Research

The link between medical conditions and fatal drownings in Canada: a 10-year cross-sectional analysis

Cody L. Dunne MD, Julia Sweet BSc, Tessa Clemens PhD

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Abstract

Background: Drowning accounts for hundreds of preventable deaths in Canada every year, but the impact of pre-existing medical conditions on the likelihood of death from drowning is not known. We aimed to describe the prevalence of pre-existing medical conditions among people who fatally drowned in Canada and evaluate the risk of fatal drowning among people with common pre-existing medical conditions.

Methods: We reviewed all Canadian unintentional fatal drownings (2007–2016) in the Drowning Prevention Research Centre Canada's database. For each fatal drowning we established whether the person had pre-existing medical conditions and whether those conditions contributed to the drowning. We calculated relative risk (RR) of fatal drowning stratified by age and sex for each pre-existing medical condition using data from the Canadian Chronic Disease Surveillance System.

Results: During 2007–2016, 4288 people fatally drowned unintentionally in Canada, of whom one-third had a pre-existing medical condition. A pre-existing medical condition contributed to drowning in 43.6% (n = 616) of cases. Fatal drowning occurred more frequently in people with ischemic heart disease (RR 2.7, 95% confidence interval [CI] 2.5–3.0) and seizure disorders (RR 6.3, 95% CI 5.4–7.3) but less frequently in people with respiratory disease (RR 0.12, 95% CI 0.10–0.15). Females aged 20–34 years with a seizure disorder had a 23 times greater risk than their age- and sex-matched cohort (RR 23, 95% CI 14–39). In general, fatal drowning occurred more often while people were bathing (RR 5.9, 95% CI 4.8–7.0) or alone (RR 1.99, 95% CI 1.32–2.97) and less often in males (RR 0.92, 95% CI 0.88–0.95) or in those who had used alcohol (RR 0.72, 95% CI 0.65–0.80), among those with pre-existing medical conditions.

Interpretation: The risk of fatal drowning is increased in the presence of some pre-existing medical conditions. Tailored interventions aimed at preventing drowning based on pre-existing medical conditions and age are needed. Initial prevention strategies should focus on seizure disorders and bathtub drownings.

Drowning is an important cause of death in Canada and some aspects of its epidemiology have been characterized.[1,2] Identifying and addressing risk factors for fatal drowning can save lives. For example, after research showed a considerable proportion of child drownings occurred in unsecured household pools and the effectiveness of pool fencing at reducing these deaths, legislative changes were introduced in Quebec.[3–5]

Although studies evaluating risk factors frequently focus on modifiable environmental or behavioural factors (e.g., infant bath seats, supervision status or alcohol and drug use),[6–11] limited research has evaluated the relation between pre-existing medical conditions and the risk of drowning.

Studies that have evaluated the association between pre-existing medical conditions and drowning are limited by small sample sizes and narrow focus on certain conditions (e.g., autism spectrum disorder, epilepsy), or are age-specific (e.g., children).[12–17] The association between various pre-existing medical conditions and drowning in different age groups is not well understood. This information could assist with the development of targeted drowning prevention strategies and prioritizing of resources spent on prevention.

Forty-four percent of Canadian adults have at least 1 chronic disease, which suggests that millions of Canadians with conditions that potentially impair their heart, lungs or brain participate in water activities.[18] Furthermore, swimming and aquatic fitness is often encouraged for those with chronic illness to promote health.[19,20] However, the public and physicians should be aware of pre-existing medical conditions that might place people at a higher risk of drowning, so that appropriate precautions can be taken to ensure safety while participating in aquatic activities.

We sought to describe pre-existing medical conditions by age group among people who fatally drowned in Canada and to evaluate the risk of fatal drowning among people with common conditions to inform future public health interventions.

Methods

We retrospectively analyzed all unintentional fatal drownings in Canada between January 2007 and December 2016 inclusive.

Data sources

We queried the Drowning Prevention Research Centre Canada's (DPRC) database for cases with drowning as a cause of death.

