Knowledge of protective measures during extreme heat events among the general public

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Abstract

Background

Extreme Heat Events (EHEs) are increasing in frequency, intensity, and duration in Canada that are resulting in high numbers of preventable heat-related illnesses and deaths. Apart from heat related injuries, extreme heat can catalyze reactions to worsen the outdoor air quality, increase wildfire occurrences, and worsen pre-existing heart conditions or chronic illnesses. Assessing the general public's knowledge of protective measures against EHEs is needed to prevent further heat-related injuries. In addition, the general public's knowledge of climate change can be determined to assess if they are aware of the contribution of extreme heat.

Methods

The online self-administered survey was created by Survey Monkey and then distributed through Facebook and Reddit. The survey contained 16 questions which consisted of demographic questions, including age, education, and geographic region. The rest of the questions were knowledge questions to assess the general public's knowledge of the health risks of extreme heat and what they can do to protect themselves from heat-related illnesses and deaths.

Results

A total of 70 Canadian participants consented to the survey. The distribution of age groups was as follows: 62% were 25 – 34 years old, 21% were 18 – 24 years old, and 17% were 35 – 64 years old. The Chi-Square test revealed that there is no association between knowledge of extreme heat protection measures and the three variables: age ($p = 0.28$), level of education ($p = 0.13$), or knowledge of climate change ($p = 0.95$).

Conclusions

While many participants have recognized the adverse health impacts of extreme heat, they could not correctly identify the symptoms of heat illnesses or the appropriate cooling behaviours to adopt during an EHE. In addition, while many agree to the fact that the majority of scientists agree that climate change is caused by human activities, there is a lack of understanding of how climate change has an impact on human health and how it will exacerbate existing health conditions.

Keywords

Extreme heat, Heatwave, Heat-related illness, human-induced climate change, protection measures

Introduction

Extreme Heat Events (EHEs) are defined as hotter and/or more humid than the typical average weather at a specific location, causing heatwaves and extreme heat warnings, drought, wildfires, and smoke (1,2). EHEs are increasing in frequency, intensity, and duration worldwide, and Canada is no exception (3). For many Canadians, the arrival of a hot summer day is welcomed after a long, cold winter. However, it is becoming increasingly apparent that too much heat can be dangerous to human health, resulting in high numbers of preventable heat-related illnesses and deaths (1,4). According to Wang et al., 2015, most of Canada, particularly in the Toronto area and parts of British Columbia, will likely experience more frequent heatwaves every summer with temperatures of 30°C or higher. Along with the rise in average temperatures, the relative mortality is expected to increase by 4-7% for each increase of 2-3 °C in the urban area (5).

EHEs are associated with increased ambulance callouts, emergency room visits and hospital admittance; elevated cardiovascular strain and other cardiovascular diseases; genitourinary diseases, respiratory diseases, mental health issues, adverse pregnancy and birth outcomes, diabetes, and increased domestic violence and violent crimes (1,6). Heat-related morbidity and mortality rates disproportionately affect certain vulnerable populations such as the elderly, the poor, those with pre-existing heart conditions or chronic illnesses, pregnant women and infants, and outdoor workers (6,7).

Extreme heat can catalyze chemical reactions by transforming car emissions and other air pollutants into ground-level ozone and smog, affecting outdoor air quality (1,5). Extreme heat also impacts wildfire occurrences due to having longer fire seasons, more dry trees to burn, and more frequent storms and lightning to start the fires (1).

Literature Review

Given the increased occurrences of EHEs and their adverse health effects on the public, especially the vulnerable populations, this literature review will demonstrate the importance of extreme heat awareness and determine the public's knowledge regarding health risks and protection measures of extreme heat.

Notable Canadian Extreme Heat Events

Some of the notable extreme events occurred across Canada, including in Winnipeg, Ottawa, Halifax, Toronto, Montreal, and British Columbia (1). In the summer of 2018 in Montreal, there were 66 heat-related deaths, whereas, in southern Quebec, there were 86 heat-related deaths (1). More recently, the 2021 June heatwave in Western Canada was the deadliest weather event in Canadian history resulting in 569 heat-related deaths (8,9). Of those 569 individuals who succumbed to the extreme heat, 79% were 65 years of age or older (8). The Human Watch Rights claimed hundreds of vulnerable populations were killed due to a lack of government support, and the vulnerable populations were left "to cope with dangerous heat on their own" and have caused "unnecessary suffering and possibly deaths" (10).

