Addressing Gaps in our Understanding of the Epidemiology of Drowning at the Global, National, and Local Level

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Abstract

Introduction: The World Health Organization (WHO) estimates that there are at least 372,000 deaths by drowning each year, making drowning the third leading cause of unintentional injury death worldwide, after road traffic crashes and falls. Despite its global impact, drowning remains a neglected public health issue and relatively under-researched area.

Objective: (1) To conduct a comprehensive epidemiological investigation and address gaps in our understanding of the drowning problem at the global, national, and local level; and (2) to provide policy-makers, advocates, and programmers with comprehensive information to inform their drowning prevention efforts.

Methods: This study involved retrospective reviews of five data sources: (1) global drowning data were extracted from the WHO mortality database for all countries that reported deaths using ICD-10 drowning codes; (2) data on non-fatal drowning victims who required hospital admission in Canada were obtained from the Canadian Institute for Health Information (CIHI)'s Discharge Abstract Database; (3) data on non-fatal drowning victims who required an emergency department visit were obtained from CIHI's National Ambulatory Care Reporting System; (4) data on unintentional fatal drowning deaths in Canada were obtained from the Drowning Prevention Research Centre Canada (DPRC) database; (5) data on child drowning fatalities in private backyard pools in Ontario were collected from the case files at the Office of the Chief Coroner for Ontario using a structured questionnaire.

Results: The results presented in this dissertation can inform drowning prevention globally, nationally, and locally. Internationally, official data categorization methods contribute to an underestimation of the burden of fatal drowning. In Canada, fatal drowning is only part of the

problem; non-fatal drowning presents a substantial burden and the characteristics of non-fatal drowning differ significantly from fatal drowning. Further, although bystander intervention plays an important role in the survival of a drowning person, non-professional bystanders often intervene with high-risk, contact rescues, or do not attempt a rescue at all. Finally, children who drown in private backyard pools in Ontario often access the pool directly from the residence, yet most municipalities have not enacted isolation fencing bylaws.

Conclusion: Addressing gaps in epidemiological drowning research at the global, national, and local level has revealed several recommendations for policy, prevention, and future research.

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Table of Contents

List of Tables

List of Figures

List of Acronyms and Symbols

AB - Alberta

AVIR - Aquatic-victim-instead-of-rescuer

BC - British Columbia

CDC - Centers for Disease Control and Prevention

CPR - Cardio Pulmonary Resuscitation

CI - Confidence Interval

CIHI - Canadian Institute for Health Information

DAD - Discharge Abstract Database

DPRC - Drowning Prevention Research Centre Canada

ED - Emergency Department

ICD - International Statistical Classification of Diseases and Related Health Problems

ICD-10 - 10^{th} revision of the International Statistical Classification of Diseases and Related Health Problems

LMICs - Low and middle income countries

MB - Manitoba

NACRS - National Ambulatory Care Reporting System

NB - New Brunswick

NL - Newfoundland

NT - Northwest Territories

NS - Nova Scotia

OCC - Office of the Chief Coroner for Ontario

ON - Ontario

OR - Odds Ratio

PE - Prince Edward Island

PFD - Personal Flotation Device

QC - Quebec

SK - Saskatchewan

SPSS - Statistical Package for the Social Sciences

WHO - World Health Organization

YK - Yukon Territory

< - less than

> - greater than

≤ - less than or equal to

≥ - greater than or equal to

Introduction

The World Health Organization (WHO) estimates that there are at least 372,000 deaths by drowning each year, making drowning the third leading cause of unintentional injury death worldwide, after road traffic crashes and falls. Despite its global impact, drowning remains a neglected public health issue; it kills two thirds as many people as malnutrition and over half as many as malaria, yet drowning does not have the attention and broad prevention efforts of these other public health concerns (WHO, 2014). The WHO acknowledges that the drowning problem is one of even greater severity than what is reflected in the current estimate because drowning deaths are significantly underreported. Moreover, as a result of the manner in which data are classified, intentional drowning deaths (suicide or homicide) and drowning deaths due to floods, boating, and water transportation accidents are often excluded from global drowning figures (WHO, 2014).

In addition to the problem of fatal drowning as an outcome of water-related incidents, non-fatal drowning is a serious concern. Several studies have indicated that there are far more incidents of non-fatal drowning requiring medical attention than deaths by drowning each year (Ellis & Trent, 1995; Kemp & Sibert, 1991; Levin, Morriss, Toro, & Turner, 1993; Lindholm & Steensberg, 1995; Murata, Nakagawa, & Takakura, 1992; Quan, Gore, Wentz, Allen, & Novack, 1989). It is estimated that for each fatality from drowning, there are one to four non-fatal drowning incidents serious enough to warrant hospitalization (Meyer, Theodorou, & Berg, 2006).

Although the majority (over 90%) of drowning deaths occur in low- and middle-income countries, and primarily occur in the African and South-East Asia regions (WHO, 2014),

drowning is also a leading cause of death in several high-income countries (WHO, 2012). In Canada, drowning is the leading cause of unintentional injury death in children 1-4 years of age, and the second leading cause in children under the age of 10. It is the third leading cause of unintentional injury death among Canadians under 60 with an average of approximately 500 water-related fatalities occurring annually (Lifesaving Society, 2013). In the most recent years for which Canadian drowning data is available (2009-2013), an average of 473 unintentional drowning deaths occurred each year and the average water-related fatality rate was 1.4 per 100,000 population. This fatality rate has decreased steadily over the past 20 years from an average of 2.0 per 100,000 population and approximately 600 drowning deaths each year in the mid-1990s (Clemens & Simoes, 2016a). Despite this long-term progress, there remains a high number of preventable water-related fatalities occurring in Canada each year.

While several studies related to drowning epidemiology and prevention in developed countries have been conducted, there are still substantial gaps in the literature. In particular, the magnitude of the underestimation of the global burden of drowning using the current categorization methods is uncertain, the non-fatal drowning problem has not been well examined, non-professional bystander intervention in drowning events has rarely been studied, and there is a paucity of Canadian studies focused on the prevention of backyard pool drowning in children. Given these gaps, this project consists of four distinct studies addressing: country-level reporting using ICD-10 codes, non-fatal drowning, lay bystander rescue, and the association between pool-fencing legislation and childhood backyard pool drowning.

The primary objective of this thesis was to conduct a comprehensive epidemiological investigation to address gaps in our understanding of the drowning problem at the global, national, and local level. A secondary objective was to provide policy-makers, public educators,

advocates, and programmers with comprehensive information to inform their drowning prevention efforts.

Chapter One: Background

1.1 Definition and Classification of Drowning

1.1.1 Definition. The definition of drowning has evolved over time. Modell proposed (1971) and modified (1981) a series of definitions that led to the use of four distinct terms: drowning with aspiration, drowning without aspiration, near-drowning with aspiration, and near-drowning without aspiration, to refer to fatal and non-fatal drowning, respectively. In 2002 these definitions were deemed unsuitable for surveillance and epidemiological research because they include the characteristics of the drowning event, pathophysiological changes, as well as the outcome. This is cumbersome and differs from typical Utstein style, a set of guidelines for uniform reporting of cardiac arrest (Cummins et al., 1991). Additionally, using separate definitions for fatal and non-fatal drowning was seen as a potential contributor to the underestimation of the magnitude of the drowning problem (van Beeck, Branche, Szpilman, Modell, & Bierens, 2005).

A systematic review of definitions for drowning incidents conducted in 2005 identified at least 20 different definitions for drowning and 13 definitions to describe non-fatal drowning. Moreover, the review found at least 20 different outcomes for drowning and non-fatal drowning incidents. The review implicated this variability as detrimental to conducting meaningful drowning prevention research with the goal of influencing global practice (Papa, Hoelle, & Idris, 2005).

This research project will thus utilize the definition adopted by consensus of the World Congress on Drowning in 2002: “Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid.” Drowning outcomes will be classified as:

death, morbidity, and no morbidity (van Beeck et al., 2005, p. 854). As such, use of the term non-fatal drowning in this text refers to drowning: morbidity and no morbidity.

1.1.2 Classification. There are multiple ways to classify injuries. The most common injury classification schemes typically include mechanism of injury, intent, and nature of injury. Mechanism of injury involves the circumstances that led to the injury occurring. Intent of injury refers to whether the injury was intentional, including self-inflicted (suicide or self-harm) and directed at others (homicide or assault), or unintentional, which are injuries that occurred without the intent to harm. Nature of injury refers to the primary physical characteristics of the injury. The purpose of standardized classification systems is to facilitate the comparison of data across different research studies and countries, and to allow for standardized, universally agreed upon definitions.

The International Classification of Diseases (ICD) is the most widely used and accepted classification system for diseases and other health problems. It is a standard diagnostic tool that was created for epidemiological and clinical purposes and is used to monitor the incidence and prevalence of health issues, including injury. A special section and codes have been created to define and code different types of injuries. In the most recent version of the ICD, version 10 (ICD-10), Chapter XIX contains codes related to injury, poisoning, and certain other consequences of external causes, and Chapter XX contains external causes of morbidity and mortality. Codes in Chapter XX permit the classification of environmental events and circumstances as the cause of injury, and are meant to be used in addition to a code from Chapter XIX. Most relevant to drowning, Chapter XIX contains code T75.1, drowning and non-fatal submersion and Chapter XX contains codes W65-W74, which identify mechanisms of injury

related to drowning. For example, W65 identifies drowning and submersion while in a bathtub (for all drowning related ICD-10 codes see APPENDIX A).

The classification of drowning morbidity and mortality using ICD-10 has posed some challenges for drowning prevention researchers and practitioners. Official data categorization methods for drowning only include the traditional drowning codes W65-W74 and exclude intentional drowning deaths (suicide or homicide) and drowning deaths caused by floods and water transport incidents. This has led to an underestimation of the death toll by drowning (Linnan et al., 2012; WHO, 2008; WHO, 2014). Evidence from high-income countries has suggested that including drowning deaths recorded under other causes such as floods (X38), water transport (V90 and V92), and intentional drowning (X92, Y21) would increase the estimated burden of fatal drowning by 39-50% (Linnan et al., 2012). The magnitude of underestimation may be even more severe in low- and middle-income countries where survey data from a number of areas have suggested a drowning rate four to five times higher than the published WHO estimates (WHO, 2008).

This research project will include both the traditional external cause codes related to drowning (W65-W74) as well as drowning that is categorized as a water transport accident (V90, V92), flood related (X38), undetermined intent (Y21), and where possible, intentional self-harm (X71) and assault by drowning (X92).

1.2 The Burden of Drowning Globally

1.2.1 Fatal drowning. In 2014, the World Health Organization (WHO) released the first ever *Global Report on Drowning*. This report summarizes the latest evidence related to the global burden of drowning and states that an estimated 372,000 drowning fatalities occurred in

2012. Due to underreporting of drowning deaths as well as the previously mentioned issues related to their classification, the true number of deaths from drowning is believed to far exceed this estimate. According to the WHO (2014), drowning is among the ten leading causes of death for people 1-24 years of age in every region of the world, and over half of all drowning deaths occur among individuals in this age group. Young children are at disproportional risk; the highest drowning rates occur among children 1-4 years of age, followed by children 5-9 years of age. Most fatal drowning victims are male; globally, males are twice as likely to drown as females. In all countries, regardless of economic development, poor and marginalized populations are at the greatest risk of drowning (WHO, 2014).

The vast majority (91%) of drowning deaths occur in low- and middle-income countries and drowning rates in these countries are 3.4 times higher than in high-income countries (WHO, 2014). In low- and middle-income countries, drowning most commonly occurs during daily living activities such as washing, collecting water, and travel across water (Rahman et al., 2009). The WHO reported that the highest estimated drowning death rates in 2012 occurred in the African region (7.9 per 100,000 population), and the South-East Asia region (7.4 per 100,000 population) (WHO, 2014). Estimates for regions such as these, where there is a high proportion of countries that do not report drowning deaths to the WHO, are often derived from cause of death modeling (Kobusingye & Bowman, 2014). While the data and models from these countries indicate a high burden of drowning, a limited number of population-based survey studies indicate that drowning death rates may be even higher than the estimates. For example, in Tanzania, the unintentional drowning rate in two rural communities was found to be 17.1 per 100,000 population (Moshiro, Mswia, Alberti, Whiting, Unwin, & Setel, 2001), and community

surveys in five countries in South and South-East Asia found a drowning rate of 30 per 100,000 population (Linnan, Cuong, Rahman, & Rahman, 2007).

Although drowning rates are lower in high-income countries, drowning is still among the leading causes of unintentional injury death for many age groups in these areas. Drowning in high-income countries most commonly occurs during recreational activities (WHO, 2014). Drowning patterns differ by country and region based on exposure to bodies of water, local geography, and urban versus rural setting (Martyn, 2014). For example, in many countries, drowning rates are higher in rural areas due to their proximity to lakes, ponds, and rivers.

1.2.2 Non-fatal drowning. The true magnitude of the burden of non-fatal drowning globally is unknown. According to the WHO (2008), estimates of the number of non-fatal drowning cases are difficult to obtain due to a lack of standardized reporting. Most countries, regardless of income level, are not required to report non-fatal drowning incidents to a central health statistics system. Some countries, however, are able to provide estimates from hospital data. In instances where non-fatal drowning data is available, reported estimates of the ratio of fatal to non-fatal drowning vary widely. The most commonly reported estimate is that for every one fatal drowning, one to four non-fatal drowning events occur (Brenner, 2003; Meyer, Theodorou, & Berg, 2006; Moran, 2010; Yang, Nong, Li, Feng, & Lo, 2007), but estimates as high as one fatal drowning to between 20 and 50 non-fatal drowning incidents have also been reported (Onyekwelu, 2009).

In a retrospective review of rescue reports recorded by lifeguards on the beaches of Rio de Janeiro between January 1972 and December 1991, Szpilman (1997) reported that 94% of the 41,279 cases that required medical treatment after being rescued were released directly from the

site after initial treatment was administered. The focus of the study was on the remaining 6% of cases who were transferred for more specialized care, however the unstudied 94% of cases represent a vast number of life-threatening incidents that required intervention, yet were never reported in the public health statistics.

Moran (2010) used the visual metaphor of an iceberg (that had originally been proposed by Schuman, Row, Glazer & Redding (1977)) to illustrate the true extent of the risk of drowning. In the metaphor, the visible tip of the iceberg represents fatal drowning incidents and reported non-fatal drowning incidents with morbidity, and the underwater base contains a substantial layer of non-fatal incidents that posed a serious threat to life but were never captured in public health statistics. Moran (2010) retrospectively reviewed four sources of data to identify fatal drowning victims, non-fatal drowning victims with morbidity, and non-fatal drowning victims with no morbidity in New Zealand youth aged 16 to 20. The visual tip of the iceberg in his study consisted of 41 fatalities and 61 hospitalizations. The underwater base of the iceberg consisted of 1,132 reported surf rescues and 810 self-reported life-threatening submersions. In both Szpilman's (1997) and Moran's (2010) studies the frequency of non-fatal drowning far exceeded that of fatal drowning.

Few epidemiological studies that analyzed the characteristics of drowning incidents included non-fatal drowning, and those that did were all conducted in high-income countries (Centers for Disease Control and Prevention, 2004; Ellis & Trent, 1995; Gulliver & Begg, 2005; Jensen, Williams, Thurman, & Keller, 1992; Ma et al., 2010; Moran, 2010; Quan, Gore, Wentz, Allen, & Novack, 1989; Ross, Elliott, Lam, & Cass, 2003; Williamson & Schmertmann, 2002). Even less is known about the non-fatal drowning problem in low- and middle-income countries.

1.3 The Burden of Drowning in Canada

1.3.1 Fatal drowning. Drowning is a significant cause of injury mortality in Canada. It is among the three leading causes of unintentional injury death for children of all ages (Yanchar, Warda, & Fuselli, 2012). Drowning accounts for approximately 3% of unintentional injury deaths each year (Parachute, 2015). The Drowning Prevention Research Centre Canada (DPRC) collects data on all unintentional water-related deaths that occur in Canada from the coroner's and medical examiner's offices in each province and territory. The DPRC produces a report each year summarizing the current data related to the burden of fatal drowning in Canada. In the most recent edition of the report, Clemens and Simoes (2016a) indicate that between 2009 and 2013, unintentional drowning accounted for a total of 2364 fatalities in Canada. This translates to a water-related fatality rate of 1.4 per 100,000 population. The current burden of drowning mortality as described by Clemens and Simoes is briefly summarized in the following sections:

Demographic characteristics of fatal drowning victims in Canada. By age, the highest water-related fatality rates in 2009-2013 were found among young adults aged 20-34 and seniors 65 and older (1.6 and 1.8 per 100,000 respectively). Within these age groups, 20-24 year-olds and 85-89 year-olds had the highest death rate (1.9 and 2.0 per 100,000 population, respectively). Over 80% of drowning fatalities occurred among men. Between 2009 and 2013 an average of 385 males drowned each year, contributing to a water-related fatality rate of 2.3 per 100,000 population. Comparatively, an average of 88 females drowned each year (0.5 per 100,000 population). Indigenous peoples were at a higher risk for drowning than non-Indigenous Canadian residents. In 2009-2013, an average of 46 drowning victims per year (10% of all drowning fatalities) were reported to be Indigenous. Comparatively, approximately 4% of the Canadian population identifies as an Indigenous person.

Body of water. Natural bodies of water such as lakes and ponds (37%), rivers and streams (28%), and oceans (9%) accounted for the majority (74%) of Canadian drowning fatalities in 2009-2013. Man-made settings such as bathtubs (9%) and pools (7%) accounted for fewer drowning fatalities. Drowning deaths in lifeguard supervised settings such as public pools and waterfronts were rare. In 2009-2013 less than 2% of all water-related fatalities occurred in a lifeguard supervised setting.

Activity at the time of the drowning. Recreational activities accounted for almost two thirds of all water-related fatalities (61%). An average of 289 people drowned in Canada each year while recreating in, on or near the water. The most common recreational activities were swimming (26%), and walking, running, or playing near water or on ice (16%). After recreational activities, daily living accounted for the next highest proportion of drowning incidents in Canada (25%). The most common daily living activities engaged in prior to drowning were bathing (33%) and motor vehicle travel (32%). Occupational activities accounted for fewer Canadian drowning fatalities (6%), the most vulnerable sector for occupational drowning deaths was commercial fishing (37%). By type of activity, boating (26%) was the most common, an average of 124 people drowned each year while engaged in some type of boating. Aquatic activities (25%), where the victim intended to be in the water at the time of the incident, were the next most common. An average of 120 people drowned each year during aquatic activities like swimming and wading.