The DPRC captures all unintentional water-related fatalities that occur in Canada in an anonymized database.[21] In brief, the database is populated from the files of the provincial and territorial offices of the chief coroners and medical examiners using a structured review process. Common data sources include records from the examining coroner's investigation, police and hospital records, toxicology and autopsy, as well as the death certificate. Project managers and a consultant coroner and epidemiologist quality check the data. The structured data collection tool undergoes regular assessment of face validity, with updates performed as indicated.[22] Chronic conditions in the database are considered present if the person who drowned meets the definitions listed in Appendix 1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.211739/tab-related-content. Most DPRC records describe additional details of the condition in the free-text synopsis.

We used the Canadian Chronic Disease Surveillance System (CCDSS) to obtain prevalence and population data for asthma, chronic obstructive pulmonary disease (COPD), dementia, epilepsy and ischemic heart disease.[23] The CCDSS is supported by the Public Health Agency of Canada (PHAC) and contains data from all individuals with provincial or territorial health insurance (about 97% of the Canadian population). It tracks chronic disease by linking individual data to hospital discharge documentation, physician billing, and diagnostic codes from the 9th or 10th revisions of the *International Classification of Diseases*. The CCDSS case definitions are available online.[23]

We combined the data for asthma and COPD and used their prevalence as a proxy for respiratory disease in Canada (they represent 99.2% of chronic respiratory disease in Canada).[24] Ischemic heart disease, epilepsy and dementia mapped well to the DPRC definitions for the related conditions.

Data extraction

We extracted age, sex, chronic medical conditions, postmortem autopsy findings, contributing drowning factors, province where the drowning occurred, population density (urban or rural) where the drowning occurred, accompaniment status, body of water type, use of alcohol before drowning and preceding activity for each case of drowning extracted from the DPRC. An incident synopsis was also provided.

Age categories included young children (aged < 5 yr), children (5–19 yr), young adult (20–34 yr), adult (35–64 yr) and older adult (≥ 65 yr). Categories for preceding activity included aquatic activity, bathing, boating, nonaquatic activity and transportation (e.g., snowmobile). Aquatic activities included those in which the person intended to be in the water, whereas nonaquatic activities included situations where the person was near but did not intend to be in the water, such as a fall. Full definitions used for the variables are included in Appendix 1.

One researcher (J.S.) coded the pre-existing medical condition(s) of each person who drowned into 6 categories: cardiovascular disease, respiratory disease, seizure disorder, physical disability, neurocognitive disorder and other. A second researcher (C.L.D.) reviewed all cases for accuracy. Discrepancies were resolved by discussion.

We reviewed each record to determine whether a pre-existing medical condition contributed to the drowning. We considered a pre-existing medical condition to be contributing if a coroner identified it as part of their investigation or 2 researchers independently agreed that based on the incident synopsis, there was a high likelihood that the pre-existing medical condition played an important role. We used the criteria described by Franklin and colleagues[12] to determine contribution (direct cause, compromising the rescue and resuscitation or related to the drowning circumstances).

Statistical analysis

We used STATA to perform all statistical analysis. We calculated odds ratios for characteristics of fatal drownings among people with a pre-existing medical condition using logistic regression, with adjustment for age, and converted these to relative risks (RRs) with 95% confidence intervals (CIs) using baseline prevalence.[25]

We calculated RR with 95% CI of fatal drowning for specific pre-existing medical conditions. We compared the prevalence of pre-existing medical conditions in the population of people who drowned with that of the general Canadian population over the same period (Appendix 2, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.211739/tab-related-content, for calculation details). Previous studies on drowning have used this method.[12,17]

Ethics approval

This study was approved by the Health Research Ethics Board of Alberta (HREBA.CHC-20-0023).

Results

During 2007–2016, 4288 people fatally drowned unintentionally in Canada. The median age of those who drowned was 44 (interquartile range [IQR] 25–60) years and most (80.5%) were male (Table 1). About two-thirds (62.9%) drowned in an urban region. We found that aquatic activity (n = 1091, 25.4%) and boating (n = 1009, 23.5%) were the most frequent preceding activities, and fatal drowning most often occurred in lakes or ponds (n = 1550, 36.1%).

