and 39
- 41 limit 40 to yr="2010 -Current"

Ovid EMBASE

- 1 (climate adj3 change*).ti,ab,kf.
- 2 (global adj3 warming).ti,ab,kf.
- 3 (greenhouse adj3 effect).ti,ab,kf.
- 4 (environmental adj3 change*).ti,ab,kf.
- 5 Global Warming/ or Greenhouse Effect/ or Climate Change/
- 6 1 or 2 or 3 or 4 or 5
- 7 (chronic adj3 (illness* or disease* or condition*)).ti,ab,kf.
- 8 (long-term adj4 (illness* or disease* or condition*)).ti,ab,kf.
- 9 chronic health condition*.ti,ab,kf.
- 10 long-term health condition*.ti,ab,kf.
- 11 non-communicable disease*.ti,ab,kf.
- 12 asthma.ti,ab,kf.
- 13 chronic obstructive lung disease.ti,ab,kf.
- 14 (diabetes adj3 mellitus).ti,ab,kf.
- 15 type 2 diabetes.ti,ab,kf.
- 16 heart disease*.ti,ab,kf.
- 17 coronary disease*.ti,ab,kf.
- 18 cardiovascular disease*.ti,ab,kf.
- 19 (ischemic adj2 heart adj2 disease*).ti,ab,kf.
- 20 Hyperlipidemia.ti,ab,kf.
- 21 rheumatoid arthritis.ti,ab,kf.
- 22 osteoporosis.ti,ab,kf.
- 23 osteoarthritis.ti,ab,kf.
- 24 cancer*.ti,ab,kf.
- 25 (kidney adj2 disease*).ti,ab,kf.
- 26 (chronic adj2 kidney adj2 disease*).ti,ab,kf.
- 27 kidney dysfunction.ti,ab,kf.
- 28 hepatitis.ti,ab,kf.
- 29 (bowel adj2 disorder*).ti,ab,kf.
- 30 Crohn's disease.ti,ab,kf.
- 31 ulcerative colitis.ti,ab,kf.
- 32 irritable bowel syndrome.ti,ab,kf.
- 33 Chronic Disease/
- 34 pulmonary disease*.ti,ab,kf.
- 35 anxiety.ti,ab,kf.
- 36 depression.ti,ab,kf.
- 37 multiple morbidit*.ti,ab,kf.



- 38 comorbidit*.ti,ab,kf.
- 39 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38
- 40 6 and 39
- 41 limit 40 to yr="2010 -Current"

APA PsycInfo

- 1 (climate adj3 change*).ti,ab,id.
- 2 (global adj3 warming).ti,ab,id.
- 3 (greenhouse adj3 effect).ti,ab,id.
- 4 (environmental adj3 change*).ti,ab,id.
- 5 Global Warming/ or Greenhouse Effect/ or Climate Change/
- 6 1 or 2 or 3 or 4 or 5
- 7 (chronic adj3 (illness* or disease* or condition*)).ti,ab,id.
- 8 (long-term adj4 (illness* or disease* or condition*)).ti,ab,id.
- 9 chronic health condition*.ti,ab,id.
- 10 long-term health condition*.ti,ab,id.
- 11 non-communicable disease*.ti,ab,id.
- 12 asthma.ti,ab,id.
- 13 chronic obstructive lung disease.ti,ab,id.
- 14 (diabetes adj3 mellitus).ti,ab,id.
- 15 type 2 diabetes.ti,ab,id.
- 16 heart disease*.ti,ab,id.
- 17 coronary disease*.ti,ab,id.
- 18 cardiovascular disease*.ti,ab,id.
- 19 (ischemic adj2 heart adj2 disease*).ti,ab,id.
- 20 Hyperlipidemia.ti,ab,id.
- 21 rheumatoid arthritis.ti,ab,id.
- 22 osteoporosis.ti,ab,id.
- 23 osteoarthritis.ti,ab,id.
- 24 cancer*.ti,ab,id.
- 25 (kidney adj2 disease*).ti,ab,id.
- 26 (chronic adj2 kidney adj2 disease*).ti,ab,id.
- 27 kidney dysfunction.ti,ab,id.
- 28 hepatitis.ti,ab,id.
- 29 (bowel adj2 disorder*).ti,ab,id.
- 30 Crohn's disease.ti,ab,id.
- 31 ulcerative colitis.ti,ab,id.
- 32 irritable bowel syndrome.ti,ab,id.
- 33 Chronic Disease/
- 34 pulmonary disease*.ti,ab,id.
- 35 anxiety.ti,ab,id.
- 36 depression.ti,ab,id.
- 37 multiple morbidit*.ti,ab,id.
- 38 comorbidit*.ti,ab,id.
- 39 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38
- 40 6 and 39



41 limit 40 to yr="2010 -Current"

Table 1S: Search Results

Database	Number of Articles
MEDLINE –OVID INTERFACE	3697
EMBASE –OVID INTERFACE	5173
PsycINFO – OVID INTERFACE	318

Total after duplicates:5974



Appendix 2: Grey Literature

1. [Health of Canadians in a Changing Climate report](#)
2. [Ontario Provincial Climate Change Impact Assessment](#) - p. 445 overviews health impacts, also see risk to healthcare sector on page xviii
3. [HealthADAPT](#)
4. [The Green Health Care Report 2020-2021](#)
5. [Global Consortium on Climate and Health Education](#) (also see [Climate Resources for Health Education](#) portal).
6. [Planetary Health Alliance](#)
7. [Asthma Exacerbation Triggered by Wildfire: A Standardized Patient Case to Integrate Climate Change Into Medical Curricula](#)
8. [Health in the Global Environmental Agenda: A policy guide](#)
9. [Let's Talk Health & Climate: Communication Guidance for Health Professionals](#)
10. [Mobilizing Public Health Action on Climate Change in Canada](#)



Appendix 3: PROGRESS- PLUS

Study	Place of Residence	Race/Ethnicity/Culture/Language	Religion	Education	Socioeconomic Status (SES)	Social Capital	Personal Characteristics	Features of Relationships	Time-dependent Relationships
Sandal et al. (2024) ¹⁸	NA	NA	NA	NA	High income 36% Upper middle income 22% Lower middle income 38% Low income 4%	NA	NA	NA	NA
Sarfaty et al. (2016) ¹⁹	NA	NA	NA	NA	NA	NA	NA	NA	NA
Krewski et al. (2012) ²⁰	NA	NA	NA	The majority of experts reported having completed at least some graduate school (81.6%)	High income country	NA	NA	NA	NA



Supplementary 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.	v
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.	1
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.	1
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.	2
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.	2, 3
Information sources*	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.	2, 3
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	16
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	3
Data charting process‡	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.	3, 4
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	2,3



Critical appraisal of individual sources of evidence§	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).	4
Synthesis of Results	13	Describe the methods of handling and summarizing the data that were charted.	4
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.	3, 4
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	5
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
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.	5-10
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	5-10
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.	11,12
Limitations	20	Discuss the limitations of the scoping review process.	12
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.	12, 13
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.	i

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

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

† A 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).

‡ The 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.

§ The 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).

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.