Clemens, Tamim, Rotondi, and Macpherson (2016) conducted a secondary analysis of DPRC data to describe the epidemiology of drowning in Canada and examined how the characteristics of drowning incidents vary by age group. Their study identified differences in the characteristics of drowning by age group across all variables that were analyzed (sex, body of

water, urban versus rural location, time of year, activity type, purpose of activity, alcohol involvement, personal floatation device use, accompaniment, and whether a rescue was attempted). Death rates (per 100,000) varied by age group. With the exception of the youngest age group (0-4 year-olds), drowning death rates increased with age. Death rates (per 100,000) were 0-4 (1.05), 5-14 (0.57), 15-19 (1.27), 20-34 (1.70), 35-64 (1.44), 65+ (1.74). As the authors note, this differs from what has been reported for the global population, including both low- and middle-income countries and other high-income countries with a similar fatal drowning burden. In both cases, the highest drowning rates are typically reported among children and youth (WHO, 2014). Clemens et al. concluded that Canadian drowning prevention initiatives should be tailored to specific age groups.

1.3.2 Non-fatal drowning. The DPRC does not currently collect data on non-fatal drowning incidents and prior to this research project, no Canadian study focusing on non-fatal drowning had ever been published. A report on the economic burden of injury published by Parachute (2015), reported that non-fatal drowning accounted for 247 hospitalizations and 1251 emergency room visits in 2010, suggesting that the incidence of non-fatal drowning may be greater than that of fatal drowning in Canada.

1.4 Drowning Patterns by Province and Territory

The DPRC produces provincial drowning reports each year summarizing the burden and characteristics of fatal drowning in each province and territory of Canada. These reports indicate that drowning patterns and rates vary substantially across regions. According to Clemens and Simoes (2016a), drowning rates are highest in the Territories. In 2009-2013 the average water-related fatality rates in the Northwest Territories, Nunavut and the Yukon were 6.9, 12.3, and

10.2 per 100,000 population respectively; considerably higher than the national average of 1.4 per 100,000 in the same period. Durkalec, Furgal, Skinner, and Sheldon (2014) analyzed search and rescue records and conducted key informant interviews to explore the role of environmental factors in injury rates in remote Northern Canada. The authors concluded that environmental determinants of injury should be considered in the management of injury risk, including drowning and cold-water immersion, particularly related to travel on sea ice during the winter.

The highest drowning rate among the provinces of Canada occurred in Newfoundland and Labrador (4.0 per 100,000). The *Newfoundland & Labrador Drowning Report, 2016 Edition* indicates that in 2009-2013, drowning rates were highest among men and middle aged adults 35 to 64 years of age. As previously mentioned, drowning risk is higher for males than females in all provinces and territories, however in Newfoundland and Labrador the sex difference is even more pronounced. Between 2009 and 2013, 95% of Newfoundland and Labrador drowning victims were male, and the average water-related fatality rate was 8.1 per 100,000 population for males, compared to 0.4 for females (Clemens & Simoes, 2016b).

The proportion of drowning deaths in natural bodies of water varies somewhat based on geographical location. The Territories and Atlantic Canada had the highest percentages of drowning deaths in natural bodies of water (86-100%) in the 2009-2013 period. Drowning fatalities in man-made settings were more common in the central provinces, the Prairies, and British Columbia (Clemens & Simoes, 2016a). In Ontario, private pools (10%) accounted for a larger proportion of drowning deaths than most other provinces. Children under the age of five are particularly vulnerable to drowning in private backyard pools in this province; 41% of children 0-5 years of age who drowned in Ontario in 2009-2013 drowned in a private backyard pool (Clemens & Simoes, 2016c).

The existing literature indicates that the burden and patterns of drowning differ between countries and regions. To obtain appropriate evidence to inform drowning advocacy and prevention efforts, epidemiological research must be conducted at the global, national, and local level. For this research study, topics were selected from each of the global, national, and local levels based on clearly identified gaps in the literature, and feasibility of timely completion.

Thesis Objective

The primary objective of this thesis was to conduct a comprehensive epidemiological investigation and address gaps in our understanding of the drowning problem at the global, national, and local level. A secondary objective was to provide policy-makers, public educators, advocates, and programmers with comprehensive information to inform their drowning prevention efforts. Specifically, this thesis will achieve these objectives by: (1) reporting the proportion of drowning deaths that are excluded using the current methodology to estimate the frequency of drowning worldwide; (2) determining the quality of country-level cause-of-death reporting on drowning fatalities; (3) describing non-fatal drowning in Canada and identifying whether the characteristics of non-fatal drowning differ significantly from those of fatal drowning; (4) describing the characteristics of bystander intervened fatal drowning incidents and determining whether the characteristics of these differ significantly from incidents where no rescue was attempted; (5) describing the characteristics of people who drowned while attempting to rescue another person; (6) examining the association between isolation fencing bylaws and the incidence of fatal drowning in private backyard pools in Ontario; and (7) describing the epidemiology of private backyard pool drowning deaths among children in Ontario. The four chapters that follow contain the manuscripts of four distinct but related studies that address each of these specific aims.

Chapter Two: Underestimating the Global Burden of Drowning: Categorization and Classification of Drowning Fatalities using ICD-10 Codes

Overview

This chapter contributes to the overall objective of this thesis by addressing gaps in our understanding of the true magnitude of the global drowning problem. It is widely held that the total number of deaths from drowning worldwide reported by the World Health Organization is an underestimation due to several issues, including methodological concerns related to the categorization and classification of drowning fatalities using ICD-10 codes. In this chapter, the proportion of drowning deaths that are excluded using the current categorization methods is estimated, and the quality of cause-of-death reporting using ICD-10 drowning codes is examined. The primary contribution of this study is that it provides evidence that the current estimate of the global burden of drowning is in-fact an underestimate.

Summary

Introduction: Drowning is a leading cause of death with an estimated 372,000 fatalities each year. Underreporting of drowning deaths, misclassification of drowning into other causes, and the current categorization methods for drowning deaths may obscure the true scale of the global death toll from drowning.

Objective: (1) To determine the proportion of drowning deaths that are excluded using the current methodology to estimate the frequency of drowning worldwide; (2) To determine if the quality of cause-of-death reporting has improved in recent years.

Methods: We conducted a retrospective descriptive study using data extracted from the World Health Organization (WHO) mortality database. Data were extracted for all countries that reported deaths using ICD-10 drowning codes, for the most recent year available. We calculated the percentage increase if all relevant codes were included to portray the magnitude of underreporting on drowning deaths using the current categorization methods. The proportion of unintentional drowning deaths coded as unspecified was calculated as a proxy measure of the quality of cause-of-death reporting.

Results: Of the 126 countries that reported mortality data to the WHO using ICD-10 drowning codes, 85 had reported at least 20 drowning deaths in the most recent year available. In 16 of these countries, including all drowning related ICD-10 codes, rather than the limited ones used now, increased the reported frequency of drowning deaths by over 100% and in 29 countries by over 50%. The average percent increase was 72%. The total proportion of unintentional drowning deaths classified as unspecified was 50%.

Conclusion: Official data categorization methods contribute to an underestimation of the total burden of drowning at the global level. Several countries continue to fail to report sufficiently specific codes in drowning mortality data submitted to the WHO.

2.1 Introduction

Drowning is a vastly neglected area of public health relative to its global impact – in 2012, drowning was the third leading cause of unintentional injury death, killing an estimated 372,000 people and resulting in over ten million disability-adjusted life years lost (Branche & van Beeck, 2014; WHO, 2014). Over 90% of these deaths occurred in low- and middle-income countries (LMICs) and drowning death rates are over three times higher in LMICs than in high-income countries. Drowning is among the ten leading causes of death for people 1-24 years of age in every region of the world. Globally, an average of 42 people die from drowning every hour of every day (WHO, 2014).

The burden of drowning is believed to be even greater than currently reported. The main factors that contribute to an underestimation of the true scale of the global drowning problem are underreporting of drowning deaths, and methodological problems with the classification and categorization of drowning deaths. Underreporting of drowning deaths can occur because the bodies of fatal drowning victims often do not make it to a facility where the death would have been documented (WHO, 2014). Similarly, in some areas cultural traditions lead to the rapid burial of bodies and the deaths are therefore not officially reported or captured. Poor quality data collection systems also contribute to underreporting (WHO, 2014).

The multi-faceted nature of drowning deaths can lead to decisions about classification that obscure the true burden of drowning (Wet & Smith, 2000). Injury deaths often have more than one contributing cause; for example, a person may have a seizure while in water that results in drowning, and the ultimate cause of death may be attributed to the seizure. In another situation where a person's vehicle leaves a roadway, enters water, and the person dies from

drowning, that drowning fatality may end up 'hidden' in a motor vehicle crash code (Wet & Smith, 2000). Similarly, if prolonged hospitalization occurs after a drowning event, the death may be classified under a different code related to a secondary cause such as respiratory failure (WHO, 2008).

Categorization methods for drowning using official guidelines have also led to an underestimation of the true global burden of drowning because they exclude water transportation related drowning deaths (including irregular movements where vessels carrying migrants or refugees sink during the journey), flood disasters, intentional drowning deaths caused by suicide or homicide, and drowning deaths where the intent could not be determined (WHO, 2014). Evidence from high-income countries has suggested that including drowning deaths currently captured under these other causes would increase the estimated burden of fatal drowning by 39-50% (Linnan et al., 2012). For example, in Canada, water transport related drowning fatalities alone account for 26% of the total number of unintentional drowning deaths each year (Clemens & Simoes, 2016a). However, using the standardized, global data categorization methods these fatalities are not included in the drowning death toll. The magnitude of underestimation may be even greater in low- and middle-income countries where survey data from a number of areas have suggested a drowning rate four to five times higher than the published WHO estimates (WHO, 2008). No study has attempted to quantify the effect that including drowning deaths that are not currently categorized as drowning would have in the estimated burden of fatal drowning globally.

In the tenth revision of the International Classification of Diseases (ICD-10), the classification system used by the WHO, the official drowning codes are W65-W74 (APPENDIX A). These codes include information on the body of water where the drowning occurred, and the

mechanism of injury. For example, W65 is drowning and submersion while in a bathtub, and W66 is drowning and submersion following a fall into a bathtub. ICD-10 also includes fourth-character sub-divisions that identify the place of occurrence of the injury (APPENDIX A). For example, W65.0 is drowning and submersion while in a bathtub, and the place of occurrence is home. Unfortunately, many countries do not report on drowning deaths with a high level of specificity using the fourth digit and many countries report the majority of their drowning deaths using the W74 code (unspecified drowning and submersion). Differences in the level of specification of reporting make cross country comparisons difficult (Martyn, 2014) and detailed reporting on drowning deaths is important for the design of drowning prevention strategies. Lu, Lunetta and Walker (2010) assessed the quality of cause-of-death reporting using ICD-10 drowning codes and found that over 50% of cases were coded as unspecified using the W74 code. The data available at the time of their study were from 1999-2007. Since then, there has been increased international attention to drowning, and data collection has improved as the result of a uniform and internationally accepted definition of drowning (Branche & van Beeck, 2014).

Currently, global drowning statistics do not represent the full magnitude of the drowning burden, and reported data are not sufficiently specific. The primary objective of this study was to determine what proportion of drowning deaths are missed in the current drowning estimates as the result of using traditional categorization methods that only include unintentional drowning (W65-W74). A secondary objective was to determine if the quality of cause-of-death reporting has improved in recent years.

2.2 Methods

This retrospective descriptive study was conducted using data extracted from the WHO mortality database. The database consists of a compilation of mortality data by age, sex, and cause of death, as reported annually by United Nations member states from their civil registration systems (WHO, 2016). The frequency of reporting to the WHO varies by member state; data is not available for all member states for every year. Therefore for ease of comparison, data were extracted for all countries that reported deaths using ICD-10 drowning codes, for the most recent year available. All ICD-10 external cause codes related to drowning were included; unintentional drowning and submersion W65-W74, intentional drowning X71 (suicide), X92 (homicide), undetermined intent (Y21), water transport related drowning and submersion V90 and V92, and flood X38 for 2003 to 2014 inclusive.

The frequency of drowning in each country was calculated for both the currently captured drowning codes (W65-W74) and all drowning codes (W65-W74, V90, V92, X38, X71, X92, Y21). To ensure statistical stability of the calculated percentages, only countries that reported more than 20 unintentional drowning deaths (codes W65-W74) were included in the final analysis. Percentage increase was then calculated to demonstrate the magnitude of underreporting on drowning deaths based on the current categorization methods. To determine if there have been any recent improvements in quality of cause-of-death reporting using ICD-10 codes for cases of unintentional drowning, the proportion of unintentional drowning deaths (codes W65-W74) coded as unspecified (code W74) was reported.

2.3 Results

Of the 126 countries that reported mortality data to the WHO using ICD-10 drowning codes, 85 had reported at least 20 drowning deaths in the most recent year available. The number of drowning deaths based on the official drowning categorization methods (codes W65-W74 only), and the number of drowning deaths based on all codes (W65-W74, V90, V92, X38, X71, X92, Y21) are listed in the second and third columns of **Table 1**, respectively. The percent increase in the total death toll from drowning in each country when using all codes rather than the currently captured codes is listed in the final column of **Table 1**. The total percent increase across all countries was 25%, and the average percent increase was 72%. In 16 of the 85 countries (19%), including all drowning related ICD-10 codes increased the drowning death toll by over 100% and in 29 countries (34%) by over 50%. The proportions of unintentional drowning deaths (codes W65-W74) classified as unspecified (W74) for each country are reported in the fourth column of **Table 1**. The total proportion of unintentional drowning deaths classified as unspecified was 50%. In 27 countries (32%), the proportion of unspecified unintentional drowning deaths exceeded 80% and in 48 countries (56%) the proportion exceeded 50%.

Table 1: Percent increase in number of drowning deaths using all drowning related ICD-10 codes and percentage of unspecified unintentional drowning cases based on the WHO mortality database.

Country	**Latest available year**	**No. of deaths from traditional codes (W65-W74)**	**No. of deaths from drowning (all codes)**	**Percent of unintentional drowning deaths (W65-W74) classified as unspecified (W74)**	**Percent increase in drowning death toll**

Saudi Arabia	2012	13	226	0%	1638%
Dominican Republic	2012	28	153	100%	446%
Austria	2014	30	143	17%	377%
Belgium	2012	53	226	66%	326%
Hong Kong SAR	2013	30	98	3%	227%
Denmark	2012	34	87	6%	156%
Sweden	2013	83	212	48%	155%
Netherlands	2013	84	203	39%	142%
Portugal	2013	81	196	69%	142%
Ireland	2012	59	141	49%	139%
Republic of Korea	2013	622	1487	53%	139%
Armenia	2012	26	60	8%	131%
Switzerland	2013	56	121	71%	116%
United Kingdom	2013	262	567	29%	116%
Australia	2011	169	358	14%	112%
Norway	2013	52	104	83%	100%
Czech Republic	2013	117	223	46%	91%
Serbia	2013	72	133	25%	85%
Germany	2013	465	856	42%	84%
Canada	2011	253	464	8%	83%
Hungary	2013	123	224	5%	82%
Slovenia	2010	28	51	4%	82%
Malaysia	2008	342	581	31%	70%
Finland	2013	131	218	5%	66%
Argentina	2013	450	734	61%	63%
Georgia	2014	49	80	65%	63%
Italy	2012	363	579	78%	60%
TYFR Macedonia	2010	24	37	58%	54%
France	2011	918	1384	82%	51%
Spain	2013	422	616	54%	46%
New Zealand	2011	71	102	4%	44%
Venezuela	2012	448	635	40%	42%
Oman	2010	29	41	38%	41%
Croatia	2013	100	136	1%	36%
Iraq	2008	430	566	52%	32%
Colombia	2012	853	1107	12%	30%
United States of America	2013	3391	4408	9%	30%
Uruguay	2013	70	90	93%	29%
Belize	2013	22	28	55%	27%
Ecuador	2013	329	412	71%	25%
Egypt	2013	1965	2452	35%	25%
Lithuania	2013	198	244	3%	23%
Japan	2013	7523	9178	11%	22%
Peru	2013	400	479	87%	20%
Brazil	2013	5117	6032	38%	18%
Mexico	2013	1998	2359	41%	18%
Poland	2013	884	1041	3%	18%
Estonia	2012	48	55	13%	15%
Puerto Rico	2013	28	32	43%	14%
Slovakia	2014	129	147	6%	14%
Trinidad and Tobago	2009	36	41	58%	14%
Kyrgyzstan	2013	214	241	56%	13%
Philippines	2008	3451	3868	99%	12%

Paraguay	2013	175	194	25%	11%
Cuba	2013	251	275	1%	10%
Jordan	2011	42	46	100%	10%
Latvia	2012	135	148	3%	10%
Nicaragua	2013	138	152	78%	10%
Republic of Moldova	2013	159	175	59%	10%
Costa Rica	2013	102	111	99%	9%
Sri Lanka	2006	865	934	77%	8%
Suriname	2012	25	27	100%	8%
El Salvador	2012	176	186	82%	6%
Bulgaria	2012	135	142	56%	5%
Chile	2013	325	342	84%	5%
Israel	2013	55	58	96%	5%
Romania	2012	657	688	54%	5%
Mauritius	2014	47	49	100%	4%
Turkey	2013	647	675	95%	4%
Cape Verde	2012	31	32	100%	3%
Azerbaijan	2007	62	63	52%	2%
Guatemala	2013	342	347	100%	1%
Guyana	2011	105	106	100%	1%
Panama	2013	118	119	19%	1%
Thailand	2006	4666	4719	100%	1%
Uzbekistan	2005	1042	1053	52%	1%
Bolivia	2003	83	83	100%	0%
Fiji	2012	67	67	100%	0%
Guadeloupe	2011	26	26	96%	0%
Kuwait	2013	26	26	96%	0%
Morocco	2012	333	334	86%	0%
Qatar	2012	21	21	90%	0%
South Africa	2013	1518	1522	99%	0%
Syrian Arab Republic	2010	132	132	98%	0%
Tunisia	2013	38	38	82%	0%
Total		**45717**	**57146**	**50%**	**25%**

2.4 Discussion

This study investigated the magnitude of the underestimation of drowning deaths by the existing data categorization methods. The findings indicate that the estimated global drowning death toll may be at least 25% higher than currently reported, and that the percent increase in the drowning death toll when including all drowning codes varies substantially by country. This has important implications for drowning prevention. From an advocacy perspective, reporting an accurate estimate of the burden of drowning that is substantially higher than currently identified

may garner more political attention and support for broad prevention efforts that target drowning at both the global and country level.

A high proportion (50%) of unintentional drowning deaths (codes W65-W74) were reported as unspecified (W74). This result is similar to the findings reported by Lu et al. (2010). However, at the time of their study, only 69 countries met the inclusion criteria of reporting at least 20 deaths in the most recent year using detailed ICD-10 coding. When we calculated the proportion of unintentional drowning deaths reported as unspecified in just those 69 countries, the proportion of unspecified unintentional drowning in our study was 43%. This may indicate a small improvement in the quality of cause-of-death reporting using ICD-10 drowning codes across countries. Having a high proportion of drowning deaths classified as unspecified also has implications for drowning prevention. Understanding the circumstances of drowning events is one key element necessary for designing targeted drowning interventions.