Among those who fatally drowned, we identified 1412 people (32.9%) as having a pre-existing medical condition. The most prevalent pre-existing medical conditions were cardiovascular disease

Table 1: Characteristics of people with and without pre-existing medical conditions who fatally drowned unintentionally in Canada (2007–2016)

Characteristic	No. (%)* of people who drowned *n* = 4288	No. (%)* of people with a PEMC who drowned *n* = 1412	No. (%)* of people without a PEMC who drowned *n* = 2876	Unadjusted RR (95% CI)	Adjusted† RR (95% CI)
Sex					
Male	3450 (80.5)	1069 (75.7)	2381 (82.8)	0.91 (0.88–0.95)	0.92 (0.88–0.95)
Age, yr					
< 5	187 (4.4)	9 (0.6)	178 (6.2)	0.27 (0.14–0.53)	
5–19	452 (10.5)	56 (4.0)	396 (13.8)	0.75 (0.56–1.01)	
20–34	1006 (23.5)	164 (11.6)	842 (29.3)	Ref.	
35–64	1804 (42.1)	646 (45.8)	1158 (40.3)	1.64 (1.52–1.74)	
≥ 65	839 (19.6)	537 (38.0)	302 (10.5)	4.9 (4.4–5.4)	
Age, yr; median (IQR)	44 (25–60)	58 (43–71)	35 (22–53)		
Location					
Rural	1591 (37.1)	402 (28.5)	1189 (41.3)	0.69 (0.62–0.76)	0.70 (0.63–0.78)
Activity					
Aquatic activity	1091 (25.4)	322 (22.8)	769 (26.7)	Ref.	
Bathing	460 (10.7)	336 (23.8)	124 (4.3)	5.6 (4.7–6.7)	5.9 (4.8–7.0)
Boating	1009 (23.5)	225 (15.9)	784 (27.3)	0.36 (0.27–0.47)	1.23 (0.98–1.52)
Nonaquatic activity	909 (21.2)	337 (23.9)	572 (19.9)	1.42 (1.26–1.60)	1.45 (1.27–1.65)
Transportation	798 (18.6)	182 (12.9)	616 (21.4)	0.83 (0.71–0.97)	0.83 (0.70–0.98)
Body of water					
Pool	330 (7.7)	138 (9.8)	192 (6.7)	Ref.	
Hot tub or whirlpool	75 (1.8)	40 (2.8)	35 (1.2)	1.59 (0.97–2.59)	1.05 (0.60–1.83)
Bathtub	467 (10.9)	341 (24.2)	126 (4.4)	3.4 (2.6–4.3)	3.1 (2.3–4.2)
Lake or pond	1550 (36.1)	423 (30.0)	1127 (39.2)	0.64 (0.53–0.77)	0.59 (0.47–0.73)
Flowing water	1181 (27.5)	292 (20.7)	889 (31.0)	0.55 (0.44–0.68)	0.54 (0.42–0.69)
Ocean	356 (8.3)	82 (5.8)	274 (9.5)	0.44 (0.32–0.60)	0.34 (0.24–0.48)
Accompaniment					
With at least 1 adult	1670 (38.9)	281 (19.9)	1389 (48.3)	Ref.	
Alone or not witnessed	2126 (49.6)	1024 (72.5)	1102 (38.3)	1.84 (1.77–1.91)	1.69 (1.6–1.7)
With bystanders only	110 (2.6)	42 (3.0)	68 (2.4)	2.75 (1.88–3.98)	1.99 (1.32–2.97)
With minors only	173 (4.0)	14 (1.0)	159 (5.5)	0.43 (0.25–0.73)	0.95 (0.54–1.61)
Alcohol use					
Present	1537 (35.8)	391 (27.7)	1146 (39.8)	0.70 (0.63–0.77)	0.72 (0.65–0.80)

Note: CI = confidence interval, IQR = interquartile range, PEMC = pre-existing medical condition, Ref. = reference category, RR = relative risk.
*Unless specified otherwise.
†Adjusted only for age.

(53.7%), physical disability (16.3%) and seizure disorder (13.7%) (Table 2). Four hundred and eighty-four people (34.3%) had a pre-existing medical condition that did not fit into a prespecified category (Appendix 3, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.211739/tab-related-content). Among people who had a pre-existing medical condition, 395 (27.9%) had more than 1.