Although every regional health authority in British Columbia declared a "heat emergency" on June 25, 2021, the responses were not sufficient to reach everyone and meet the demand for emergency services (10). Some municipalities and First Nations with a heat action plan in place were able to operate cooling centres and misting stations, add public water fountains and distribute bottled water, and provide financial support for air conditioners, fans, and air purifiers for elders or others who are at-risk to the heatwave (10). Despite the responses from the municipalities and regional health authorities, many thought the available response did not meet the expectations due to inaccessibility to the cooling centers for those who are wheelchair users, for those without access to a vehicle to drive to the center, or the fact that the cooling centers closed after 7 pm even though the heatwave continued after the sunset (10).

How to Prevent Heat-Related Illnesses

Given the global trend in increased heat-related illnesses and deaths as the EHE and climate change progress, there is a necessity for interventions to be applied at the individual, household, and community levels (1,11).

Adopting cooling behaviours and preparing for the heat at an individual level is crucial because as little as a 3°C increase in core body temperature can put someone in danger (12). According to the

Government of Canada, n.d., the number of extremely hot days (over 30°C) in a year is expected to be more than double in some parts of Canada in the next 30 years, increasing heat-related morbidity and mortality drastically. In preparation, it is recommended to check the local weather forecasts and alerts regularly to ensure when to avoid exposure to the outdoors as well as being in tune with the body to recognize the symptoms of heat illness: dizziness, nausea or vomiting, headache, rapid breathing and heartbeat, extreme thirst, and decreased urination with unusually dark yellow urine (13). It's important to recognize these signs because heat exhaustion can progress to heat stroke if left untreated (12). The progression from heatstroke to death can happen rapidly (within hours), making 15% of the cases fatal (12).

Other important cooling behaviours to adopt include drinking water even before feeling thirsty to stay hydrated; using air conditioners, swamp coolers, floor or ceiling fans if one has access; and avoiding sun exposure by finding oneself in a shade or air-conditioned spots like the shopping malls, libraries, cooling centres, movie theatre, community centres, swimming pools or beaches (7,13).

Adopting these cooling behaviours can be challenging for some individuals as they could be financially, physically, or mentally challenged. This is when interventions on the household and community level can be beneficial to ensure the health and safety of everyone during EHEs. Neighbours, friends and families, and community organizations can develop "check on your neighbour" programs or adopt buddying systems in the event of an emergency (2).

Sampson et al., 2013, mention some unintentional harmful behaviours that the public members may adopt during the EHEs, including waiting until one gets thirsty to hydrate, misusing a fan with windows closed or using a fan at > 45°C with low humidity may increase the chance for heat-related morbidity and mortality due to an acceleration of body heating and physiological heat strain on the body (7,14). Other factors that are associated with increased morbidity and mortality during EHE include the use of alcohol, medications, and illegal narcotics as they will have an impact on one's ability to sweat and

vasodilate as part of heat loss response, as well as influence one's behaviour in cool-seeking behaviours and ultimately leading to dehydration (6).

Challenges in Heat-Related Illnesses Prevention

Despite the recognition of evidence-based interventions during EHEs amongst health professionals, some challenges and barriers are present in mitigation and adaptation strategies, mainly due to social determinants of health (SDOH) affecting accessibility to resources, disconnect in risk communication, and inaccurate risk perceptions of heat (4,11,15).

For example, air conditioning has multiple benefits, such as dramatically decreasing indoor temperatures and alleviating heat strain (14). However, for some groups, the financial cost can be a barrier as the cost of the equipment and utility bills can be too costly (7). Even going to cooling locations such as public pools, libraries, malls, and water parks can be a barrier as those places may always be located on major public transportation routes or unable to pay entrance fees; similarly, undocumented immigrants may be hesitant or unable to seek out public cooling locations due to fear of getting caught (7).

Risk communications play a crucial role in reducing community vulnerability to extreme weather events; however, efficient risk communication strategies continue to be a challenge for reaching vulnerable populations, such as low-income communities, the elderly, visible minorities, and people with disabilities due to complex language and information or contradictory information (15).

Social isolation also has a significant health impact during EHEs, particularly severe for vulnerable populations as they are most likely to be disconnected from news and social networks that provide risk communication; lack access to emergency resources and cooling aids such as air conditioners or fans; and lack risk perception to prepare for EHEs adequately (4,11,15). Kafeety et al., 2020 emphasize how social isolation is a key risk factor during EHE and incorporating social connection should be considered in strategies to reduce heat-related morbidity and mortality rate.