Strengths and Limitations. This is the first study that we are aware of to quantify the effect of excluding water-transport, flood, intentional, and undetermined intent drowning deaths using a global sample by extracting data from the WHO Mortality Database. A key limitation of the study is that several countries are not yet using ICD-10 coding, and in some cases, these countries have very high drowning burdens. For example, in 2010, 11,981 people were reported to have drowned in the Russian Federation, a death rate of 7.8 per 100,000 (WHO, 2014), however the Russian Federation is not yet using ICD-10 and thus could not be included in this study. Another issue is that even when all drowning-related codes are included, several drowning deaths are likely still 'hiding' in other codes such as motor vehicle crash codes which do not specify drowning and thus could not be included in this study. Finally, this study did not address issues of underreporting caused by poor data collection systems and bodies that did not

make it to a medical facility where the death could be recorded. This study is simply a first step in attempting to estimate the true magnitude of the global drowning problem. Further investigation into the categorization and classification of drowning deaths is needed. Country-level studies that utilize other methods, such as media analysis or verbal autopsy to capture drowning deaths should be used to supplement data from countries where cause-of-death reporting to the WHO is limited.

2.5 Conclusion

The findings of this study confirm that the current methods used to capture drowning data contribute to an underestimation of the total burden of drowning at a global level. Further, many countries continue to fail to report sufficiently specific codes in drowning mortality data submitted to the WHO. High quality cause-of-death reporting would provide better information for the design of drowning prevention strategies. To move closer to an accurate estimate of the global death toll from drowning, all drowning-related ICD-10 codes should be included in official estimates.

Chapter Three: The Epidemiology of Non-Fatal Drowning in Canada

Overview

This chapter contributes to the overall objective of this thesis by addressing gaps in our understanding of the non-fatal drowning problem using national data. High quality data and research related to non-fatal drowning are scarce. Estimates of the ratio of fatal to non-fatal drowning vary widely in the literature and the characteristics of non-fatal drowning are not well understood. This study utilizes non-fatal drowning data from two databases maintained by the Canadian Institute for Health Information and fatal drowning data from the Drowning Prevention Research Centre Canada database to estimate the ratio of fatal to non-fatal drowning in Canada. It also demonstrates that the characteristics of non-fatal drowning differ significantly from those of fatal drowning. The primary contribution of this study is that it provides previously unreported data on the incidence of non-fatal drowning and identifies the need for drowning prevention programs and policies to target non-fatal drowning in addition to fatal drowning.

Summary

Introduction: Despite the fact that non-fatal drowning is a significant cause of morbidity from water-related injury events, there is a paucity of information on its incidence. Most epidemiological studies of drowning have focused on fatalities only; consequently, there is a lack of evidence on the characteristics of non-fatal drowning. The majority of existing non-fatal studies focus on children and adolescents only, and often do not include water transport related drowning events.

Objective: (1) To describe non-fatal drowning in Canada; and (2) to identify which characteristics, if any, differ significantly between non-fatal and fatal drowning incidents.

Methods: This retrospective study was conducted using data collected on drowning incidents in Canada over a five-year period, from fiscal year 2008/09 to 2012/13. Data were extracted from three databases, the Discharge Abstract Database, the National Ambulatory Care Reporting System, and the Drowning Prevention Research Centre database. Victims of a non-fatal drowning incident who required ambulatory care or who were discharged by an acute care facility in Canada were compared to fatal drowning cases where the cause of death was unintentional drowning, as determined by the coroner or medical examiner.

Results: The ratio of fatal to non-fatal drowning was 1:3. The characteristics of non-fatal drowning differed significantly from those of fatal drowning across all variables: age, sex, province, urban versus rural residence, and external cause.

Conclusions: The study results suggest that there may be a basis for expanding drowning prevention interventions to target characteristics specific to non-fatal drowning. Further research related to non-fatal drowning is warranted.

3.1 Introduction

The epidemiology of fatal drowning globally, particularly in high-income countries, has been well described (Clemens, Tamim, Rotondi, & Macpherson, 2016; Lunetta, Smith, Penttila, & Sajantila, 2004; Peden & McGee, 2003; Quan & Cummings, 2003; Salomez & Vincent, 2003; Schyllander, Janson, Nyberg, Eriksson, & Ekman, 2013; Sheikhazadi & Ghadyani, 2009; Shetty & Shetty, 2007; Tan, 2004; WHO, 2014). However less is known about the scope of the non-fatal drowning problem. Estimates of the ratio of fatal to non-fatal drowning vary widely in the literature, with non-fatal drowning incidents reported to be between two and fifty times more common than fatal drowning incidents (Brenner, 2003; Layon & Modell, 2009; Moon & Long, 2002; Onyekwelu, 2009; Suominen & Vahatalo, 2012; Wallis, Watt, Franklin, Nixon, & Kimble, 2015; Weinstein & Krieger, 1996).

Non-fatal drowning contributes substantially to the economic burden of injuries. In Canada, the total cost of drowning in 2010 was 187 million dollars (Parachute, 2015). A study conducted in the United States demonstrated that approximately 50% of non-fatal drowning victims required hospitalization or transfer for more specialized care. This is compared to only 5% hospitalization or transfer for all unintentional injuries (Centers for Disease Control and Prevention [CDC], 2004). Moreover, non-fatal drowning incidents often result in long-term morbidity. As many as one third of all non-fatal drowning sufferers have been reported to sustain significant neurological damage due to anoxic encephalopathy (Onyekwelu, 2009).

Despite the fact that non-fatal drowning is a significant cause of morbidity from water-related injury events, there is notably less information on its incidence and associated risk factors. Most epidemiological studies of drowning have focused on fatalities only; there is a lack

of information on the characteristics of non-fatal drowning. Moreover, the majority of the existing non-fatal studies focus on children and adolescents only and often do not include water transport related drowning events.

In the few studies that have described epidemiology specific to non-fatal drowning (CDC, 2004; Felton, Myers, Liu, & Winders Davis, 2015; Jensen, Williams, Thurman, & Keller,1992; Moran, 2010; Pearn, 1979; Quan, Gore, Wentz, Allen, & Novack, 1989; Ross, Elliott, Lam, & Cass, 2003; Wallis et al., 2015; Williamson & Schmertmann, 2002), there was some indication that the characteristics of non-fatal incidents may differ from those of fatal incidents. In particular, differences have been reported in the proportion of male versus female victims, as well as the type of body of water where incidents are most likely to occur. However, these studies either limited the population to children and/or adolescents only (Felton et al., 2015; Jensen et al., 1992; Moran, 2010; Pearn, 1979; Quan et al, 1989; Ross et al., 2003, Wallis et al., 2015), or did not utilize multivariable analysis to determine significant characteristics of non-fatal drowning (CDC, 2004; Willliamson & Schmertmann, 2002).

The burden of fatal drowning in Canada has been well established (Clemens et al., 2016; Clemens & Simoes, 2016a; Canadian Red Cross, 2013) however, there is a paucity of information regarding the scope and epidemiology of non-fatal drowning. A recent population based study of unintentional fatal drowning in Canada indicated that the age profile of fatal drowning victims in Canada differs from what has been reported by other countries, including other high-income countries with similar drowning death rates (Clemens et al., 2016). The highest death rates in Canada were found among individuals 20 years of age and older, with seniors 65 years of age and older having the highest death rate of all groups. In contrast, other countries have reported the highest rates among children and youth (Sheikhazadi & Ghadyani,

2009; Quan & Cummings, 2003; WHO, 2014). Based on this, it is not surprising that the majority of the non-fatal drowning studies that have been conducted in other countries focus on children and/or adolescents only. However, understanding the epidemiology of non-fatal drowning in the total population may be important for the prevention of all drowning, especially in the Canadian context.

Having knowledge of the characteristics of non-fatal incidents at all ages will allow the developers of drowning prevention campaigns to target all drowning victims as opposed to focusing on fatalities only. In addition, increased prevention of non-fatal drowning incidents may decrease the burden to the healthcare system. As such, the primary objective of this study was to describe non-fatal drowning in Canada. A secondary objective was to identify which characteristics, if any, differ significantly between non-fatal and fatal drowning incidents.

3.2 Methods

3.2.1 Study population and design. This retrospective study was conducted using data collected on drowning incidents in Canada over a five-year period, from fiscal year 2008/09 to 2012/13. Victims of a non-fatal drowning incident who required ambulatory care or who were discharged by an acute care facility in Canada were compared to fatal drowning cases where the cause of death was unintentional drowning, as determined by the coroner or medical examiner.

3.2.2 Non-fatal drowning data collection. Data on non-fatal drowning victims who required hospital admission were obtained from the Discharge Abstract Database (DAD) for the period of 2008/09 to 2012/13. The DAD is maintained by the Canadian Institute for Health Information (CIHI) and captures administrative, clinical, and demographic information on hospital discharges. Data is received directly from acute care facilities or from their respective

health authority or department of health, with the exception of Quebec. Data on the patient and the nature of their stay are collected from the patient's chart at the time of their discharge from hospital and recorded on an abstract provided by CIHI. This data collection is performed by health information professionals who assign diagnosis codes using International Classification for Diseases tenth revision (ICD-10) (CIHI, 2016a).

Data on non-fatal drowning victims who required hospital-based and community based ambulatory care including day surgery, outpatient and community-based clinics, and emergency departments, were obtained from the National Ambulatory Care Reporting System (NACRS). CIHI receives data directly from participating facilities or from their regional health authorities or ministries of health (CIHI, 2016b). During the study period, NACRS data were only available from two provinces; Ontario and Alberta. Data from Ontario were obtained for the period of 2008/09 to 2012/13, and data from Alberta were obtained for the period of 2010/11-2012/13.

3.2.3 Fatal drowning data collection. Data on all fatal drowning cases were obtained from the Drowning Prevention Research Centre (DPRC) database. Deaths were classified as drowning and data collected if drowning was included as a cause of death in the coroner's report, based on the autopsy or other findings. Trained local data collectors entered each of the provincial coroner's offices annually to conduct structured reviews of the coroner and police reports for all water-related deaths. The questionnaire, data collection and data entry process has been previously described (Clemens et al., 2016). The DPRC data is not classified using ICD codes, as such the cases were manually mapped to the appropriate ICD-10 code for comparison. The fields used to determine the code were "type of body of water" and "type of activity". This process was quality controlled by double entry and compare.

3.2.4 Measures. The primary outcome variable was drowning (non-fatal or fatal), based on the internationally agreed upon definition (van Beeck, Branche, Szpillman, Modell, & Bierens, 2005). For non-fatal drowning, this was determined by the relevant ICD-10 codes, including water transport related drowning and submersion V90, V92, unintentional drowning and submersion W65-W74, intentional drowning X71, X92, and undetermined intent Y21 (see APPENDIX A for further detail). For fatalities, outcome was determined by whether drowning was identified as the cause of death based on the autopsy or other findings.

The selection of exposure variables was limited by what information was available from all three of the DAD, NACRS and the DPRC databases. Analysis was performed using measures of age categorized as 0-4, 5-14, 15-19, 20-34, 35-64, and 65+; sex; province; urban versus rural residence location based on the Statistics Canada definition (Statistics Canada, 2006a), or recorded as other if the patient was homeless, resided outside of Canada, or residence location was unknown; and external cause, a diagnosis code used to identify the environmental events that caused the drowning, categorized as water transport, bathtub, swimming pool, natural water, other, and unspecified.

3.2.5 Statistical analysis. First, univariate analysis was conducted and descriptive statistics were reported to summarize the characteristics of non-fatal drowning incidents requiring emergency department visit or hospital admission in Canada. After this initial analysis, certain cases were removed in order to minimize the potential of duplication between groups. Individuals who presented to emergency departments and were subsequently admitted directly to an acute care facility, or died on or after arrival, were removed from the NACRS data for the remainder of the analysis and only included in the hospital admissions data, or the fatal data, respectively. Similarly, drowning victims who were admitted to hospital but subsequently died

were removed from the DAD data, and only included in the fatal data. Intentional cases (suicide/self-harm and homicide) were also removed to facilitate comparison with the fatal drowning data which includes unintentional and undetermined cases only. An estimated ratio of fatal to non-fatal drowning was then calculated using the data from the province of Ontario, as this was the province with the most comprehensive data available.

At the bivariate level, chi square tests were performed to examine the relationship between non-fatal drowning and age, sex, province, urban versus rural incident location and external cause. In the event of an expected cell count of less than five, a Fisher's Exact Test was used. Multivariable logistic regression was then used to estimate the adjusted odds ratios (OR) for each measure, mutually adjusting for all other variables in the model. The precision of each adjusted OR was assessed by its 95% confidence interval. All analysis was carried out using Statistical Package for Social Sciences (SPSS) version 23 (IBM Corp, 2014).

3.3 Results

All non-fatal drowning cases extracted from NACRS are described in **Table 2**. These included non-fatal drowning incidents requiring ambulatory services (ED visit) in Ontario for fiscal years 2008-2012 and Alberta for fiscal years 2010-2012. A total of 3135 cases were extracted, 604 (19%) of these individuals were admitted to hospital and 191 (6%) died on or after arrival. These 795 cases were removed for subsequent analysis. All non-fatal drowning cases extracted from the DAD are described in **Table 3.** These included non-fatal drowning incidents requiring admission to an acute care facility (hospital admission) in all provinces and territories of Canada except for Quebec. A total of 1148 cases were extracted, 138 (12%) of these cases

died, and thus were removed for subsequent analysis. The estimated ratio of fatal to non-fatal drowning in Ontario was 1:2.8.

Table 2: Non-fatal drowning incidents resulting in ED visits: Ontario 2008-2012, Alberta 2010-2012.

	No.	Percent
Total	3135	100
Province		
Ontario	2552	81.4
Alberta	583	18.6
Urban vs. Rural Residence		
Urban	2327	74.2
Rural	684	21.8
Other	124	4.0
Age		
0-4	433	13.8
5-14	502	16.0
15-19	326	10.4
20-34	777	24.8
35-64	866	27.6
65+	231	7.4
Sex		
Male	2042	65.1
Female	1093	34.9
Visit Disposition		
Discharged to place of residence (private dwelling)	2245	71.6
Client triaged and then left the Emerg Dept	54	1.7
Client assessed, left without treatment	6	0.2
Left against medical advice before treatment completed	10	0.3
Admitted into reporting facility as an inpatient to critical care unit or operating room	118	3.8
Admitted into reporting facility as an in-patient to another unit	303	9.7
Transferred to another acute care facility directly	183	5.8
Transferred to another non-acute care facility directly	8	0.3
Death after arrival	165	5.3
Death on arrival (includes in ER)	26	0.8
Intra facility transfer to day surgery/clinic	7	0.2
Discharge to place of residence (institution)	10	0.3
External Cause		
Watercraft accident	158	5.0
Water-transport without accident to watercraft	1052	33.6
Other unspecified water transport	12	0.4
Bathtub	96	3.1
Fall into bathtub	48	1.5
Swimming pool	296	9.4
Fall into swimming pool	189	6.0
Natural water	236	7.5
Fall into natural water	195	6.2
Other	53	1.7
Unspecified	644	20.5

Suicide/self harm	72	2.3
Homicide	63	2.0
Undetermined intent	21	0.7

Table 3: Non-fatal drowning incidents resulting in hospital admission: All provinces and territories excluding Quebec, 2008-2012.

	No.	Percent
Total	1148	100
Province		
Newfoundland	25	2.2
Prince Edward Island	7	0.6
Nova Scotia	57	5.0
New Brunswick	37	3.2
Ontario	468	40.8
Manitoba	51	4.4
Saskatchewan	57	5.0
Alberta	171	14.9
British Columbia	263	22.9
Territories	12	1.0
Urban vs. Rural Residence		
Urban	856	74.6
Rural	238	20.7
Other	54	4.7
Age		
0-4	238	20.7
5-14	174	15.2
15-19	87	7.6
20-34	165	14.4
35-64	346	30.1
65+	138	12.0
Sex		
Male	752	65.5
Female	396	34.5
Discharge Disposition		
Transferred to another facility providing inpatient care	68	5.9
Transferred to a long term care facility	47	4.1
Transferred to other	11	1.0
Discharged to a home setting with support services	41	3.6
Discharged home	819	71.3
Signed out (against medical advice)	23	2.0
Died	138	12.0
Did not return to hospital after signing out with a pass	<5	
External Cause		
Watercraft accident	50	4.4
Water-transport without accident to watercraft	129	11.2
Other unspecified water transport	5	0.4
Bathtub	72	6.3
Fall into bathtub	18	1.6
Swimming pool	210	18.3

Fall into swimming pool	81	7.1
Natural water	131	11.4
Fall into natural water	110	9.6
Other	39	3.4
Unspecified	221	19.3
Suicide/Self Harm	56	4.9
Homicide	8	0.7
Undetermined intent	18	1.6

During the study period, 2283 people died from unintentional drowning in Canada. A total of 890 of these deaths occurred in Ontario in 2008-2012 or Alberta in 2010-2012. These 890 fatal cases were compared to the non-fatal cases requiring ED visit extracted from the NACRS database. A total of 1867 drowning fatalities occurred in all provinces and territories of Canada excluding Quebec and were compared to the non-fatal cases requiring hospital admission extracted from the DAD database. **Table 4** shows the frequencies and percentages of non-fatal drowning victims requiring ED visit and fatal drowning victims. Compared with fatalities, non-fatal drowning patients presenting to an ED were more likely to be younger, more likely to be female, and more likely to drown as a result of water-transportation ($p < 0.001$). The proportion of non-fatal drowning also varied by province and victims of non-fatal drowning requiring ED visit were more likely to live in a rural area than fatal drowning sufferers ($p< 0.001$).

Table 4: Characteristics of non-fatal drowning incidents requiring ED visit and fatal drowning: Ontario 2008-2012, Alberta 2010-2012.