We found that most drowning deaths occurred when the person was alone or when the drowning was not witnessed (63.3%–84.4%). People with cardiovascular disease (36.1%), respiratory disease (33.7%) and physical disability (27.8%) drowned most frequently in lakes and ponds. People with seizure (52.6%) or neurocognitive disorders (28.1%) drowned most frequently in bathtubs. We identified a pre-existing medical condition as contributing to the fatal drowning in 616 cases (43.6%) (Appendix 4, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.211739/tab-related-content).

Table 2: Characteristics of people who fatally drowned unintentionally in Canada (2007–2016), by type of pre-existing medical condition

Characteristic	No. (%) of people who fatally drowned* *n* = 1412				
	With cardiovascular disease *n* = 759	With respiratory disease *n* = 98	With seizure disorder *n* = 194	With a physical disability *n* = 230	With neurocognitive disorder *n* = 128
Sex					
Male	604 (79.6)	71 (72.4)	129 (66.5)	154 (67.0)	95 (74.2)
Age, yr					
< 5	0 (0.0)	2 (2.0)	3 (1.6)	1 (0.43)	4 (3.1)
5–19	2 (0.3)	5 (5.1)	18 (9.3)	12 (5.2)	15 (11.7)
20–34	24 (3.2)	7 (7.1)	63 (32.5)	31 (13.5)	12 (9.4)
35–64	330 (43.5)	40 (40.8)	96 (49.5)	114 (49.6)	34 (26.6)
≥ 65	403 (53.1)	44 (44.9)	14 (7.2)	72 (31.3)	63 (49.2)
Location					
Rural	241 (31.8)	34 (34.7)	37 (19.1)	52 (22.6)	24 (18.8)
Activity					
Aquatic activity	202 (26.6)	21 (21.4)	35 (18.0)	43 (18.7)	19 (14.8)
Bathing	156 (20.6)	25 (25.5)	98 (50.5)	52 (22.6)	36 (28.1)
Boating	141 (18.6)	16 (16.3)	12 (6.2)	24 (10.4)	6 (4.7)
Nonaquatic activity	163 (21.5)	21 (21.4)	37 (19.1)	74 (32.3)	48 (37.5)
Transportation	93 (12.2)	14 (14.3)	9 (4.6)	34 (14.8)	16 (12.5)
Body of water					
Pool	88 (11.6)	10 (10.2)	20 (10.3)	20 (8.7)	18 (14.1)
Hot tub or whirlpool	27 (3.6)	0 (0.0)	5 (2.6)	8 (3.5)	1 (0.8)
Bathtub	159 (20.9)	25 (25.5)	102 (52.6)	53 (23.0)	36 (28.1)
Lake or pond	274 (36.1)	33 (33.7)	25 (12.9)	64 (27.8)	24 (18.8)
Flowing water	122 (16.1)	13 (13.3)	19 (9.8)	59 (25.7)	34 (26.6)
Ocean	43 (5.7)	8 (8.2)	7 (3.6)	11 (4.8)	8 (6.3)
Accompaniment					
With at least 1 adult	163 (21.5)	24 (24.5)	25 (12.9)	28 (12.2)	10 (7.8)
Alone or not witnessed	547 (72.1)	65 (66.3)	151 (77.8)	178 (77.4)	108 (84.4)
With bystanders only	25 (3.3)	1 (1.0)	3 (1.6)	7 (3.0)	2 (1.6)
With minors only	6 (0.8)	1 (1.0)	7 (3.6)	3 (1.3)	1 (0.8)
Alcohol use					
Present	216 (28.5)	29 (29.6)	27 (13.9)	59 (25.7)	16 (12.5)