Research Question

The purpose of the study is to conduct a knowledge survey to assess if the general public is aware of the health risks of extreme heat and what they can do to protect themselves from heat-related illnesses and death. The study will also assess whether there were associations between age, education level, and climate change knowledge with extreme heat protection. This research can be a useful tool for the stakeholders with delivering targeted health education and promotion of extreme heat health and safety. Furthermore, stakeholders can distribute more long-term risk communication regarding climate change and its impact on extreme weather events, and health risks along with mitigation and prevention actions.

Methods and Materials

The data were collected within Canada via an online self-administered survey using SurveyMonkey. The online survey was posted and remained active on Reddit and Facebook groups for three weeks, from January 27, 2022, to February 17, 2022. With an estimated completion time of seven minutes, the survey consisted of demographic, knowledge, and practice questions to assess the general public's knowledge of extreme heat events and the health impacts. Statistical analyses were done using Microsoft Excel 365 and Real Statistics (16). A $100 VISA gift card from BCIT was used for participants who entered their email into a random draw for a prize.

Inclusion and Exclusion Criteria

Any Canadian resident over 18 years of age was eligible to participate in the study. Any individual who is not a resident of Canada or under 18 years of age was excluded from the study. Friends, family, and classmates of the author were also excluded from the study.

Results

Descriptive Data

Nominal and ordinal data were collected from the survey. A total of 16 questions were asked in the survey. The first four questions consisted of demographic questions, including age, education, and geographic region. The rest of the questions were about the general public’s knowledge of extreme heat

illnesses and how to prevent them. For the analysis, the 'Prefer not to answer' options were omitted due to the potential outlier effect; however, the 'Prefer not to answer' choices in the first three questions were included to show that those results were collected in the survey (17).

Descriptive Statistics

A total of 70 Canadian participants consented to the survey. The descriptive statistics data was exported and visually presented on pie charts and bar graphs to show the distribution of the responses of each group. The descriptive results from the first three questions are shown below. Participants aged ranged from 18 years old to 64 years old (Figure 1). Most of the participants were between 25 – 34 years of age at 62%, whereas the age range between 18 – 24 years old was at 21%, and between 35 – 64 years old was at 17%. The participants in the age range of 35-64 were combined into one group as there were not enough participants in that age range.

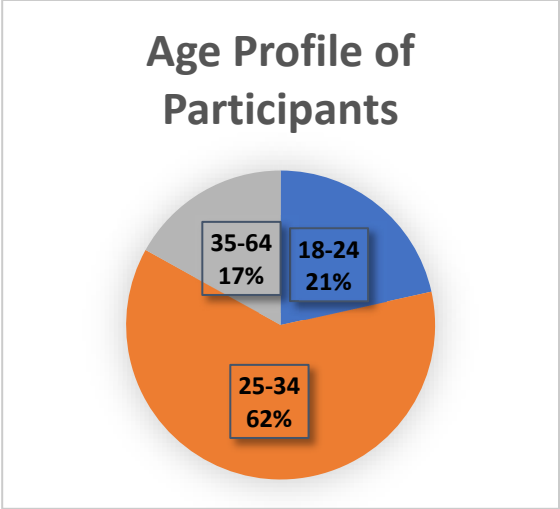

Figure 1. Age Profile of Participants

Most of the participants completed University-level education as shown in Figure 2. 52% of the participants had a Bachelor's or Post-Graduate Degree, while 9% had Trade or College diploma, 36% had a High school Diploma or less education. 3% of the participants opted not to answer the question.

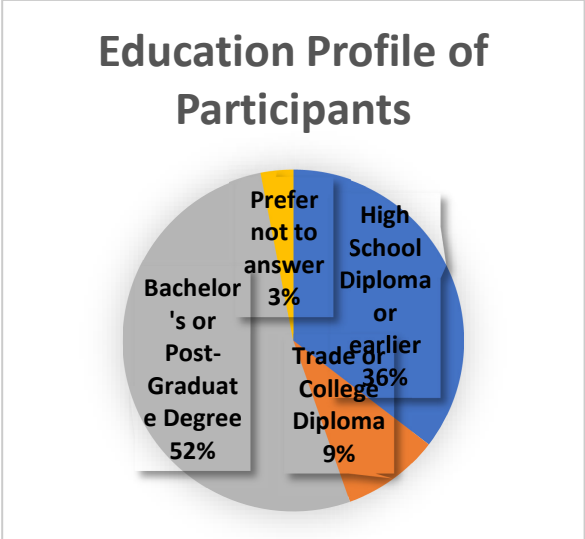

Figure 2. Education Profile of Participants

To compare if there is a statistically significant association between the level of knowledge on extreme heat protection and the level of knowledge on climate change, the participants were given a knowledge test. 51% of the participants correctly answered 0 – 2 questions, therefore categorized them as 'Not Knowledgeable.' 40% of the participants correctly answered 3 – 4 questions, therefore categorized them as 'Somewhat Knowledgeable.' 9% of the participants correctly answered 5 – 6 questions, therefore categorized them as 'Very Knowledgeable' in Climate change and its impact.