	Total No. (%)	Non-Fatal Drowning No. (%)	Fatal Drowning No. (%)	Significance
Total	3148 (100)	2258 (71.7)	890 (28.3)	
Age				P <0.001
0-4	303 (9.6)	253 (11.2)	50 (5.6)	
5-14	397 (12.6)	356 (15.8)	41 (4.6)	
15-19	319 (10.1)	269 (11.9)	50 (5.6)	
20-34	819 (26.0)	611 (27.1)	208 (23.4)	
35-64	996 (31.6)	641 (28.4)	355 (39.9)	
65+	314 (10.0)	128 (5.7)	186 (20.9)	
Sex				P <0.001

Male	2139 (67.9)	1435 (63.6)	704 (79.1)	
Female	1009 (32.1)	823 (36.4)	186 (20.9)	
Province				P <0.001
Ontario	2633 (83.6)	1838 (81.4)	795 (89.3)	
Alberta	515 (16.4)	420 (18.6)	95 (10.7)	
Urban vs. Rural				P <0.001
Urban	2426 (77.1)	1679 (74.4)	747 (83.9)	
Rural	645 (20.5)	510 (22.6)	135 (15.2)	
Other	77 (2.4)	69 (3.1)	8 (0.9)	
External Cause				P <0.001
Water transport	1300 (41.3)	1131 (50.1)	169 (19.0)	
Bathtub	198 (6.3)	83 (3.7)	115 (12.9)	
Swimming pool	377 (12.0)	291 (12.9)	86 (9.7)	
Natural water	721 (22.9)	289 (12.8)	432 (48.5)	
Other	115 (3.7)	27 (1.2)	88 (9.9)	
Unspecified	437 (13.9)	437 (19.4)	<5	

Table 5 shows the frequencies and percentages of non-fatal drowning victims requiring hospital admission and fatal drowning victims. Compared to fatal drowning victims, non-fatal drowning patients requiring hospital admission were more likely to be young children or youth, more likely to be female, and more likely to drown in a swimming pool (p <0.001). The proportion of non-fatal drowning incidents also varied by province (p <0.001).

Table 5: Characteristics of non-fatal drowning requiring hospital admission and fatal drowning in Canada.

	Total No. (%)	Non-Fatal Drowning No. (%)	Fatal Drowning No. (%)	Significance
Total	2820 (100)	953 (33.8)	1867 (66.2)	
Age				P <0.001
0-4	288 (10.2)	213 (22.4)	75 (4.0)	
5-14	240 (8.5)	158 (16.6)	82 (4.4)	
15-19	179 (6.3)	71 (7.5)	108 (5.8)	
20-34	603 (21.4)	138 (14.5)	465 (24.9)	
35-64	1094 (38.8)	276 (29.0)	818 (43.8)	
65+	416 (14.8)	97 (10.2)	319 (17.1)	
Sex				P <0.001
Male	2157 (76.5)	633 (66.4)	1524 (81.6)	
Female	663 (23.5)	320 (33.6)	343 (18.4)	
Province				P <0.001
Newfoundland	129 (4.6)	21 (2.2)	108 (5.8)	
The Maritimes	223 (7.9)	91 (9.5)	132 (7.1)	

Ontario	1161 (41.2)	366 (38.4)	795 (42.6)	
Manitoba	184 (6.5)	47 (4.9)	137 (7.3)	
Saskatchewan	156 (5.5)	49 (5.1)	107 (5.7)	
Alberta	304 (10.8)	138 (14.5)	166 (8.9)	
British Columbia	601 (21.3)	231 (24.2)	370 (19.8)	
Territories	62 (2.2)	10 (1.0)	52 (2.8)	
Urban vs. Rural				P = 0.074
Urban	2030 (72.0)	694 (72.8)	1336 (71.6)	
Rural	691 (24.5)	217 (22.8)	474 (25.4)	
Other	99 (3.5)	42 (4.4)	57 (3.1)	
External Cause				P <0.001
Water transport	646 (22.9)	180 (18.9)	466 (25.0)	
Bathtub	257 (9.1)	78 (8.2)	179 (9.6)	
Swimming pool	366 (13.0)	249 (26.1)	117 (6.3)	
Natural water	1136 (40.3)	201 (21.1)	935 (50.1)	
Other	202 (7.2)	32 (3.4)	170 (9.1)	
Unspecified	213 (7.6)	213 (22.4)	<5	

Adjusted associations between non-fatal drowning requiring ED visit and each independent variable are shown in the first two columns of **Table 6**. Significant differences were noted across all independent variables: age, sex, province, urban versus rural residence, and external cause. When compared to seniors (65 years of age and older), the odds of non-fatal drowning requiring an ED visit was 10.88 times (95% CI: 7.06-16.74) higher for young children 0-4 years of age, 13.03 times (95% CI: 8.39-20.22) higher for youth 5-14 years of age and 6.56 times (95% CI: 4.25-10.11) higher for teenagers 15-19 years of age. Although both fatal and non-fatal drowning events were more likely to occur among males than females, the odds of non-fatal drowning requiring an ED visit was 2.62 times (95% CI: 2.09-3.28) higher among females compared to fatal drowning.

Compared to fatal drowning incidents, the odds of non-fatal drowning requiring an ED visit was higher in Alberta than Ontario (OR 1.68, 95% CI: 1.27-2.23) and somewhat higher among those who live in rural areas (OR 1.45, 95% CI: 1.14-1.86). Compared to drowning events caused by submersion in or falling into natural water, the odds of non-fatal drowning

requiring ED visits occurring as the result of a water transport related incident was 11.43 times (95% CI: 9.01-14.48) higher than for fatal drowning victims. Submersion in or falling into a swimming pool (OR 3.18, 95% CI: 2.31-4.39), and other or unspecified external causes related to drowning (OR 7.84, 95% CI: 5.84-10.53) were both also associated with an increased odds of non-fatal drowning compared to fatal drowning. The odds of non-fatal drowning requiring ED visit was lower for drowning incidents involving submersion in or falling into a bathtub than drowning fatalities, but this difference was not significant in the multivariable regression model (OR 0.89, 95% CI: 0.61-1.31).

Table 6: Adjusted associations between characteristics and non-fatal drowning.

	ED Visits		Hospital Admissions	
	OR	95% CI	OR	95% CI
Age				
0-4	**10.88**	**7.06-16.74**	**8.29**	**5.62-12.21**
5-14	**13.03**	**8.39-20.22**	**5.17**	**3.49-7.65**
15-19	**6.56**	**4.25-10.11**	**2.28**	**1.51-3.43**
20-34	**3.82**	**2.77-5.28**	1.09	0.79-1.51
35-64	**2.45**	**1.81-3.32**	1.12	0.84-1.50
65+	1.00		1.00	
Sex				
Male	1.00		1.00	
Female	**2.62**	**2.09-3.28**	**2.03**	**1.64-2.51**
Province				
Ontario	1.00		1.00	
Alberta	**1.68**	**1.27-2.23**	**1.98**	**1.45-2.68**
Newfoundland			**2.33**	**1.65-3.23**
The Maritimes			0.80	0.47-1.38
Manitoba			**0.64**	**0.42-0.99**
Saskatchewan			1.09	0.71-1.67
British Columbia			**1.94**	**1.52-2.48**
Territories			0.55	0.25-1.21
Urban vs. Rural				
Urban	1.00		1.00	
Rural	**1.45**	**1.14-1.86**	0.94	0.74-1.18
External Cause				
Water transport	**11.43**	**9.01-14.48**	2.25	**1.76-2.89**
Bathtub	0.89	0.61-1.31	1.17	0.82-1.68
Swimming pool	**3.18**	**2.31-4.39**	**5.62**	**4.15-7.61**
Natural water	1.00		1.00	
Other/Unspecified	**7.84**	**5.84-10.53**	**5.87**	**4.48-7.69**

Adjusted associations between non-fatal drowning requiring hospital admission and each independent variable are shown in the third and fourth column of **Table 6.** Significant differences were noted across age, sex, province, and external cause. When compared to seniors 65 and older, the odds of non-fatal drowning requiring hospital admission was 8.29 times (95% CI: 5.62-12.21) higher among young children under the age of 5 and 5.17 times (95% CI: 3.49-7.65) higher for youth between the ages of 5 and 14 as compared to fatal drowning. Again both fatal and non-fatal drowning events were more likely to occur among males, but the odds of non-fatal drowning requiring hospital admission was twice (OR 2.03 95% CI: 1.64-2.51) as high among females compared to fatal drowning.

Compared to Ontario, the odds of non-fatal drowning incidents requiring hospital admission were higher in Alberta (OR 1.98, 95% CI: 1.45-2.68), Newfoundland and Labrador (OR 2.33, 95% CI: 1.65-3.23), and British Columbia (OR 1.94, 95% CI: 1.52-2.48), and lower in Manitoba (OR 0.64, 95% CI: 0.42-0.99).

Compared to drowning events caused by submersion in or falling into natural water, the odds of non-fatal drowning requiring hospital admission was 5.62 times (95% CI: 4.15-7.61) higher for incidents involving submersion in or falling into a swimming pool. Water transport (OR 2.25, 95% CI: 1.76-2.89), and other or unspecified external causes related to drowning (OR 5.87, 95% CI: 4.48-7.69) were both also associated with an increased odds of non-fatal drowning compared to fatal drowning. The odds of non-fatal drowning events requiring hospital admission occurring as a result of submersion in or falling into a bathtub were almost equal to that of fatal drowning incidents (OR 1.17, 95% CI: 0.82-1.68).

3.4 Discussion

Drowning prevention requires targeting all drowning incidents, including those where the drowning person survives, yet prior to this study little was known regarding the scope and epidemiology of non-fatal drowning in Canada. This study compared drowning data from three separate databases, including two sources of non-fatal drowning data. The findings suggest that the incidence of non-fatal drowning exceeds that of fatal drowning. A conservative estimate based on data reported from emergency departments and hospital admissions in Ontario suggests that for every one person who dies from unintentional drowning, three suffer a non-fatal unintentional drowning that requires urgent medical attention.

While this estimate is an important step towards understanding the scope of the non-fatal drowning problem in Canada, it is an under-estimation as it does not include non-fatal drowning victims who were treated on scene and did not seek further medical attention, those who attended a family physician or clinic, and those who did not receive any treatment at all. Nevertheless, it is clear from the results of this study that fatal drowning is only part of the drowning problem in Canada. Additionally, 19% of non-fatal drowning victims who were seen in an emergency department in this study were hospitalized. While this proportion is lower than the 50% that was reported by the Centers for Disease Control and Prevention (2004) study, it is still substantially higher than the hospitalization rate for all injuries in Canada. In 2010, approximately 6% of Canadians who visited an emergency room as the result of an injury were hospitalized (Parachute, 2015). The proportion of non-fatal drowning patients who required hospitalization is more than triple that of all injuries.

A secondary objective of this study was to investigate the characteristics of non-fatal drowning incidents as they differ from fatal drowning events. Significant characteristics of non-fatal drowning which resulted in increased odds of being a non-fatal drowning victim requiring either an ED visit or hospital admission were noted across age, sex, province, urban versus rural residence location, and external cause.

Age. In general, young age was significantly associated with increased odds of being a non-fatal drowning victim as opposed to a fatal drowning case. In those who visited an ED, the highest odds were found among 5-14 year-olds, followed by 0-4 year-olds. For non-fatal drowning victims requiring hospital admission, the highest odds were found among 0-4 year-olds and decreased with age. Studies from other countries have demonstrated that there is a high incidence of non-fatal drowning among young children. In the United States, Ellis and Trent (1995) and Quan et al. (1989) found that the highest non-fatal drowning incidence rates occurred among children under the age of five (18.4/100,000 and 8.7/100,000, respectively) and the Centers for Disease Control (2004) found that 40% of all non-fatal drownings had occurred among children under the age of five. Comparing non-fatal drowning victims to fatal drowning victims, Williamson and Schmertmann (2002) found that children under five represented a greater proportion of non-fatal drownings than fatal drownings (35% versus 15%). This study has demonstrated that there is a significant difference between the age profile of non-fatal drowning victims and fatal drowning victims.

Sex. Although the majority of drowning incidents, both fatal and non-fatal, occurred among males, a greater proportion of non-fatal drowning victims were female. Approximately 6 out of 10 non-fatal drowning victims were male, compared to approximately 8 out of 10 fatal drowning victims. Female gender was associated with increased odds of non-fatal drowning,

especially in those presenting to an emergency department. An over representation of males in non-fatal drowning patients has been observed in previous studies. Ellis and Trent (1995) found that males had a non-fatal drowning rate 1.7 times that of females and almost two thirds of non-fatal drowning cases were male in both Gulliver and Begg's (2005) study and Ma et al.'s (2010) study. Of the hospitalized victims in Moran's (2010) study, 83% were male and of the rescued victims, 62% were male.

Consistent with this study, previous research that compared fatal to non-fatal drowning data demonstrated that the proportion of female victims in non-fatal drowning cases was higher than that in fatal drowning cases. The Centers for Disease Control (2004) found that non-fatal drowning rates were nearly twice as high for males as for females but that fatal drowning rates were almost five times as high for males as for females. Further, Williamson and Schmertmann (2002) found that males represented 68% of non-fatal drowning cases as opposed to 79% of fatal drowning cases. This study has demonstrated that the sex makeup of non-fatal drowning victims is significantly different than that of fatal drowning victims.

Location. Province and urban versus rural incident location were significantly different characteristics of non-fatal drowning as compared to fatal drowning. For non-fatal drowning victims requiring ED visit, data was only available from Ontario and Alberta. And the odds of suffering a non-fatal drowning was higher in Alberta and slightly higher for individuals living in rural areas. For non-fatal drowning victims requiring admission to an acute care facility, data were available from all provinces and territories in Canada except for Quebec. Compared to Ontario, the odds of suffering a non-fatal drowning was significantly higher in Alberta, Newfoundland and Labrador, and British Columbia, and significantly lower in Manitoba. For non-fatal drowning victims requiring admission to an acute care facility, rural residence was not

significantly associated with non-fatal drowning. While it is positive that the increased non-fatal drowning events in certain provinces and areas did not result in fatalities, geographical location as a significant characteristic of non-fatal drowning requires further investigation.

External Cause. This is one of the first studies of non-fatal drowning to include water-transport related drowning (ICD-10 codes V90 and V92). Interestingly, water transport accounted for half (50%) of all of non-fatal drowning incidents requiring an emergency department visit and almost one fifth (19%) for those admitted to hospital, 32% overall. These findings differ from what Quan et al. (1989) reported in a non-fatal drowning study which did include water transport related drowning. In their study, only 18% of drowning cases involved boating, and the case fatality rate of boating submersions was 83%. This difference may be partially accounted for by the fact that Quan et al. (1989) only included individuals less than 20 years of age.

Implications. This study has important implications for drowning prevention. Given the burden of non-fatal drowning, prevention initiatives should target both non-fatal and fatal drowning incidents. In Canada, non-profit organizations such as the Canadian Red Cross and the Lifesaving Society use fatal drowning data to determine their public education strategies and community initiatives (Canadian Red Cross, 2016a; Lifesaving Society, 2012a). This study has demonstrated that the characteristics of non-fatal drowning differ significantly from those of fatal drowning. As such, drowning prevention organizations may need to expand their approaches to target non-fatal drowning victims in addition to drowning fatalities. For example, the drowning death rate among children under the age of 5 in Canada has decreased over the past 20 years, and 5-14 year-olds have the lowest fatal drowning rates of all age groups (Clemens et al., 2016). However in this study, young age was significantly associated with non-fatal drowning,

suggesting that children and youth should be considered a high-risk group and remain a priority for drowning prevention work. Similarly, it has been reported that over 80% of fatal drowning victims in Canada are male (Clemens et al., 2016), by contrast around 65% of non-fatal drowning victims were male in the present study, indicating that females should also be addressed by drowning prevention groups.

Strengths and Limitations. This is the first study on non-fatal drowning in Canada and the first study that we are aware of to use multivariable analysis to identify significantly different characteristics between non-fatal and fatal drowning with a study population that includes all age groups. Although the study provides important new information about non-fatal drowning, there are inherent limitations. The fatal drowning data were collected from the provincial and territorial coroner's and medical examiner's offices where cases can take several years to close, thus some drowning deaths may still be under investigation and therefore missed by this study. Additionally, given that complete data on non-fatal drowning incidents both requiring emergency department visit and requiring hospital admission were only available for the province of Ontario during the study period, the estimated ratio of fatal to non-fatal drowning may not be nationally representative. Although efforts were made to ensure that cases were not repeated in multiple groups, we cannot confirm that the non-fatal groups and the fatal group are completely mutually exclusive due to de-identification of the data. Previous studies of non-fatal drowning have indicated that ethnicity may be associated with the risk of non-fatal drowning (Felton et al. 2015). Unfortunately, ethnicity information was not available from the databases used in this study and therefore could not be included in the multivariable analysis. Nevertheless, the estimate of fatal to non-fatal drowning reported in this study is an important first piece of information in an area that is previously unexplored in Canada.

3.5 Conclusion

Drowning is a serious public health problem that contributes to the economic burden of injury and fatal drowning is just one small part of this problem. For every one fatal drowning that occurs in Ontario it is estimated that at least three non-fatal drowning events occur. Further, the percentage of hospital admissions is very high compared to that of other injuries. The epidemiological characteristics of non-fatal drowning differ significantly from those of fatal drowning. In order to prevent all drowning incidents, including those that do not result in death, drowning prevention interventions should expand their focus to include the risk factors associated with non-fatal drowning. Further research related to non-fatal drowning in Canada is warranted.

Chapter Four: Characteristics of Bystander Rescue Attempts in Fatal Drowning Incidents

Overview

This chapter contributes to the overall objective of the thesis by addressing gaps in our understanding of lay bystander rescue intervention using national data. It is well established that bystander intervention plays a critical role in the survival of a drowning person, but how and when bystanders intervene in drowning events has rarely been explored. This study provides an analysis of all bystander rescue intervened and non-intervened fatal drowning incidents in Canada over a seven-year period. Incidents where the bystander fatally drowned trying to rescue another person are also described. The primary contribution of this study is that it identifies a gap in Canadian drowning prevention initiatives and recommends that such strategies expand to include public education on safe rescue techniques for lay rescuers.

Summary

Introduction: Despite evidence that immediate rescue and initiation of resuscitation plays a vital role in determining the outcome of a drowning victim, research on bystander rescue interventions remains limited.

Objective: (1) To explore bystander rescue interventions in fatal drowning incidents in Canada; and (2) to describe the characteristics of rescuers who drowned while attempting to rescue another person.

Methods: A retrospective analysis was conducted using data that were collected for fatal drowning incidents occurring in Canada between 2005 and 2012. The primary outcome variable was a fatal drowning event in which a lay bystander attempted a rescue. Independent variables considered for multivariable logistic regression were: age and sex of drowning person, province, body of water, urban versus rural incident location, time of year, type of activity, purpose of activity, accompaniment, number of drowning persons involved in the incident and ice conditions.

Results: During the study period, 3,656 people died as the result of an unintentional drowning incident in Canada. In 1460 cases, a rescue was attempted by a lay bystander. In 590 cases the decedent was accompanied at the time of the incident but no rescue was attempted. The regression model identified significant differences in the characteristics of rescue intervened compared to non-intervened incidents. 71 bystanders fatally drowned while attempting to rescue another person.

Conclusions: Even when present, lay bystanders do not always attempt a rescue, and when they do, the most common rescue type is a high-risk, contact rescue. A tragic outcome of this is that

some bystanders who attempt a rescue fatally drown during the attempt. Canadian drowning prevention initiatives should include public education on safe rescue techniques for lay rescuers.