Figure 1 shows the proportion of drowning deaths in which a pre-existing medical condition was identified as a potential contributor, stratified by age category. The risks of fatal drowning for people with pre-existing ischemic heart disease, respiratory disease, seizure disorder and neurocognitive disorder, stratified by age and sex, are presented in Table 3. The relative risks of fatal drowning for people with ischemic heart disease, respiratory disease and seizure disorder, stratified by age, are presented in Figure 2. We found that ischemic heart disease (RR 2.7, 95% CI 2.50–3.00) and seizure disorders (RR 6.2, 95% CI 5.40–7.30) were associated with an increased risk of fatal drowning. Among people with ischemic heart disease, we observed increased risk in all adult age groups except for females aged 20–34 years (RR 3.4, 95% CI 0.48–24.00). Among people with seizure disorders, all age and sex categories showed a significantly increased risk of fatal drowning. The greatest risk was observed in females aged 20–34 years (risk was 23 times greater than for the general population: RR 23, 95% CI 14.00–39.00). Respiratory disease was associated with decreased risk of fatal drowning for all ages and sexes.

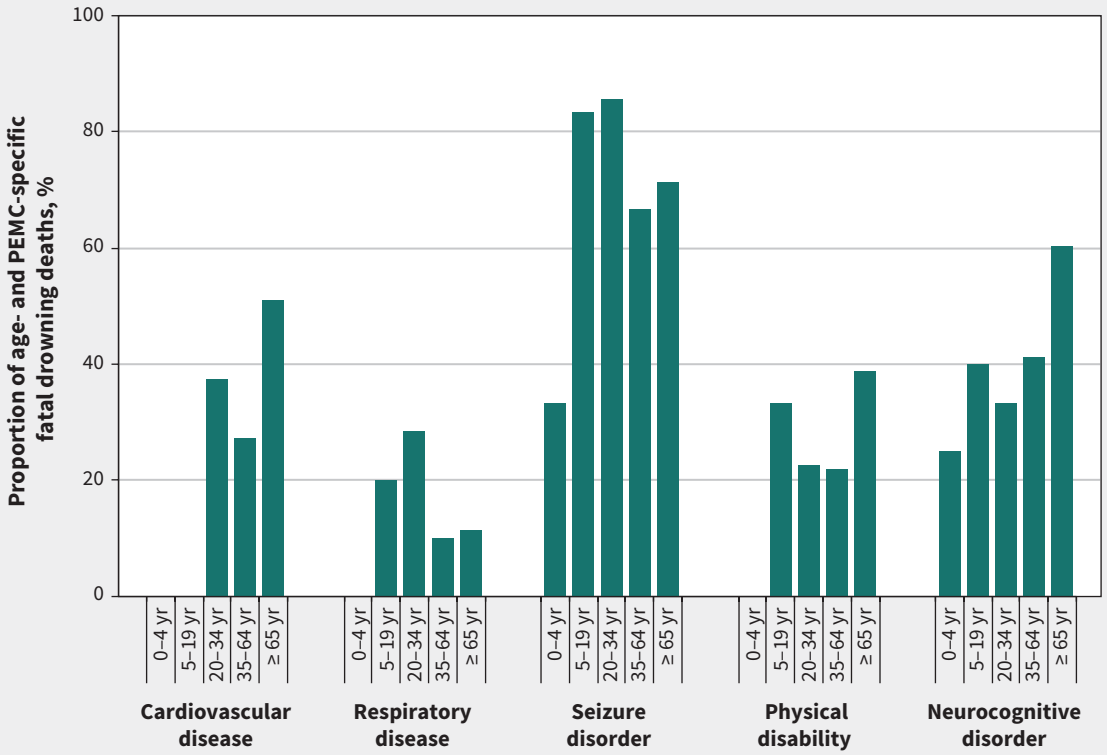

Figure 1: Contribution of 5 pre-existing medical conditions to drowning deaths in Canada from 2007 to 2016, stratified by age category. Note: more than 1 pre-existing condition may have been identified as a potential contributor in a single case of drowning.