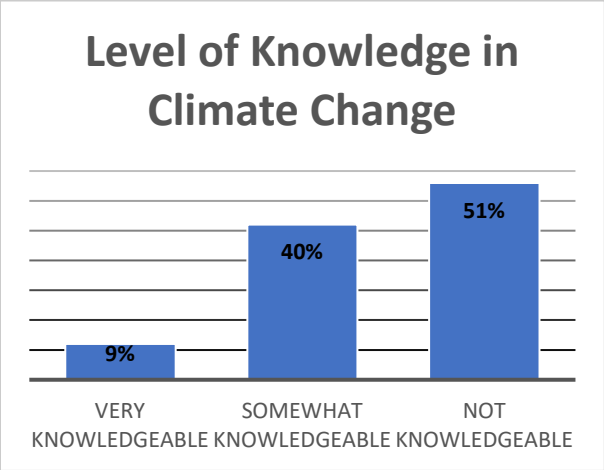

Figure 3. Level of Knowledge in Climate Change

Inferential Statistics

All the data from SurveyMonkey were exported to Microsoft Excel 365, statistical tests were performed using Real Statistics (2021), and lastly, inferential statistics were done using the Pearson Chi-square test to determine associations between the level of knowledge on extreme heat protection and three variables: level of education, age, and knowledge on climate change. The Chi-square test is commonly used in survey-type research as the data collected are nominal, not numerical (18). This test of independence provides information on the observed differences between the variables and on which categories account for the observed differences (18). The three null and alternate hypotheses and the interpretations are summarized in Table 1.

Table 1: Summary of the null and alternate hypotheses and the inferential test results

H_o and H_A	Test Used	Result	Conclusion
H_o1: There is no association between level of education and knowledge on extreme heat protection **H_A1**: There is an association between level of education and knowledge on extreme heat protection	Chi-square test	p-value = 0.1254	p-value is > 0.05, therefore, do not reject Ho and conclude that there is no statistically significant association between the level of education and extreme heat protection.
H_o2: There is no association between age and knowledge on extreme heat protection **H_A2**: There is an association between age and knowledge on extreme heat protection	Chi-square test	p-value = 0.275	p-value is > 0.05, therefore, do not reject Ho and conclude that there is no statistically significant association between the age and knowledge on extreme heat protection.
H_o3: There is no association between knowledge on climate change and knowledge on extreme heat protection **H_A3**: There is an association between knowledge on climate change and knowledge on extreme heat protection	Chi-square test	p-value = 0.953	p-value is > 0.05, therefore, do not reject Ho and conclude that there is no statistically significant association between knowledge on climate change and knowledge on extreme heat protection.

Interpretation of Results

When the variables were compared to the level of knowledge on extreme heat protection, none of the variables (level of education, age, and knowledge of climate change) showed a statistically significant association. Although the results showed no association, there is a potential for Type II error or rejecting the null hypothesis when it is actually true due to the analysis of data with a small sample size of 65 (10).

Discussion

Extreme Heat Protection Measures Knowledge

The result of the study indicates that the general knowledge of extreme heat protection measures among the public in Canada is moderate. They are aware of important preventative measures to adopt during a heatwave such as what to wear and when to drink liquids to stay hydrated. 85% of participants have correctly answered that the changes in core body temperature as little as 3°C can put someone in danger which shows they are aware of the potential grave impact of extreme heat (12). Additionally, 71% of participants have correctly identified the best clothing to wear during a heatwave and 78.46% of participants know they should drink plenty of liquids before feeling thirsty to stay cool and promote body heat loss response.

While many recognize the health impact of extreme heat, they could not correctly recognize all the symptoms of heat illnesses as only 22% of participants were able to identify all five symptoms. It's important to recognize different signs and symptoms of heat illness as these can be presented on an individual differently and progress to heatstroke – when one's core body temperature reaches at least 40.6 °C – and ultimately become fatal without any medical intervention (12).