4.1 Introduction

Studies have established that bystanders can make a critical difference in the survival of a drowning person (Claesson, Lindqvist, & Herlitz, 2014; Grmec, Strnad, & Podgorsek, 2009; Marchant et al., 2008; Venema, Groothoff, & Bierens, 2010). The likelihood of surviving a drowning event is improved when immediate rescue and resuscitation are initiated. Submersion time and length of time before onset of cardio-pulmonary resuscitation have both been identified as predictors of morbidity and mortality in drowning incidents (Kyriacou, Arcinue, Peek, & Kraus, 1994; Suominen et al., 2002; Suominen & Vahatalo, 2012; Quan, Wentz, Gore, & Copass, 1990; Youn, Coi, Yim, & Park, 2009). Moreover, without the immediate first aid and basic resuscitation techniques that can only be initiated by on-scene bystanders, subsequent advanced resuscitation techniques, such as defibrillation and administering medication, appear to be of little value in most cases (Wigginton, Pepe, Mann, Persse, & Sirbaugh, 2006). Individuals who happen to witness a drowning event therefore play a pivotal role that may determine the outcome of the drowning person.

Despite this, the range of bystander response to drowning incidents has rarely been studied. In one of the only existing studies to specifically examine the role of bystanders in drowning incidents, Venema, et al. (2010) reviewed 289 rescue reports from the Dutch Society to Rescue People from Drowning and found that bystanders, when confronted with a life-threatening drowning situation, often acted adequately and successfully regarding rescue and resuscitation, despite the fact that it was often in an unsafe circumstance. This study was limited by the quality of the data in the rescue reports, and it did not include all rescue events in the Netherlands. Moreover, this study only described drowning incidents where a rescue was attempted, consequently no association between incident characteristics and the likelihood of

bystander rescue intervention was reported. Claesson, Lindqvist, Ortenwall, and Herlitz (2012) described the characteristics associated with rescue from drowning as reported by the Swedish Fire and Rescue Services and found that bystander resuscitation had been attempted in 44% of all cases. Although the focus of their study was the professional rescues initiated by emergency response services, the authors did note that bystanders had often performed a rescue before the arrival of professional rescuers. Additionally, the bystanders had sometimes put their own lives at risk due to a lack of necessary skills or equipment.

A relatively infrequent but devastating outcome of bystanders attempting a rescue in an unsafe circumstance is that the rescuer him or herself drowns. Few studies have examined drowning fatalities where the decedent was attempting to rescue another person at the time of death. In a retrospective analysis of post-mortem information, an Australian study reported that 103 rescuers drowned over a period of 7 years; 90% of the rescuers were male, 84% died while trying to rescue someone they knew, and in 74% of cases the rescued person survived (Franklin & Pearn, 2011). In Turkey, an analysis of drowning incidents reported in the media revealed that 28 rescuers drowned in one year; 80% of the rescuers were male, 87% drowned while rescuing someone they knew, and in 29% of cases the rescued person survived (Turgut, 2012). More studies are needed to identify the common traits in those who drown while attempting a rescue, and no such analysis has ever been published in Canada.

Meaningful, if partial, information related to bystander involvement in drowning incidents can be obtained from the files of fatal drowning victims found in the provincial and territorial coroner's offices. The purpose of this study was to utilize this data source to explore bystander rescue interventions in Canada. The primary objectives were: (1) to describe the characteristics of bystander intervened fatal drowning incidents; and (2) to determine which

characteristics differed significantly between drowning incidents where a bystander attempted a rescue and those where no rescue was attempted. A secondary objective was to describe the characteristics of rescuers who drowned while attempting to rescue another person.

4.2 Methods

4.2.1 Study Population and Design. This retrospective study was a secondary analysis of data that were collected by the Drowning Prevention Research Centre Canada (DPRC). The data are routinely collected from the coroner's and medical examiner's offices in all provinces and territories of Canada. For this study, the population included all unintentional drowning fatalities where the incident date fell within the study period of January 1, 2005 to December 31, 2012. Excluded were drowning deaths that were classified as suicide or homicide. Cause of death and intent were determined based on the coroner or medical examiner's classification, using the autopsy or other findings.

4.2.2 Data Collection. Data collectors entered each of the provincial and territorial coroner's or medical examiner's offices annually to conduct structured reviews of the files for all water-related deaths. Data collectors were trained to ensure accurate and consistent data extraction. Common sources of data included the coroner's investigation statement, post mortem examination report, police report, hospital records, and death certificate. A structured questionnaire was used to obtain data on cause of death; location of incident; activity type and purpose of activity; rescue attempt; and personal, equipment and environmental risk factors. The face validity of the questionnaire has been assessed several times since it was created in 1991 and questions have been altered, added, or removed to ensure the most reliable and comprehensive data on water-related fatalities is collected (McCullough, 2005). The DPRC

undertook an in-depth review of the questionnaire in 2010, and the revised questionnaire that was established as a result of that review was used to collect the data that was analyzed in this study.

Project managers supervised the data collectors in each province and territory. All completed questionnaires were verified for admissibility, completeness, and internal consistency by a national project manager as well as a consultant epidemiologist. Data entry was done at the national level and quality controlled through double entry.

4.2.3 Measures. The primary outcome variable was a fatal drowning event in which a non-professional (lay) bystander attempted a rescue. Professional rescuers were defined as firefighters, police officers (including Royal Canadian Mounted Police), emergency medical services personnel such as paramedics, and lifeguards. A wide range of variables that are captured by the DPRC were selected for investigation as potential characteristics associated with bystander rescue intervention. These included victim demographic factors: age categorized as 0-4, 5-14, 15-19, 20-34, 35-64, and 65+, sex, as well as the following incident specific factors: body of water defined as ocean, lake or pond, flowing water, bathtub, pool, or other; urban versus rural setting based on the statistics Canada definition (Statistics Canada, 2006a); time of year divided into Canada's warmer months (May through September) and the rest of the year; type of activity which describes what the victim was doing at the time of the incident, including whether or not the victim intended to be in or on the water; purpose of activity which describes whether the activity was recreational, daily living, occupational or an attempted rescue; accompaniment which measures whether the victim was alone or with others at the time of the incident; alcohol involvement by companions which indicates whether the drowning victim's accompanying friends had consumed alcohol prior to the incident; alcohol involvement by

decedent which indicates whether the drowning victim had consumed alcohol prior to the incident; number of drowning persons which indicates whether there were one or more drowning victims involved in the incident; ice conditions which measures whether the incident occurred on a body of water that was frozen (or partially frozen); light conditions categorized as light, twilight, or dark; water depth which describes the depth of the water at the time and location of the incident; and distance from safety which measures how far the drowning person was from safety such as the shore, dock or poolside at the time of the incident.

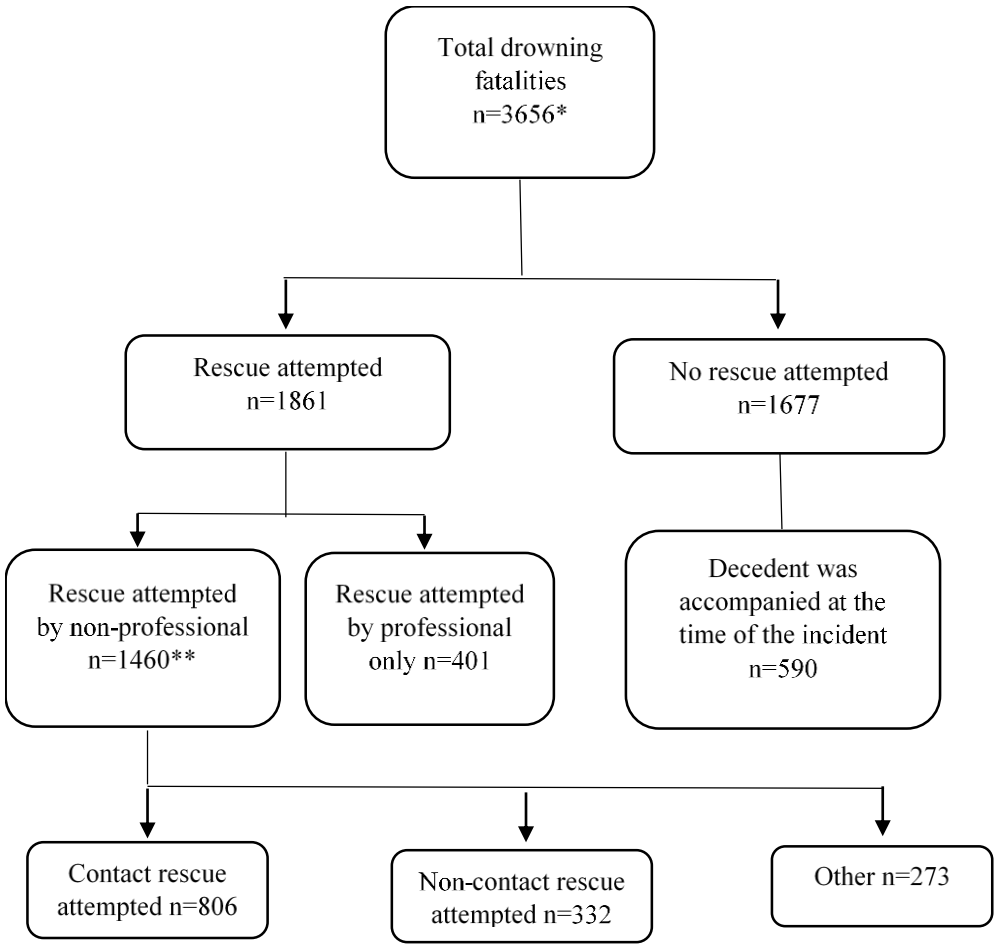
4.2.4 Statistical Analysis. First, univariate analysis was conducted and descriptive statistics were reported to summarize the characteristics of rescue intervened and non-intervened drowning in Canada. At the bivariate level, chi square tests were performed to examine the relationship between bystander intervention and each independent variable. In the event of an expected cell count of less than five, a Fisher's Exact Test was used. Unadjusted odds ratios were reported for each of the variables for which less than 10% of the information was missing from the files. These were age of drowning victim, sex of drowning victim, province, body of water, urban versus rural incident location, time of year, type of activity, purpose of activity, accompaniment, whether it was a single or multiple victim incident, and ice conditions. Variables with more than 10% missing information were excluded from subsequent analysis. Risk was estimated by the use of odds ratios (ORs) and the precision of each OR was assessed by its 95% confidence interval. Multivariable logistic regression was then used to estimate the adjusted ORs for each potential characteristic mutually adjusting for each variable in the model. The precision of each adjusted OR was assessed by its 95% confidence interval. Finally, univariate analysis was conducted and descriptive statistics were reported to summarize the characteristics of rescuers who drowned while attempting to save another person from drowning.

All analysis was carried out using the Statistical Package for Social Sciences (SPSS) version 23 (IBM Corp, 2014).

4.3 Results

During the study period, 3,656 people died as the result of an unintentional drowning incident. **Figure 1** shows the frequency of rescue intervention by bystanders. In 1861 cases (50.9%) a rescue was attempted by a bystander, in 1677 cases (45.9%) a rescue was not attempted by a bystander, and in 118 cases (3.2%) whether or not a rescue was attempted could not be determined. In 590 (35.2%) of the cases where a rescue was not attempted, the drowning person was accompanied at the time of the incident. Of the 1861 incidents where a bystander rescue was attempted, 1460 (78.5%) of the bystanders were not a professional rescuer. The features of these lay bystander rescues are summarized in **Table 7**. Of the non-professional attempted rescues, 806 (55.2%) involved a contact rescue, where the rescuer came into direct physical contact with the drowning victim that they were attempting to rescue. The most common contact rescue was a carry (n=618, 76.7%), where the rescuer physically carried the victim to land and removed them from the water. Fewer non-contact rescues were attempted (n=332, 22.7%), the most common of these were boat rescues (n= 162, 48.8%).

Figure 1: Summary of bystander rescue interventions in fatal drowning incidents in Canada 2005-2012.



*In 118 cases, whether or not a rescue was attempted could not be determined
**In 49 cases, the type of rescue could not be determined

Table 7: Features of non-professional bystander rescues.

	No.	Percent (%)
Total	1460	100.0
Type of Rescue Attempt		
Carry – Using direct physical contact, remove the drowning person from danger	618	42.3
Tow – Swim out to the drowning person and tow them back to safety using an aid	24	1.6
Swim – Swim out to the drowning person and provide them with an aid	164	11.2
Row – Use a boat to reach the drowning person	162	11.1
Wade – Wade into the water and provide an aid to the drowning person	33	2.3
Reach – Reach with an aid to the drowning person	85	5.8
Throw – Throw an aid to the drowning person	20	1.4
Talk – Try to talk the drowning person to safety, see if they can help themselves	32	2.2

Other – e.g. Removing victim from bathtub	273	18.7
Rescue attempted, type unknown	49	3.4
Relationship to Drowning Person		
At least one rescuer known to drowning person	1122	76.8
Rescuer(s) unknown to drowning person	292	20.0
Link to drowning person not specified	46	3.2

Table 8 shows the frequencies and percentages of the drowning incidents with and without lay bystander rescue intervention for each independent variable. Significant differences were found across all characteristics, at the significance level of $p \leq 0.003$. Compared to incidents where no rescue was attempted, rescue intervened drowning events were more likely to involve younger drowning victims. Certain provinces, such as British Columbia, Ontario, and Quebec had a higher proportion of bystander rescue intervened drowning events than incidents where no rescue was attempted. Rescue intervened drowning fatalities were more likely to occur in pools and less likely to occur in oceans and rivers compared to non-intervened drowning incidents. Drowning events where a rescue was attempted were more likely to occur in urban environments and in the warmer months (May-September).

Table 8: Characteristics of bystander rescue intervened and non-intervened drowning in Canada 2005-2012.

	Total No. (%)	Bystander Rescue Attempted No. (%)	No Rescue Attempted No. (%)	Significance
Total	3137 (100.0)	1460 (100.0)	1677 (100.0)	
Age of victim				P < 0.001
<5	162 (5.2)	154 (10.6)	8 (0.5)	
5-14	139 (4.4)	106 (7.3)	33 (2.0)	
15-19	220 (7.0)	94 (6.4)	126 (7.5)	
20-34	757 (24.1)	329 (22.5)	428 (25.5)	
35-64	1326 (42.3)	552 (37.8)	774 (46.2)	
65+	531 (16.9)	224 (15.4)	307 (18.3)	
Sex of victim				P < 0.001
Male	2570 (81.9)	1133 (77.6)	1437 (85.7)	
Female	567 (18.1)	327 (22.4)	240 (14.3)	
Province				P < 0.001

AB	248 (7.9)	96 (6.6)	152 (9.1)	
BC	454 (14.5)	219 (15.0)	235 (14.0)	
MB	154 (4.9)	51 (3.5)	103 (6.1)	
NB	81 (2.6)	27 (1.8)	54 (3.2)	
NL	135 (4.3)	39 (2.7)	96 (5.7)	
NS	100 (3.2)	38 (2.6)	62 (3.7)	
ON	1126 (35.9)	547 (37.5)	579 (34.5)	
PE	10 (0.3)	5 (0.3)	5 (0.3)	
QC	598 (19.1)	350 (24.0)	248 (14.8)	
SK	139 (4.4)	55 (3.8)	84 (5.0)	
Territories	92 (2.9)	33 (2.3)	59 (3.5)	
Body of water				P < 0.001
Ocean	281 (9.0)	95 (6.5)	186 (11.1)	
Lake or pond	1199 (38.2)	579 (39.7)	620 (37.0)	
River or stream	875 (27.9)	327 (22.4)	548 (32.7)	
Bathtub	323 (10.3)	140 (9.6)	183 (10.9)	
Pool	212 (6.8)	193 (13.2)	19 (1.1)	
Other	246 (7.8)	125 (8.6)	121 (7.2)	
Urban vs. rural				P = 0.003
Urban	1856 (59.2)	905 (62.0)	951 (56.7)	
Rural	1270 (40.5)	553 (37.9)	717 (42.8)	
Time of year				P < 0.001
Summer	2074 (66.1)	1104 (75.6)	970 (57.8)	
Rest of Year	976 (31.1)	354 (24.2)	622 (37.1)	
Unknown	87 (2.8)	<5	85 (5.1)	
Type of activity				P < 0.001
Aquatic	782 (24.9)	571 (39.1)	211 (12.6)	
Bathing	319 (10.2)	138 (9.5)	181 (10.8)	
Boating	787 (25.1)	305 (20.9)	482 (28.7)	
Other transportation	451 (14.4)	164 (11.2)	287 (17.1)	
Non Aquatic	646 (20.6)	272 (18.6)	374 (22.3)	
Unknown	152 (4.8)	10 (0.7)	142 (8.5)	
Purpose of activity				P < 0.001
Recreational	1929 (61.5)	1058 (72.5)	871 (51.9)	
Daily living	773 (24.6)	290 (19.9)	483 (28.8)	
Occupation	144 (4.6)	52 (3.6)	92 (5.5)	
Attempted rescue	65 (2.1)	45 (3.1)	20 (1.2)	
Unknown	226 (7.2)	15 (1.0)	211 (12.6)	
Accompaniment				P < 0.001
Alone	1528 (48.7)	505 (34.6)	1023 (61.0)	
With others	1465 (46.7)	875 (59.9)	590 (35.2)	
Unknown	144 (4.6)	80 (5.5)	64 (3.8)	
Alcohol involvement by companions*				P < 0.001
Alcohol involved	470 (30.1)	213 (23.2)	257 (40.0)	
No alcohol involved	581 (37.2)	389 (42.4)	192 (29.9)	
Unknown	509 (32.6)	316 (34.4)	193 (30.1)	
Alcohol involvement by decedent				P < 0.001
Alcohol involved	1116 (35.6)	426 (29.2)	690 (41.1)	
No alcohol involved	1679 (53.5)	869 (59.5)	810 (48.3)	
Unknown	342 (10.9)	165 (11.3)	177 (10.6)	
Number of drowning persons				P < 0.001
Single victim incident	2696 (85.9)	1308 (89.6)	1388 (82.8)	
Multiple victim incident	441 (14.1)	152 (10.4)	289 (17.2)	

Ice conditions				P < 0.001
Ice conditions present	208 (6.6)	98 (4.9)	149 (8.5)	
No ice	2786 (88.8)	1843 (92.4)	1493 (85.0)	
Unknown	143 (4.6)	33 (2.3)	110 (6.6)	
Light conditions				P < 0.001
Light	1594 (50.8)	961 (65.8)	633 (37.7)	
Twilight	149 (4.7)	81 (5.5)	68 (4.1)	
Dark	541 (17.2)	179 (12.3)	362 (21.6)	
Unknown	446 (14.2)	38 (2.6)	408 (24.3)	
Water depth				P < 0.001
Bathtub/ditch	319 (10.2)	138 (9.5)	181 (10.8)	
0-1 meter	297 (9.5)	162 (11.1)	135 (8.1)	
1.1-2.5 meters	366 (11.7)	247 (16.9)	119 (7.1)	
> 2.5 meters	735 (23.4)	353 (24.2)	382 (22.8)	
Unknown	1420 (45.3)	560 (38.4)	860 (51.3)	
Distance from safety				P < 0.001
Bathtub/ditch	319 (10.2)	138 (9.5)	181 (10.8)	
0-2 meters	623 (19.9)	328 (22.5)	295 (17.6)	
2.1-25 meters	343 (10.9)	218 (14.9)	125 (7.5)	
26-50 meters	139 (4.4)	87 (6.0)	52 (3.1)	
>50 meters	359 (11.4)	155 (10.6)	204 (12.2)	
Unknown	1354 (43.2)	534 (36.6)	820 (48.9)	

*Relevant cases only n=1560 (victim was accompanied by companions at the time of the incident)

Compared to drowning incidents where a lay bystander rescue was not attempted, rescue intervention was more likely to occur during aquatic activities where the drowning person had intended to be in the water at the time of the incident, and the purpose of the activity was more likely to be recreational. Rescue interventions were more likely to occur when the drowning person was accompanied, and when it was a single victim drowning event, as opposed to more than one person drowning at the same time. In cases where the drowning person was accompanied by companions, companions were less likely to have consumed alcohol in rescue intervened drowning events compared to incidents where no rescue was attempted, however this information was missing from one third of all relevant files. The drowning person was also less likely to have consumed alcohol in rescue intervened drowning events than those where no rescue was attempted. Compared with non-intervened incidents, bystander rescues were less likely to occur when ice conditions were present. Light conditions, water depth and distance

from safety all differed in rescue intervened drowning cases as compared to those with no intervention, however this information was missing in a large proportion of the files.