Table 3: Relative risk of fatal drowning among people with pre-existing medical conditions in Canada (2007–2016), by age and sex

	RR (95% CI)				
PEMC	People aged 1–19 yr	People aged 20–34 yr	People aged 35–64 yr	People aged ≥ 65 yr	All ages
Ischemic heart disease					
All	–	8.7 (5.6–14)	4.0 (3.6–4.6)	2.3 (2.0–2.6)	2.7 (2.5–3.0)
Male	–	8.8 (5.6–14)	3.2 (2.8–3.6)	1.8 (1.5–2.1)	2.2 (2.1–2.5)
Female	–	3.4 (0.48–25)	5.0 (3.7–6.8)	2.9 (2.2–3.7)	3.8 (3.1–4.5)
Respiratory disease					
All	0.07 (0.03–0.14)	0.05 (0.03–0.11)	0.14 (0.10–0.19)	0.13 (0.10–0.18)	0.12 (0.10–0.15)
Male	0.07 (0.03–0.16)	0.04 (0.02–0.11)	0.14 (0.10–0.20)	0.12 (0.09–0.18)	0.11 (0.09–0.14)
Female	–	0.11 (0.03–0.44)	0.19 (0.11–0.35)	0.16 (0.09–0.28)	0.17 (0.11–0.24)
Seizure disorder					
All	7.0 (4.4–11)	8.8 (6.7–12)	6.8 (5.5–8.5)	1.8 (1.0–3.2)	6.3 (5.4–7.3)
Male	5.4 (3.0–9.8)	6.1 (4.3–8.8)	5.4 (4.2–7.1)	1.3 (0.6–2.7)	4.9 (4.0–5.9)
Female	12 (5.5–25)	23 (14–39)	13 (8.7–19)	3.2 (1.3–7.7)	12 (8.9–15)
Neurocognitive disorder					
All	–	–	–	1.04 (0.80–1.4)	–
Male	–	–	–	1.22 (0.90–1.7)	–
Female	–	–	–	1.10 (0.68–1.8)	–

Note: CI = confidence interval, PEMC = pre-existing medical condition, RR = relative risk.