Another preventive measure that the participants had poor knowledge of was adopting appropriate cooling behaviours during an EHE. Only 31% of the participants were able to correctly identify a harmful behaviour to adopt during a heatwave – using a fan with windows closed – whereas many participants thought 'Spending a few hours in A/C spots such as shopping malls, cooling centres, or pools' was not an appropriate cooling behaviour which is concurrent with a journal by Sampson et al.,

2013. Those who unintentionally adopt harmful behaviours or don't seek cooling centres are at greater risk for heat-related illnesses and death (7). The result demonstrates a lack of knowledge and usage of cooling centres set up by communities due to different barriers such as lack of transportation, accessibility issues, preconceived perception, or financial issues(7).

Climate Change Knowledge

The general public in Canada has low to moderate knowledge of climate change based on the study. While many have answered the fact that the majority of scientists agree that climate change is caused by anthropogenic activities as true (at an overwhelming 85.94%), many could not correctly answer the effect the Greenhouse gases on the atmosphere, the possible changes in weather events/consequences associated with climate change, as well as what was agreed upon during the recent UN Climate Change Conference in Glasgow in 2021.

Although many recognize the fact that the frequency and intensity of extreme weather events are increasing due to climate change, there is a lack of understanding of how climate change has an impact on human health nor how it will exacerbate existing health conditions, ultimately creating a tremendous amount of burden on the healthcare system (6,14)

Limitations

This study was subject to several limitations due to poor survey response and the delivery method of the surveys to the general public via an online, self-administered survey. An insufficient sample size (64 participants) was a constraint to acquiring a statistically significant p-value and generalizing the result to a wider population (20). Although online surveys can reduce the threat the external validity since selection bias is reduced, they can have an impact on internal validity as the self-reported data may be inaccurate or dishonest (21).

Additionally, the online, self-administered surveys were distributed on Facebook groups and Subreddit which attract a certain sample population, such as users in the 18 - 29 age group that make up 44% of the users, whereas there was a lack of responses from users in the 51 and above

age groups that only make up 7% of the users (22). Within the community-based Facebook and Subreddit groups, the author faced limitations to distribute the survey links simply because of the "No Survey Links" policy within groups as they deem it as spam. Due to these limitations, the external validity of the study may have been threatened, creating a sampling bias.

Knowledge Translation

The study aims to help the public health professionals and decision-makers to increase the targeted dissemination of information to raise awareness of extreme heat risks and what resources are available to stay safe and cool during an EHE. In B.C., many schools, long-term care facilities, and residential homes are not equipped with an A/C unit. Increased communication and awareness of cooling centres and other community-run programs during a heatwave can provide a refuge for those who may not be equipped to stay cool and protect themselves from extreme heat (13,15).

During an extreme weather event, the risk communication tends to focus on short-term messages around health hazards and preventive measures, however, it's crucial to distribute more long-term risk communications around climate change and its impact on human health by educating the public on climate resiliency and mitigation strategies (15).

Lastly, many studies have concurred heat is a selective killer, putting the greater risk of heat-related morbidity and mortality on our vulnerable populations such as older adults, those experiencing homelessness, low-income earners, and people with chronic illnesses (12). The study can urge the stakeholders to address health inequities and the challenges that the vulnerable populations face during the EHEs when designing their Heat Action Plans by incorporating social connections through community-based programs. (11).

Future Research

The area of interest for future research are:

1. The general public's knowledge about how their built environment is equipped for the next extreme heat event in Canada.
2. Research changes in knowledge, behaviour and attitude of the

general public between during and post 2021 BC Heat Dome.

3. Research how the general public is receiving information on climate change and its adverse effects on health.

Conclusion

Extreme heat events are increasing in frequency and intensity that can result in multiple medical events and even death as seen and felt by the recent heat dome in 2021 (1,9). The knowledge assessment of the general public through a self-administered, online survey concluded that the Canadians have a moderate to a high level of knowledge regarding protection measures during an EHE. The knowledge includes adopting appropriate cooling behaviour before and during a heatwave. In contrast, they have a low to moderate level of knowledge of climate change and its impact on human health. The findings support the increased need for long-term risk communications around climate change as a strategy to reduce the health risks posed by advancing climate change and its effect on extreme weather events.

Although the study concluded that there are no statistically significant associations between age, level of education, and level of knowledge on climate change, the study can help the stakeholders to increase health promotion and protection programs from extreme heat in individual, household and community levels.

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Competing Interest

The author declares that they have no competing interests.

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