Unadjusted associations between rescue intervened drowning incidents and potential characteristics are shown in the first two columns of **Table 9**. At the bivariate level, significant differences were noted across all variables; age, sex, province, body of water, urban versus rural incident location, time of year, type of activity, purpose of activity, accompaniment, number of drowning persons, and ice conditions. In the multivariable logistic regression model (n=3137), age and sex of the drowning victim, province, type of body of water, type of activity, accompaniment, and number of drowning persons were all significant characteristics of rescue intervened drowning incidents when compared to non-intervened events. Adjusted associations are shown in the third and fourth column of **Table 9.**

Table 9: Unadjusted and adjusted associations between characteristics and rescue intervened drowning incidents.

	Unadjusted OR	95% CI	Adjusted OR	95% CI
Age of decedent				
<5	**26.99**	**13.15-55.40**	**21.46**	**9.91-46.51**
5-14	**4.50**	**3.00-6.76**	**2.45**	**1.51-3.98**
15-19	1.05	0.78-1.40	0.71	0.50-1.01
20-34	1.08	0.90-1.29	**0.76**	**0.61-0.95**
35-64	1.00		1.00	
65+	1.02	0.83-1.26	0.99	0.77-1.26
Sex of decedent				
Male	1.00		1.00	
Female	**1.73**	**1.44-2.08**	**1.92**	**1.50-2.46**
Province				
AB	**0.67**	**0.51-0.89**	0.70	0.49-1.01
BC	0.99	0.79-1.23	1.29	0.98-1.71
MB	**0.52**	**0.37-0.75**	**0.51**	**0.33-0.81**
NB	**0.53**	**0.33-0.85**	0.59	0.33-1.06
NL	**0.43**	**0.29-0.64**	0.61	0.37-1.01
NS	**0.65**	**0.43-0.99**	0.60	0.36-1.03
ON	1.00		1.00	
PE	1.06	0.31-3.68	0.72	0.15-3.44
QC	**1.49**	**1.22-1.83**	**1.74**	**1.36-2.23**

SK	**0.69**	**0.48-0.99**	**0.58**	**0.37-0.91**
Territories	**0.59**	**0.38-0.92**	0.94	0.55-1.61
Body of water				
Ocean	**0.55**	**0.42-0.72**	0.90	0.61-1.33
Lake or pond	1.00		1.00	
River or stream	**0.64**	**0.53-0.76**	**0.61**	**0.49-0.77**
Bathtub	0.82	0.64-1.05	1.92	0.46-7.96
Pool	**10.86**	**6.69-17.63**	**7.26**	**4.09-12.89**
Other	1.1	0.84-1.45	**1.45**	**1.01-2.06**
Urban vs. rural				
Urban	**1.23**	**1.07-1.42**	0.92	0.75-1.13
Rural	1.00		1.00	
Time of year				
Summer	**2.00**	**1.71-2.34**	1.23	0.99-1.54
Rest of Year	1.00		1.00	
Type of activity				
Aquatic	**4.28**	**3.46-5.29**	**2.54**	**1.96-3.30**
Bathing	1.21	0.93-1.57	0.91	0.22-3.76
Boating	1.00		1.00	
Other transportation	0.90	0.71-1.15	1.34	0.93-1.93
Non Aquatic	1.15	0.93-1.42	1.04	0.77-1.41
Purpose of activity				
Recreational	1.00		1.00	
Daily living	**0.49**	**0.42-0.59**	0.90	0.66-1.23
Occupation	**0.47**	**0.33-0.66**	1.02	0.67-1.57
Attempted rescue	**1.85**	**1.09-3.16**	1.65	0.89-3.03
Accompaniment				
Alone	1.00		1.00	
With others	**3.00**	**2.59-3.49**	**5.67**	**5.40-7.16**
Number of drowning persons				
Single victim incident	**1.79**	**1.45-2.21**	**3.39**	**2.59-4.44**
Multiple victim incident	1.00		1.00	
Ice conditions				
Ice conditions present	**1.96**	**1.45-2.64**	1.48	0.96-2.28
No ice	1.00		1.00	

When compared to 35-64 year-olds, the odds of rescue intervention in fatal drowning incidents was 26.99 times (95% CI: 13.15-55.40) higher among children under the age of 5 and 4.50 times (95% CI: 3.00-6.76) higher among children 5-14 years of age. Although the majority of drowning fatalities occurred among men in both rescue intervened and non-intervened drowning incidents, the odds of rescue intervention was twice (OR 1.92, 95% CI: 1.50-2.46) as high among female drowning victims.

Compared to Ontario, the odds of rescue intervention occurring was lower in Manitoba (OR 0.51, 95% CI: 0.33-0.81), and Saskatchewan (OR 0.58, 95% CI: 0.37-0.91) and higher in Quebec (OR 1.74, 95% CI: 1.36-2.23). Characteristics of rescue intervened incidents also differed by body of water. Compared to a lake or pond, the odds of bystander rescue intervention was 7.26 times (95% CI: 4.09-12.89) higher when the drowning occurred in a pool and 39% (95% CI: 0.49-0.77) lower when the drowning occurred in a river.

When compared to boating related activities, the odds of rescue intervention was 2.54 times (95% CI: 1.96-3.30) higher during aquatic activities, where the drowning person had intended to be in the water at the time of the incident. The odds of lay rescue intervention was 5.67 times (95% CI: 5.40-7.16) higher when the drowning person was accompanied at the time of the incident and 3.39 times (95% CI: 2.59-4.44) higher when it was a single victim incident as opposed to multiple people drowning at one time.

In 71 cases, a person drowned while attempting to rescue someone else who was in distress, and died during the attempt. The characteristics of incidents where the rescuer him or herself drowned are summarized in **Table 10**. The majority of bystanders who drowned while attempting a rescue were male (85.9%) and were either seniors 65 and older (63.4%), or young adults 20 to 34 years of age (28.2%). The greatest proportion of rescuer fatalities occurred in Ontario and Quebec (66.2%). Rescuer drowning deaths were most likely to occur in a lake or pond (46.5%) or flowing water such as a river or stream (40.8%) and more commonly occurred in urban (62.0%) than rural (38.0%) areas. The majority of incidents that involved a bystander rescuer fatally drowning occurred during the warmer months in Canada (May-September), however 11.3% of rescuers drowned while attempting an ice rescue. Bystander rescue related

drowning incidents most commonly occurred during daylight hours (85.9%) and 31.0% of the deceased rescuers had consumed alcohol prior to attempting the rescue.

Detailed information related to the distressed person who the rescuer was attempting to save when they drowned was only available for the most recent two years of the study period (n=14). In all of these cases, the rescuer and the drowning person knew each other prior to the incident and in over half (57%) of these incidents, the distressed person that the rescuer was attempting to save survived the incident.

Table 10: Characteristics of rescuers who drowned while attempting to rescue another person.

	No.	Percent (%)
Total	71	100.0
Age		
0-19	<5	
20-34	20	28.2
35-64	<5	
65+	45	63.4
Sex		
Male	61	85.9
Female	10	14.1
Province		
Western (British Columbia, Alberta, Saskatchewan, Manitoba)	15	21.1
Central (Ontario, Quebec)	47	66.2
Atlantic (New Brunswick, PEI, Nova Scotia, Newfoundland and Labrador)	7	9.9
Northern (Yukon, Northwest Territories, Nunavut)	<5	
Body of Water		
Ocean	5	7.0
Lake or Pond	33	46.5
River	29	40.8
Pool	<5	
Other	<5	
Time of Year		
Summer	57	80.3
Rest of year	14	19.7
Urban vs. rural		
Urban	44	62.0
Rural	27	38.0
Alcohol involvement		
Alcohol involved	22	31.0
No alcohol involved	29	40.8
Unknown	20	28.2
Ice conditions		

Ice conditions present	8	11.3
No ice	60	84.5
Unknown	<5	4.2
Light conditions		
Light	61	85.9
Twilight/Dark	7	9.9
Unknown/Indoor Incident	<5	4.2

4.4 Discussion

This study investigated the characteristics of bystander rescue intervention using the information available from post-mortem records on fatal drowning incidents that occurred in Canada. The findings indicate that although lay bystander rescue intervention is quite common, in over one third (35%) of the drowning events where no rescue was attempted, there were bystanders present at the time of the incident who did not act. Moreover, when bystanders did intervene, the most common rescue type was a contact rescue, which involves direct physical contact with the drowning person, resulting in the highest risk to the rescuer. A tragic outcome of this is that 71 bystanders fatally drowned while attempting to rescue another person.

Multivariable logistic regression revealed that the characteristics of drowning incidents where a lay bystander rescue attempt occurred differed from those where no rescue was attempted. Significant factors associated with rescue intervened drowning events were age and sex of the drowning victim, province, body of water, type of activity, accompaniment, and number of drowning victims involved in the incident. The increased odds of rescue intervened drowning events involving children are congruent with a concept published by Franklin & Pearn (2011) called the aquatic-victim-instead-of-rescuer (AVIR) syndrome. The authors define the AVIR syndrome as involving an altruistic and instinctive impulse of an adult, usually a parent or relative, to save a drowning child. The instinctive nature of this response poses a challenge for

the promotion of safe, non-contact rescue strategies. However, understanding what circumstances prompt a lay bystander to intervene in a drowning event may lead to the creation of targeted strategies to increase the frequency of safe intervention by bystanders in drowning events. This could lead to improved outcomes for the drowning person and reduce the risk to the rescuer.

Further investigation into the characteristics affecting lay bystander rescue intervention identified in this study is warranted. Specifically, understanding why the odds of bystander rescue intervention differed by province, was higher in pools and lower in rivers, and was higher when the victim had been engaged in an aquatic activity, may enable practitioners to improve the safety of rescue interventions under these circumstances, and increase the frequency of safe interventions in settings where they were less common. For example, one possible explanation for the findings of this study is that rescue equipment may be more regularly available at pools. Equipment has been proven to reduce the effort necessary to rescue a drowning victim and to reduce risk to the rescuer (Michniewicz, Walczuk, & Rostkowska, 2008). Increasing the availability of rescue equipment in other settings may increase the frequency of safe bystander rescue intervention. Rescue equipment is further discussed later in this chapter.

The increased odds of bystander rescue intervention in incidents where the drowning person was accompanied is congruent with Venema et al.'s (2010) finding that many bystanders are willing to intervene when they witness a drowning event. However, many of these rescues involved a high-risk contact rescue, which confirms that there is a need for improved bystander rescue related education strategies. The fact that the odds of bystander rescue intervention was lower when multiple people were drowning at the same time indicates that drowning prevention

strategies focused on bystander rescue intervention should include instruction related to safely intervening in a multiple victim drowning incident.

Creating public awareness can be a powerful tool for making progress in drowning prevention. Several groups such as lifesaving societies, injury prevention committees and other non-governmental organizations have been active in strengthening public awareness related to drowning prevention. Together, such groups have educated communities on water safety and the specific risk factors related to drowning (WHO, 2014). Moreover, long-term declines in drowning in a number of countries are associated with the establishment and community actions of lifesaving societies (WHO, 2014).

In Canada, public awareness activities and community based actions related to drowning have typically focused on primary or pre-event prevention. The Lifesaving Society, The Canadian Red Cross, Parachute Canada, The Canadian Safe Boating Council and other injury prevention groups have launched campaigns related to ice safety, effective supervision of children in and near the water, boating safety and the importance of wearing a lifejacket, infant and child bath safety, and backyard pool safety (Canadian Red Cross, 2016b; Canadian Safe Boating Council n.d.; Lifesaving Society, 2012b; Parachute Canada, n.d.). Additionally, several groups advocate for Canadians to be trained and prepared to deliver post-event treatment measures such as Cardio Pulmonary Resuscitation (CPR) (Canadian Red Cross, 2016c: Heart & Stroke, 2016; Lifesaving Society, 2012c; St. John Ambulance, 2016). Public education campaigns have encouraged lay rescuers who observe an unconscious person and are not trained to deliver high-level medical care to call 911 and administer compression only (hands only) CPR with easy to remember slogans such as “push hard, push fast” (Heart & Stroke, 2016). However,

there is a paucity of education initiatives related to secondary (during the injury event) prevention in drowning incidents such as safe rescue intervention.

It has been suggested that empowering all people with basic, safe (non-contact) rescue skills may be a solution to reduce the incidence of deaths to rescuers (Franklin & Pearn, 2014). Moreover, by attempting a safe rescue, bystanders can make a critical difference in the survival of a drowning person (Claesson et al., 2014; Grmec et al., 2009; Marchant et al., 2008; Venema et al., 2010). The results of this study indicated that even when bystanders witness a drowning event, they do not always attempt a rescue, and when they do, it is often a high-risk contact rescue. Educating the Canadian public on the importance of attempting a safe, non-contact rescue, and equipping them with the knowledge and skills required to achieve this may reduce the incidence of rescuer fatalities and may also improve the chances of survival for persons who are drowning. A recent study reported the results of an intervention aimed at educating participants in a family water safety program on safe rescue. Analysis of post-intervention surveys suggested that knowledge of safe bystander rescue techniques and protocols improved as a consequence of participation in the program (Moran, Webber, & Stanley, 2016). Further research is needed to establish an effective intervention that would reach a greater proportion of the public, especially individuals who are most likely to witness a drowning incident.

The use of rescue equipment reduces risk to the rescuer by either preventing the rescuer from having to enter the water, or increasing buoyancy to assist with an in-water rescue (Thompson & Wooler, 2014). The types of rescue equipment that are most commonly made available to bystanders are those that prevent the rescuer from having to enter the water; reach rescue aids, throw lines or throw bags, and life rings. A reach rescue aid, such as a pole, can be used by a rescuer to stay on land and reach out to the drowning victim without direct contact. A

throw line or throw bag is a simple device that allows a bystander to remain on land and throw one end of a rope out to the drowning person. A life ring often accompanies a throw line. The buoyant ring is thrown into the water, close to the victim (Thompson & Wooler, 2014).

In the case of public pools and spas in Canada, legislation requires that rescue equipment is provided and maintained. In Ontario for example, all public pools, including apartment building and hotel pools, must provide a conveniently located reaching pole and two buoyant throwing aids with securely attached rope (Ontario Regulation 565, 1990). This may, in part, contribute to the findings from this study that attempted rescues were far more likely to occur in pools, and that few rescuers fatally drowned in pools. The Lifesaving Society (2002; 2011a; 2011b) has released guidelines for other bodies of water such as private backyard pools and waterfronts that recommend rescue equipment be provided, however there is currently no legislation in place to support these guidelines. While rescue equipment can be found at some public waterfronts in Canada, this equipment may not always be well maintained, and there are several popular aquatic locations where there is no rescue equipment at all. Creating policies that mandate the provision of rescue equipment for public use at all public access waterfront areas may increase the frequency of safe bystander intervention in drowning events as well as decrease the risk of fatal drowning for rescuers.

Strengths and Limitations. This is the first study in Canada to examine bystander rescue interventions and to describe the characteristics of bystanders who fatally drowned while attempting to rescue another person. There are several limitations that should be considered. As with all drowning studies that use coronial data, there is a potential for information bias caused by the proxy respondent nature of reporting on drowning deaths. Coroners and police officers rarely witness the drowning event that they are reporting on, and must rely on witness statements

for information, including details related to bystander rescue intervention. Unless the bystander fatally drowned, the Drowning Prevention Research Centre did not collect data on the age and sex of the bystander who attempted to rescue the decedent. This information would be valuable for designing targeted drowning prevention strategies.

Another limitation of using post-mortem data is that only unsuccessful rescues were included. Any non-fatal drowning incidents where bystander rescue intervention occurred and both the rescuer and the drowning person survived were not included in this data source. Therefore, part of the picture is missing when it comes to bystander rescue intervention in Canada. Additionally, due to the resulting lack of denominator data, the risk of fatal drowning while attempting to rescue another person cannot be reported. Nevertheless, the results from this study make an important contribution to the relatively under-researched area of lay bystander rescue. Further, this is the first study of its kind to be conducted in Canada, and the results suggest that drowning prevention interventions may need to expand their focus to include secondary prevention strategies such as teaching basic, safe rescue techniques to the Canadian population.

4.5 Conclusion

Bystander intervention plays a critical role in the survival of a drowning person. Retrospective analysis of fatal drowning incidents in Canada revealed that when present, bystanders often intervened with a high-risk, contact rescue, or did not intervene at all. Current drowning prevention initiatives in Canada should expand to include secondary prevention strategies such as educating the public on safe rescue techniques and creating policies to ensure adequate equipment is provided to assist with non-contact rescues. The characteristics of

drowning events where a rescue intervention did occur differed from those in which a rescue was not attempted. Further investigation into the circumstances that motivate a lay bystander to intervene in a drowning event may inform the development of secondary prevention interventions targeted at safe bystander rescues. Moreover, promoting the use of basic, safe rescue techniques among lay bystanders who come across a drowning person may reduce the devastating and preventable outcome of bystanders fatally drowning while attempting to rescue a drowning person.