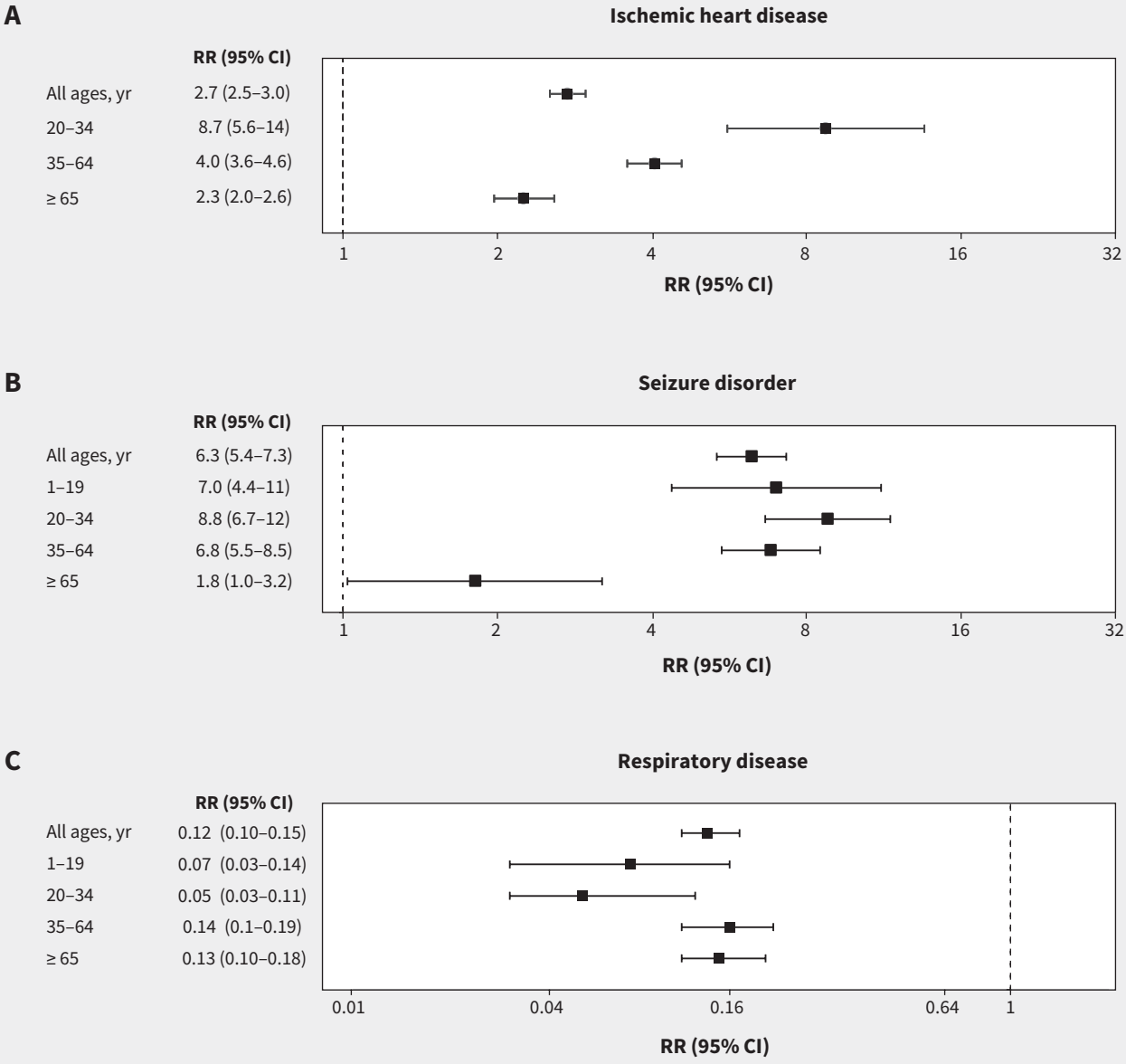

Figure 2: Relative risk of fatal drownings for people with (A) ischemic heart disease, (B) seizure disorder and (C) respiratory disease compared with the general population of Canada, stratified by age. Note: CI = confidence interval, RR = relative risk.

Interpretation

People in Canada benefit from public health messaging, rescue training programs and legislation that mitigate the risk of unintentional drowning. Despite these protective measures, higher risk groups exist. More than 400 drowning fatalities occur annually in Canada, and drowning is one of the leading causes of injury-related deaths.[26] We found a high rate of pre-existing medical conditions among people who unintentionally fatally drowned, and high relative risks of fatal drowning among those with some pre-existing medical conditions. Globally, drowning contributes to the second highest burden of years of life lost because of an unintentional injury.[27]

Interventions to prevent drowning should be tailored to specific at-risk groups.

A 1993 study found that 5% of fatal drownings in Alberta were considered to be directly related to seizures: 60% occurred in baths, and 83% of people had subtherapeutic levels of their antiepileptic drugs.[16] In our study, 13.7% of people had a seizure disorder and 52.6% of deaths occurred in bathtubs. We were unable to evaluate levels of antiepileptic drugs, but the high proportion of seizure-related drownings reinforces the need for medication compliance before entering the water. Two studies involving children reported an increased risk of drowning associated with pediatric seizure disorders.[12,28] Our study supports these findings.

Young women with seizure disorders had the greatest risk of drowning of all ages, sexes and pre-existing medical conditions.

There is little evidence on the best interventions to protect people with seizure disorders during recreation and daily activities such as bathing. Recommendations include showering instead of tub bathing with someone either supervising or monitoring nearby; participating in water activities in a supervised pool environment or using a buddy system in open water; and always wearing a properly fitted life jacket in open water.[28,29] Because it is impossible to guarantee seizure-free periods in water,[16] water safety recommendations should continue for life.

Drowning in bathtubs is common among those with seizure disorders, as well as most other pre-existing medical conditions. This may be an important first target for public health messaging as it is relevant to other medical conditions, and safety planning is easier to implement than in other locations.

Cardiovascular disease was present in more than half of drowning deaths in people with a pre-existing medical condition. We are not aware of any studies that have evaluated the risk of fatal drowning among persons with cardiovascular disease; however, several studies have found a high prevalence among persons who fatally drowned, especially among older adults.[15,30,31] We found that younger adults with ischemic heart disease had a higher relative risk of fatal drowning than older adults. The reason for this is unclear, and research is needed because ischemic heart disease in younger adults is increasing.[32]

People with ischemic heart disease should not avoid water activities. Several studies have shown that there is improvement in health and quality of life for those who use water activity as exercise and rehabilitation.[33–36] Instead, people with cardiovascular disease should speak with a health care provider before water activity, gradually increase intensity, wear a life jacket and participate in a supervised setting or with a trained buddy.