Chapter Five: Municipal Fencing Legislation and Private Backyard Pool Drowning Deaths in Ontario

Overview

This chapter contributes to the overall objective of the thesis by addressing gaps in our understanding of drowning prevention at the local level. Private backyard pools are the most common setting for child drowning in Ontario. This study provides an analysis of the role of perimeter versus isolation fencing in backyard pool drowning deaths among children under 5 years of age, and summarizes the current requirements of municipal pool enclosure legislation in Ontario. The primary contribution of this study is that it provides evidence that all municipalities should enact pool enclosure bylaws that require four-sided, isolation fencing for all new and existing in-ground and above-ground pools.

Summary

Introduction: Private backyard pools are consistently the most common setting where children under 5 years of age drown in Canada, yet no research on the impact of pool fencing and municipal bylaws on the risk of childhood drowning in Canada has been published.

Objective: (1) To examine the association between isolation fencing bylaws and the incidence of fatal drowning in private backyard pools in Ontario; and (2) to describe the epidemiology of private backyard pool drowning deaths among children in Ontario.

Method: Individual level descriptive analysis was performed using data collected from files at the Ontario Provincial Coroner's office for all children under the age of 5 who suffered a drowning death in a private backyard pool over a fifteen-year period, 1999-2013. Municipal pool enclosure bylaws were reviewed and drowning death rates were calculated and compared across Ontario municipalities.

Results: During the study period, 54 children under the age of 5 drowned in a private backyard pool in Ontario. The highest death rate was found among 2-year-olds (0.9 per 100,000) and the male to female ratio was 3.5:1. The majority of children (61%) drowned after accessing an unobstructed pool directly from the residence. Less than 1% of the 414 local municipalities in Ontario enacted the recommended pool enclosure legislation during or since the study period.

Conclusions: All municipalities, especially those in Southern Ontario, should enact pool enclosure bylaws that require four-sided, isolation fencing with self-closing, self-latching gates for all new in-ground and above-ground pools, as well as the retrofitting of existing pools.

5.1 Introduction

The majority (75%) of drowning fatalities in Canada occur in natural bodies of water; however private backyard pools are consistently the most common setting where children under 5 years of age drown (Clemens, Tamim, Rotondi, & Macpherson, 2016). In the summer of 2010 in the province of Ontario alone, 8 children under the age of 5 drowned in a private backyard pool (OCC Ontario, 2011). Pool fencing is a passive environmental intervention designed to prevent drowning in this age group. The World Health Organization's (WHO) *Global report on drowning* identifies ten actions to prevent drowning. The first of these is to install barriers controlling access to water. Among other recommendations, the WHO suggests installing four-sided, isolation fencing, with self-closing and self-latching gates, as well as enacting legislation to support this measure (WHO, 2014).

A number of studies conducted primarily in Australia and the United States have provided evidence that pool fencing reduces the risk of drowning among children (Blum & Shield, 2000; Pitt & Balanda, 1991; Stevenson, Rimajova, Edgecombe, & Vickery, 2003). Additionally, studies have examined whether the type of fence has implications for drowning prevention. In particular, isolation versus perimeter fencing, how easily a fence can be climbed, and presence of a self-closing gate have all been examined (Fergusson & Horwood, 1984; Intergovernmental Working Party on Swimming Pool Safety, 1988; Pitt & Balanda, 1991; Rabinovich, Lerner, & Huey, 1994). A meta-analysis of available studies conducted by Thompson and Rivara (2010) found the odds ratio (OR) for drowning in a fenced versus unfenced pool to be 0.29 (95% CI: 0.16-0.55), and the OR for isolation fencing versus perimeter fencing to be 0.17 (95% CI: 0.07-0.44); suggesting the protective effects of fencing in general, and isolation fencing in particular.

In a drowning review conducted in 2011, the Office of the Chief Coroner for Ontario published a number of recommendations including that all municipalities in the Province of Ontario should pass pool enclosure municipal bylaws that mandate barrier safety requirements for new pools as well as retrofitting for existing pools (OCC Ontario, 2011). This review only included drowning deaths that occurred during the summer months of 2010. No long term analysis of pool fencing and/or enclosure bylaws as a factor affecting the risk of childhood drowning in Canada has been published.

Drowning is a leading cause of death among children in Canada and private backyard pools are the most common setting where children in this age group drown. Given that many of the Canadian backyard pool drowning fatalities occur in Ontario, the most populous province, and that studies from other countries have proven isolation pool fencing reduces the risk of drowning in private backyard pools, it is not surprising that the Office of the Chief Coroner for Ontario released the 2011 recommendation that all municipalities in the province should pass isolation pool enclosure bylaws. However, this was only a recommendation, there is no legal obligation for municipalities to change their pool fencing bylaws. The primary objective of this study was to examine the association between isolation fencing bylaws and the incidence of fatal drowning in private backyard pools in Ontario. The secondary objectives were to (1) describe the epidemiology of private backyard pool drowning deaths among children in Ontario; (2) understand how the children accessed the pool prior to the drowning incident; and (3) examine the enclosure bylaws that were in place in the municipality where the drowning occurred.

5.2 Methods

5.2.1 Study Population and Design. Retrospective data analysis was conducted using data collected from files available at the Office of the Chief Coroner for Ontario. The study population consisted of all children under the age of 5 who suffered a drowning death in a private backyard pool over a fifteen-year period (January 1, 1999 – December 31, 2013) in Ontario. All subjects were identified by querying the Ontario Coroner's database. Deaths were classified as a private backyard pool drowning and data were collected if drowning was included as a cause of death in the coroner's report, based on the autopsy or other findings, and the aquatic setting of the incident was a private backyard pool. Private backyard pools were defined as all single unit residence outdoor pools including: in-ground, above-ground – fixed installation, and above-ground – wading type pool.

Our original intention was to use a multi-level ecologic study design where the drowning death rate in municipalities with fence and gate legislation would be compared to that in municipalities with less strict legislation and no legislation. With this goal, municipalities were grouped into one of three groups depending on the requirements of their pool enclosure legislation during the study period. Municipalities that required four-sided isolation fencing were grouped into the "recommended legislation group", meaning the bylaws in that municipality met the requirements that were recommended by the Chief Coroner for Ontario. Those that required three-sided perimeter fencing were grouped into the "less legislation group". Each municipality was included in either the "recommended legislation" or "less-legislation" group the year after the by-law came into effect in that municipality. A "no-legislation" group included all municipalities that did not have pool enclosure by-laws in place, as well as the other municipalities in the years before the by-law was enacted. For example, the municipality of

Toronto had three-sided perimeter fencing bylaws in place from the start of the study period until 2010, and was thus grouped into the "less legislation group" for those years. In 2010, Toronto enacted isolation fencing bylaws, and was thus included in the "recommended legislation group" for study years 2011 to 2013.

5.2.2 Data Collection. Data on backyard pool drowning incidents were collected using a questionnaire with 15 questions (APPENDIX B). Data sources included all documents found in the coroner's file of each identified victim. These documents included the coroner's investigation statement, police report, and hospital records. The photographs and diagrams contained within the coroner's file were used to verify written documentation. Paper questionnaires filled out at the coroner's office were converted to electronic format for analysis. Data entry was completed with appropriate quality control, including double entry and compare. All data were kept completely confidential. Participant names were not extracted from the coroner files. All collected data were encrypted and stored on a password protected laptop. To ensure anonymity, cell sizes less than 5 are not reported and death rates are reported by upper-tier municipality or census division rather than local municipality.

Data on municipal pool enclosure bylaws were obtained through internet searches. In instances where the bylaw was not available online or clarification was required, municipalities were contacted directly through email and/or telephone.

5.2.3 Measures. The primary outcome measure in this study was unintentional fatal drowning that occurred in a private backyard pool in the province of Ontario. Analysis was performed on age and sex, as well as the following incident specific factors: type of private pool categorized as in-ground, above-ground – fixed installation, or above-ground – wading type

pool; link to home which identifies whether or not the pool was directly linked to the home by a patio or terrace; accompaniment which indicates whether the child was alone or with an adult or other minors at the time of the incident; supervision which identifies whether the child was supervised at the time of the incident and whether or not this supervision was distracted; private pool access which describes how entry to the pool area was achieved; type of fence categorized as no fence present, four sided, or three sided; type of gate categorized as no gate present, gate was both self-closing and self-latching, or gate was neither self-closing nor self-latching, or self-closing, but not self-latching, or self-latching but not self-closing; location of pool which describes whether the child drowned in their own home pool or that of a friend/relative or neighbour; and municipality categorized as recommended legislation, less legislation, and no legislation.

Municipal by-laws were measured based on whether they required four-sided isolation fencing; whether the need for a self-closing, self-latching gate was specified; whether a minimum height of 4 feet was required; whether the bylaw specified that fence construction should inhibit climbing; and whether retrofitting was required for existing pools. Any bylaw that required four-sided isolation fencing was grouped into the "recommended legislation" category. Municipalities with any combination of the remaining specifications were grouped into the "less legislation" category, and municipalities with no pool enclosure bylaw in place were grouped into the "no legislation" category.

5.2.4 Statistical analysis. Drowning death rates were calculated per 100,000 population per year. Denominators for rates were annual estimates of the population under the age of 5 for each municipality. Yearly estimates were obtained from Statistics Canada by census sub-division for the median year of the study (Statistics Canada, 2006b). The census sub-divisions

align with the local municipalities and the estimates provided by Statistics Canada were more complete than those provided by the individual municipalities.

Our original intention was to use Poisson regression methods to estimate relative risks and 95% confidence intervals. Unfortunately, few municipalities had enacted the "recommended legislation" therefore the recommended legislation group was too small to proceed with this method. Instead, univariate analysis was conducted and descriptive statistics were reported to summarize the characteristics of childhood backyard pool drowning deaths. Univariate analysis was also conducted to describe the current requirements of pool enclosure bylaws in Ontario. We then mapped the death rates of children under the age of 5 in Ontario by census division (Statistics Canada, 2006c) using ArcMap v.10.3 (ESRI, 2015). All statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 23 (IBM Corp, 2014).

5.3 Results

During the study period, 54 children died of unintentional drowning in a private backyard pool in Ontario. **Table 11** shows the frequencies, percentages, and death rate per 100,000 population per year for each variable. The highest drowning rates were found among toddler aged children. The average age of the deceased was 2 years and this age group had the highest death rate (0.90/100,000), followed by one-year-olds (0.77/100,000). The youngest decedent in the study was 9 and a half months old. By sex, the highest death rate was found among boys (0.77/100,000), almost 80% of the children who drowned in a private backyard pool were male.

Table 11: Characteristics of private backyard pool drowning deaths among children under five in Ontario.

	No.	Percent (%)	Death Rate per 100,000/year
Total	54	100.0	0.51
Age			
<1	<5		0.10
1	16	29.6	0.77
2	19	35.2	0.90
3	11	20.4	0.51
4	6	11.1	0.28
Sex			
Male	42	77.8	0.78
Female	12	22.2	0.23
Type of Private Pool			
In-ground	27	50.0	0.26
Above-ground – fixed installation	22	40.7	0.21
Above-ground – wading type pool	<5		0.03
Specific type unspecified	<5		0.02
Link to Home			
Linked by patio/terrace	23	42.6	0.22
Not linked	18	33.3	0.17
Not specified	13	24.1	0.12
Type of Fence			
No fence present	5	9.3	0.05
Four-sided fence	9	16.7	0.09
Three-sided fence	29	53.7	0.28
Unknown	11	20.4	0.10
Type of Gate			
No gate present	15	27.8	0.14
Self-closing/latching gate	<5		0.02
Non self-closing/latching gate	14	25.9	0.13
Specific type unspecified	11	20.4	0.10
Unknown	12	22.2	0.11
Access to Private Pool			
Directly from residence	31	57.4	0.29
Through gate in four-sided fence	9	16.7	0.09
Left unattended in pool area (no fence/gate entry)	6	11.1	0.06
Through side gate into immediate area	<5		0.03
By climbing over/under secure fence	<5		0.02
Location of Pool			
Own home	33	61.1	0.31
Relative/friend's home	13	24.1	0.12
Neighbour's home	5	9.3	0.05
Home daycare setting	<5		0.03
Accompaniment			
Alone	42	77.8	0.40
With adult	8	14.8	0.08
With other minors only	<5		0.04
Supervision			
Supervision present but distracted	31	57.4	0.29

No supervision present	23	42.6	0.22
Municipality			
Recommended legislation	<5		0.01
Less legislation	48	88.9	0.46
No legislation	5	9.2	0.05

The majority of the drowning deaths occurred in traditional in-ground pools (50.0%) or permanent above-ground pools (40.7%). The number of drowning fatalities did not differ greatly whether the pool was directly linked to the home by a patio or terrace (42.6%) or not (33.3%) and this information was often not included in the file (24.1%). The most common type of fencing observed in the drowning cases was three-sided perimeter fencing (53.7%). Information on height of fence was often missing from the file and thus not included in analysis. Only 29.6% of the files included information on the height of the fence. Information on type of gate was also often incomplete (42.6% of cases did not specify type of gate), however it was observed that over half (53.7%) of the pools in the study were known to have either no gate present, or a gate that was either not self-closing, not-self latching, or neither.

In terms of how the child accessed the pool, 57.4% of children in the study accessed the pool directly from the residence. Almost two thirds (61.1%) of children drowned in a pool in the backyard of their own home, and another quarter (24.1%) drowned in the backyard of a friend or relative's house. Less than 10% of children drowned in a neighbour's pool. The majority (77.8%) of children were alone at the time of the incident and in 55.6% of cases this was because their supervisors were present but distracted at the time.

There are three different types of municipalities in Ontario, upper-tier municipalities, lower-tier municipalities, and single-tier municipalities. Upper-tier municipalities are regions, counties, or districts that consist of several lower-tier municipalities. Upper-tier municipalities provide services such as: arterial roads, transit, policing, sewer and water systems, waste

disposal, and health and social services. Lower-tier municipalities are cities, towns, townships, or villages that provide local services that are not provided by the upper-tier municipality. Single-tier municipalities include separated municipalities that may be geographically located within or adjacent to an upper-tier municipality, but are not part of that upper-tier municipality for municipal purposes. Single-tier municipalities are responsible for all services to their residents. Lower-tier and single-tier municipalities are referred to collectively as local municipalities. Local municipalities are responsible for enacting and enforcing pool enclosure bylaws.

For example, **Figure 2** is a map of the municipalities in the Greater Toronto Area. Halton, Peel, York, and Durham are examples of upper tier municipalities that are responsible for such services as policing, health, and social services. Within the upper-tier municipality of Halton; Halton Hills, Milton, Burlington, and Oakville are lower-tier municipalities responsible for local services including enacting and enforcing pool enclosure bylaws. City of Toronto is an example of a single-tier municipality responsible for all services, including enacting and enforcing pool enclosure bylaws.

Figure 2: Map of Greater Toronto Area upper-tier, lower-tier, and single-tier municipalities.

Source: Wikimedia Commons (2006)

There are 444 municipalities in Ontario, 30 are upper-tier municipalities and 414 are local municipalities comprised of 241 lower-tier and 173 single-tier municipalities (APPENDIX C). Less than 1% (0.7%) of these 414 local municipalities enacted the recommended legislation during the study period. **Table 12** describes the requirements of the municipal pool enclosure bylaws. The majority of municipalities had enacted pool fencing bylaws that required a self-closing and self-latching gate (81.4%), a minimum height of 4 feet (83.3%), and fence construction that inhibits climbing (65.0%). In less than half (42.8%) of the municipalities, the pool enclosure bylaws included both in-ground and above-ground pools, as opposed to just in-

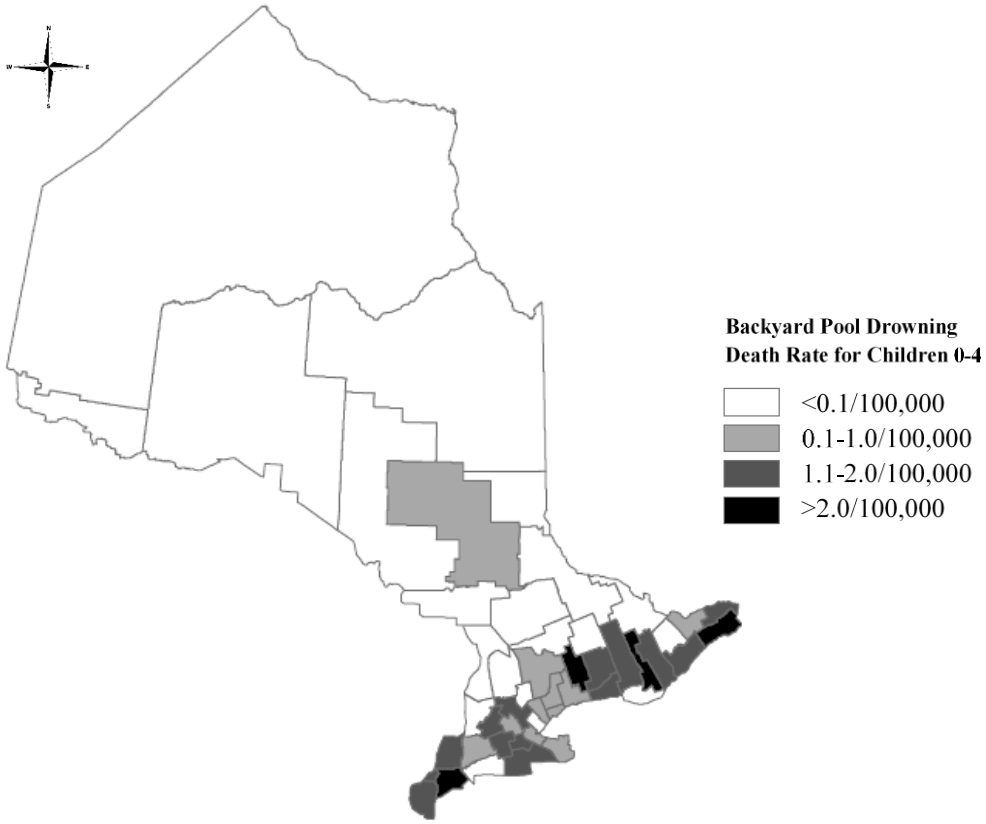
ground pools. Few municipalities (3.4%) required that the pool enclosures of existing pools be retrofitted to comply with the current pool enclosure bylaw.

Table 12: Summary of requirements of existing municipal pool enclosure bylaws in Ontario.

Requirement	**Percent (%)**
Requires four-sided isolation fencing	0.7
Specifies self-closing self-latching gate	81.4
Specifies minimum height of fence 4 feet	83.3
Includes both in-ground and above-ground pools	42.8
Specifies fence construction that inhibits climbing	65.0
Requires retrofitting of existing pools	3.4

Figure 3 displays the death rates per 100,000 population per year by census division. The census divisions map closely to the upper-tier municipalities. Areas with the darkest shading have the highest death rates. The shaded areas are clustered in the urban and sub-urban areas of southern Ontario. None of the local municipalities within the most darkly shaded areas had enacted the recommended legislation. **Table 13** lists the upper-tier municipalities with the highest drowning rates for children under the age of 5 in private backyard pools. For emphasis, none of the local municipalities within the areas listed in this table had enacted the recommended legislation.