We found that people with respiratory disease were at lower risk of death from drowning across all ages. A similar effect among children with asthma has been found.[12] This is surprising, as water activities can be an exertional trigger for respiratory symptoms, and many people with these diagnoses have less physiologic reserve when exposed to a submersion or immersion event. One hypothesis for the decreased risk is that people with respiratory disease have an increased awareness of the potential dangers that water poses to them.[12] As a result, extra caution (or even avoidance) may be taken pre-emptively to prevent an adverse event. This may extend to people with neurocognitive or physical disabilities and is supported by an Australian study on drowning in people with autism spectrum disorder.[17] However, it is not clear why this hypothesis would apply to only some pre-existing medical conditions and not others like heart disease and seizure disorders. Studies assessing the beliefs of patients with different pre-existing medical conditions regarding participation in water activities would help to further our understanding.

Several risk factors for fatal drowning have been previously investigated, one of which is alcohol use.[37] Surprisingly, we found that alcohol use was associated with a decreased risk (RR 0.72, 95% CI 0.65–0.80) of drowning in people with a pre-existing medical condition compared with those without. It is unlikely that this effect can be explained by assuming that those who have medical conditions drink alcohol while participating in water activities less often than those without. Future investigations should evaluate the link between these 2 risk factors.

Limitations

Data that informed this study were already collected, and details about pre-existing medical conditions were limited in some cases. We were not able to adjust our analysis for potential confounders other than age and sex of the person who drowned (e.g., contemporaneous alcohol use or witnessed status). Canadian Chronic Disease Surveillance System data do not include patients who did not seek medical care and patients of physicians who do not report billing codes. This may underestimate the prevalence of chronic diseases in Canadians and slightly underestimate the risk. In general, owing to unmeasured confounders, the interpretation of the results should focus on the direction of risk, with cautious interpretation of specific values.

Some variables in the DPRC (e.g., activity or alcohol use preceding drowning) are subject to information bias because coroners and police did not witness the drowning. We believe the impact of this bias is small because ascertainment of the outcome and most exposures were based on objective findings.

We did not have data for nonfatal drownings and thus could not compare the relation of pre-existing medical conditions to fatal compared with nonfatal drownings. Mental health disorders were not consistently recorded in the DPRC and could not be included in our analysis. Future research should explore the association between mental health disorders and fatal drowning.

We used a previously described method[12] to determine whether the pre-existing medical condition directly contributed to the drowning. However, this method has not been externally validated and is likely to underestimate the total impact of pre-existing medical conditions on fatal drowning because indirect contributions were not accounted for by the method. Finally, the relation of several pre-existing medical conditions and their interactions to fatal drowning could not be assessed.

Conclusion

About one-third of all people who fatally drowned unintentionally in Canada between 2007 and 2016 had a pre-existing medical condition, and, in at least half, a pre-existing medical condition directly contributed to the drowning. Prevention strategies tailored to specific conditions and age groups are needed. Initial public health interventions should focus on people with seizure disorders and safety in the performance of activities of daily living (e.g., bathing), as these are strongly associated with increased risk of fatal drowning.

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Affiliations: Department of Emergency Medicine (Dunne), University of Calgary, Calgary, Alta.; International Drowning Researchers' Alliance (Dunne, Clemens), Kuna, Idaho; Faculty of Medicine (Sweet), University of Ottawa, Ottawa, Ont.; Drowning Prevention Research Centre Canada (Clemens), Toronto, Ont.

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Data sharing: The data used in this study were sourced from coroner's and medical examiner's offices and is not publicly available owing to its sensitive nature. Therefore, the data set supporting the findings in this study cannot be shared unless the person has obtained ethical approval according to the terms of the research agreements with each of the provincial and territorial chief coroner's and chief medical examiner's offices. Applications for access to the data can be made to experts@drowningresearch.ca.

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Correspondence to: C. Dunne, cody.dunne@ucalgary.ca