Figure 3: Backyard pool drowning death rates among children under 5 years of age in Ontario**.**



Source: Office of the Chief Coroner for Ontario, Drowning Data 1999-2013, Ontario Census Divisions (Statistics Canada, 2006)

Table 13: Top 25 highest private backyard pool drowning death rates for children under 5 by upper tier municipality**.***

Upper Tier Municipality	**Average Death Rate per Year**
Lennox and Addington, Ontario	3.4/100,000
Stormont, Dundas and Glengarry, Ontario	2.4/100,000
Chatham-Kent, Ontario	2.2/100,000
Kawartha Lakes, Ontario	2.1/100,000
Hastings, Ontario	2.0/100,000
Frontenac, Ontario	1.9/100,000
Northumberland, Ontario	1.8/100,000
Brant, Ontario	1.7/100,000
Prescott and Russell, Ontario	1.6/100,000

Perth, Ontario	1.5/100,000
Leeds and Grenville, Ontario	1.4/100,000
Haldimand-Norfolk, Ontario	1.2/100,000
Peterborough, Ontario	1.1/100,000
Essex, Ontario	1.1/100,000
Oxford, Ontario	1.1/100,000
Wellington, Ontario	1.1/100,000
Lambton, Ontario	1.0/100,000
Niagara, Ontario	0.9/100,000
Waterloo, Ontario	0.9/100,000
Sudbury, Ontario	0.8/100,000
Hamilton, Ontario	0.7/100,000
York, Ontario	0.6/100,000
Middlesex, Ontario	0.6/100,000
Simcoe, Ontario	0.6/100,000
Ottawa, Ontario	0.4/100,000

*Death rates should be interpreted with caution due to small sample size

5.4 Discussion

The epidemiology of childhood drowning in private backyard pools in Ontario, Canada reflects the findings of similar studies conducted in Australia (Blum & Shield, 2000; Pearn & Nixon, 1977; Stevenson et al., 2003) and the United States (Morganstern, Bingham, & Reza, 2000). Specifically, that male children are overrepresented among the deceased and that toddler-aged children are at the highest risk of drowning in a private backyard pool. The magnitude of the overrepresentation of boys in this study differs from what has been reported on child drowning in Canada in previous studies. In a study that included all bodies of water and all provinces and territories in Canada, Clemens et al. (2016) reported that the sex difference among drowning fatalities was least pronounced in the under 5 age group, where approximately one third of decedents were female. In this study of backyard pool fatalities only, nearly 8 out of 10 of the children who drowned were male. This may reflect sex differences in the development and exploratory nature of children (Blum & Shield, 2000), or may be indicative of the risk

factors of parental socialization and children's perceptions of injury (Pitrowski & Cameranesi, 2015). Studies have shown that parents tend to socialize male and female children differently; parents are more likely to caution female children from risky behaviours but to encourage male children (Galligan & Kuebli, 2011). Gender differences in children's appraisals of risk and perceptions of injury severity have been shown to influence risk taking behaviours (Pitrowski & Cameranesi, 2015).

Although the greatest proportion (50%) of private backyard pools where children drowned in this study were traditional in-ground pools, the number of drowning deaths that occurred in above-ground pools was greater than what has been reported in studies from other countries. Almost half (46%) of children in this study drowned in an above-ground pool compared to less than one third in Lawson & Oliver's (1978) study (31%) and Blum & Shield's (2000) study (27%). Without reliable data on the prevalence of in-ground and above-ground pools in the different countries it is not possible to deduce anything concrete from this finding, however it is clear that child drowning in above-ground pools is a problem in Ontario, Canada.

In cases where information on the type of fence was recorded in the file, two thirds of the enclosures were three-sided, with the house acting as the fourth side. It is not surprising that the majority of children (22) who drowned in a pool with three-sided fencing accessed the pool directly from the house. Of the 9 children who drowned in a pool with four-sided fencing, 6 accessed that pool through a gate that was not self-closing, not self-latching, or neither. These 28 fatalities may all have been prevented if four-sided, isolation fencing with a self-closing, self-latching gate had been present. Few children (less than 5) drowned after climbing over or under a secured fence. The overwhelming majority of the children in this study drowned in a pool in the backyard of their own home or a relative or friend's home. Few (less than 5) children

drowned in a neighbour's pool. Notably, drowning in a neighbour's pool is the type of incident that three-sided fencing would be more effective in preventing. The fact that over half of the children who drowned had adult supervision at the time of the incident reinforces the need for passive interventions such as isolation fencing and its associated legislation. Children were able to enter the pool area while their supervisors were distracted by such things as another child, the telephone ringing, or household chores, demonstrating that active interventions such as supervision alone are not effective in preventing all child drowning fatalities.

The findings from this study related to type of fence and how the child accessed the pool are similar to those reported by the studies from other countries (Blum & Shield, 2000; Morganstern et al., 2000; Pearn & Nixon, 1977; Stevenson et al., 2003). Children who drowned most commonly accessed the pool unobstructed from their own home or that of a friend or relative. In the years since those studies were published, several regions in Australia and New Zealand have mandated isolation fencing for private swimming pools (Fencing of Swimming Pools Act 1987; Royal Lifesaving Society Australia, n.d; Victorian Building Authority, 2014). In 2011, the Office of the Chief Coroner for Ontario conducted a drowning review and released the recommendation that all municipalities in Ontario should enact isolation fencing bylaws, yet to date, less than 1% of the 414 local municipalities in Ontario have acted on this recommendation. Mapping the private backyard pool drowning rates by census division has demonstrated that the child drowning problem is greatest in the urban and suburban municipalities of Southern Ontario. All local municipalities, but especially those in these areas should enact and enforce the recommended pool enclosure legislation.

Several of the existing pool-enclosure bylaws in Ontario that mandate three-sided perimeter fencing indicate that doors and windows on the wall of the building that makes up the

fourth side of the enclosure must be locked. This should not be considered an alternative to four-sided isolation fencing. As other studies have suggested, door and window locks are unlikely to be effective in preventing toddlers from accessing the pool and drowning, even when the locks themselves are child resistant, because adults may leave them unlocked (Blum & Shield, 2000).

Strengths and limitations. This is the first study to assess the characteristics of private backyard pool drowning deaths in Canada and the first to review the municipal pool enclosure bylaws in all 414 Ontario local municipalities. There are several limitations to this study that must be considered. Due to the proxy respondent nature of reporting on drowning deaths, information bias is a possibility. Coroners and police officers often rely on witness statements to complete their reports. However, wherever possible, objective data sources such as photographs of the scene were used to verify the information in the written documents. Second, some data were missing and could not be obtained through follow up with the sources. As a result of the fact that so few municipalities had enacted the recommended legislation, we were unable to use advanced analysis strategies to demonstrate a lower death rate in municipalities with recommended legislation. However, that so few municipalities have enacted the recommended bylaws is in itself an important finding of this study. Exposure data is needed to calculate the increased risk of drowning in a pool that does not comply with the recommended legislation. Notwithstanding these limitations, this is the first study to examine private backyard pool drowning deaths and the associated municipal legislation in Canada, and the results provide important information for both lawmakers and pool owners in Canada.

5.5 Conclusion

Drowning is among the leading causes of death for children in Canada, and in Ontario 0-4-year-olds are more likely to drown in a private backyard pool than any other body of water. This study demonstrated that children who drowned were most likely to access the pool directly from the residence. Other studies have proven that four-sided isolation fencing reduces the risk of child drowning in private pools. Moreover, the World Health Organization and the Office of the Chief Coroner for Ontario have both released recommendations that all municipalities should enact pool enclosure legislation that requires four-sided, isolation fencing. Despite this, fewer than 1% of municipalities in Ontario have enacted the recommended legislation. Over half of the drowning fatalities observed in this study may have been prevented if four-sided isolation fencing with self-closing, self-latching gates had been in place. All municipalities need to enact pool enclosure bylaws that require four-sided, isolation fencing with self-closing, self-latching gates for all new in-ground and above-ground pools, as well as the retrofitting of existing pools to reduce the devastating impact of childhood drowning in Ontario.

Chapter Six: Discussion

Each of the four preceding chapters in this thesis addresses a gap in our understanding of the epidemiology of drowning at the global, national, or local level. At the global level, mis-categorization of drowning fatalities using ICD-10 codes may contribute to an underestimation of the frequency of drowning worldwide by 25%. Nationally, non-fatal drowning accounts for a greater number of drowning incidents than fatal drowning in Canada each year, and the characteristics of these events differ significantly from those of fatal drowning. Further, although rescue intervention is crucial to the survival of a drowning person, in Canada, bystanders do not always attempt a rescue, and when they do it is often a high risk, contact rescue. These attempted rescues can lead to the rescuer themselves drowning. At the local level, despite evidence to support the effectiveness of isolation pool fencing, and a recommendation from the Office of the Chief Coroner that all municipalities should enact pool enclosure bylaws that mandate four-sided fencing, most Ontario municipalities do not have such bylaws in place. Children under the age of 5 continue to fatally drown as a result of accessing private backyard pools directly from the residence, unobstructed by isolation fencing.

6.1 Strengths

These findings make substantial contributions to the drowning prevention literature. The results presented in Chapter Two and Chapter Three are particularly important from an advocacy perspective. As outlined in the introduction to this thesis, drowning is a leading cause of death, and using the current categorization methods, it results in over two thirds the number of fatalities globally as malaria and over half as many as malnutrition (WHO, 2014). However, drowning does not garner the same level of attention nor have the broad public health initiatives of these

other causes of mortality. The methodological activity of calculating the percent increase in the frequency of drowning using all relevant ICD-10 codes has provided evidence to support amending the standard categorization methods for drowning as one necessary step towards reporting the true global burden of drowning. Reporting an accurate estimate of the mortality rate from drowning that compares in impact to other causes of death may draw greater attention and support for global drowning prevention efforts.

Further, non-fatal drowning is believed to contribute substantially to the total burden of drowning, and the need to obtain more information on the frequency and characteristics of the non-fatal drowning problem has been identified as a priority for drowning prevention research (WHO, 2014). As one of the first studies to use a total population sample (all ages) and include all relevant drowning diagnosis codes (including water transport), the study presented in Chapter Three contributes substantially to this area. Of particular relevance is the finding that serious non-fatal drowning incidents that require medical treatment outnumber deaths from drowning in Canada threefold. An additional strength of this study is the finding that the characteristics of non-fatal drowning incidents differ significantly from those of fatal drowning events. This has important implications for drowning prevention which are described later in this chapter.

The finding that bystanders who witness a drowning event often either do not intervene at all, or put themselves at risk by performing a contact rescue, represents a significant contribution to a relatively unexplored area in drowning research. Chapter Four demonstrates that there is a missing piece in the drowning prevention puzzle in Canada and that lay rescuers need to be trained in basic, safe rescue techniques. Finally, the finding that children who fatally drown in private backyard pools most commonly access the pool unobstructed, directly from the

residence, and that less than 1% of local municipalities have enacted the recommended isolation fencing bylaws, identifies a significant local policy flaw in Ontario.

6.2 Limitations

This research project has a number of limitations which are discussed within each chapter. The limitations are primarily related to the data sources. The WHO Mortality Database used in Chapter Two was limited to countries that report drowning data to the WHO using ICD-10 codes. Several countries therefore, including some with a high burden of drowning, such as the Russian Federation, could not be included in the study. Further, using this data source to explore the magnitude of underestimation in the currently reported frequency of drowning fatalities did not address the issue of underreporting of drowning deaths.

The coronial data used to obtain information on fatal drowning incidents in Chapter Three, Four, and Five contains the potential for information bias caused by the proxy respondent nature of reporting on drowning deaths. Coroners and police officers often rely on witness statements for information on the circumstances of drowning incidents. Given the type of variables used to compare fatal drowning to non-fatal drowning in Chapter Three (age, sex, location, external cause), this limitation is more of a concern in Chapter Four and Five where the details related to bystander rescue intervention, backyard pool access, and fencing information may have been misreported. Another limitation of using coronial data is that cases in the provincial and territorial coroner's and medical examiner's offices can take several years to close, therefore some drowning deaths may have still been under investigation and consequently not included in this body of research.

The non-fatal drowning data extracted from the Canadian Institute for Health Information (CIHI) databases used in Chapter Three were limited in terms of the number of variables that could be analyzed. We did not have access to the robust number of variables available in the fatal drowning data. Examining potential characteristics of non-fatal drowning such as purpose of activity which describes whether the activity was recreational, daily living, occupational or an attempted rescue; alcohol involvement; personal flotation device (PFD) use which describes whether or not a PFD such as a lifejacket was worn at the time of the incident in relevant situations such as boating; accompaniment which measures whether the victim was alone or with others at the time of the incident; and details related to rescue intervention would further inform our understanding of non-fatal drowning in Canada. Moreover, although efforts were made to ensure that cases were not repeated in multiple groups, it was not possible to confirm that the non-fatal groups and the fatal group were completely mutually exclusive due to de-identification of the data across all databases used in Chapter Three.

It is important to note that while the studies that comprise this thesis address gaps in our understanding of the epidemiology of drowning at the global, national, and local level, these are not the only gaps in the drowning literature. In particular, this thesis did not address the paucity of information on drowning risk and interventions for vulnerable populations in Canada, including Indigenous peoples and new immigrants, or the disparities in drowning risk for populations of low socio-economic status in all areas of the world.

6.3 Context

The findings reported in this thesis can be interpreted in the context of other drowning prevention research. The results presented here either provide evidence to support widely held

beliefs that were previously unproven, or in cases where some evidence did exist, are generally in agreement with previous research. In particular, this thesis provides evidence to support the pervasive view that the current categorization methods used to report on drowning deaths are contributing to an underestimation of the global burden of drowning (Linnan et al., 2012; WHO, 2008; WHO, 2014) and that the incidence of non-fatal drowning exceeds that of fatal drowning and contributes substantially to the total burden from this injury type (Brenner, 2003; Layon & Modell, 2009; Moon & Long, 2002; Onyekwelu, 2009; Suominen, & Vahatalo, 2012; Wallis, Watt, Franklin, Nixon, & Kimble, 2015; Weinstein & Krieger, 1996).

In the few studies that had examined the characteristics of non-fatal drowning (CDC, 2004; Felton, Myers, Liu, & Winders Davis, 2015; Jensen, Williams, Thurman, & Keller,1992; Moran, 2010; Pearn, 1979; Quan, Gore, Wentz, Allen, & Novack, 1989; Ross, Elliott, Lam, & Cass, 2003; Wallis et al., 2015; Williamson & Schmertmann, 2002), limited evidence indicated that the characteristics of non-fatal incidents may differ from those of fatal incidents. In particular, differences were reported in the proportion of male versus female victims, as well as the type of body of water where incidents were most likely to occur. Consistent with this, the results presented in Chapter Three of this thesis identified significant characteristics of non-fatal drowning across age, sex, province, urban versus rural residence location, and external cause.

From the perspective of recommendations for prevention, findings from this research project confirmed those of previous studies at both the national and local level. The results from the bystander rescue study in Chapter Four confirmed Franklin & Pearn's (2014) suggestion that all people should be empowered with basic, safe rescue skills. Further, the results reported in Chapter Five are consistent with those reported by previous studies of child drowning in private backyard pools in other countries (Blum & Shield, 2000; Morganstern, Bingham, & Reza, 2000;

Pearn & Nixon, 1977; Stevenson, Rimajova, Edgecombe, & Vickery, 2003). In the years since those studies were published, several regions in Australia and New Zealand have mandated isolation fencing for private swimming pools (Fencing of Swimming Pools Act 1987; Royal Lifesaving Society Australia, n.d.; Victorian Building Authority, 2014). In contrast, the review of pool enclosure legislation in this study identified that less than 1% of the 414 local municipalities in Ontario had enacted appropriate legislation, despite the evidence from other countries and a recommendation from the Office of the Chief Coroner for Ontario.

6.4 Implications for Prevention

The findings of this body of research have important implications for drowning prevention. The four primary implications are: 1) all drowning related ICD-10 codes should be included in official estimates; 2) drowning prevention interventions should expand their focus to include the risk factors associated with non-fatal drowning; 3) secondary drowning prevention strategies related to bystander rescue interventions are needed; 4) all municipalities in Ontario should enact pool enclosure bylaws that mandate isolation pool fencing for new and existing pools.

Global drowning estimates. Findings from this thesis indicate that the estimated global drowning death toll may be at least 25% higher than currently reported. This has important implications for drowning prevention advocacy. Reporting a more accurate estimate of the global burden of drowning that is substantially higher than what is currently identified may garner more political attention and support for drowning prevention efforts at both the global and local level.

Non-fatal drowning prevention. The results of this research indicate that fatal drowning is only a part of the drowning problem in Canada. Non-fatal drowning contributes

substantially to the burden of drowning and non-fatal drowning incidents that require medical care are more frequent than drowning deaths. Historically, Canadian drowning prevention efforts have used fatal drowning data to determine their public education strategies and community initiatives (Canadian Red Cross, 2016a; Lifesaving Society, 2012a). The epidemiological characteristics of non-fatal drowning differ significantly from those of fatal drowning. To prevent all drowning, including incidents that do not result in death, drowning prevention interventions should expand their focus to include the risk factors associated with non-fatal drowning. In particular, targeted strategies related to children, females, and drowning incidents occurring as a result of water transportation and submersion in or falling into a swimming pool should all be included in drowning prevention program planning.

Secondary prevention interventions. Findings from this thesis indicate that even when bystanders witness a drowning event, they do not always attempt a rescue, and when they do, it is often a high-risk contact rescue. Educating the Canadian public on the importance of attempting a safe, non-contact rescue, and equipping them with the knowledge and skills required to achieve this may reduce the incidence of rescuer fatalities and may also improve the chances of survival for persons who are drowning. As described in Chapter Four, in Canada, public awareness activities and community based actions related to drowning have typically focused on primary or pre-event prevention, and tertiary or post-event treatment measures (Canadian Red Cross, 2016b; Canadian Red Cross, 2016c; Canadian Safe Boating Council, n.d.; Heart & Stroke, 2016; Lifesaving Society, 2012b; Lifesaving Society, 2012c; Parachute Canada, n.d.; St. John's Ambulance, 2016). The results reported in this research project indicate that interventions related to secondary (during the injury event) prevention in drowning incidents are currently both lacking and necessary. Current drowning prevention initiatives in Canada should

expand to include secondary prevention strategies such as educating the public on safe rescue techniques and creating policies to ensure adequate equipment is provided to assist with non-contact rescues.

Pool enclosure policy implications. Results from this thesis have important implications for policy. Descriptive analysis of the characteristics of backyard pool drowning deaths among children in Ontario and mapping the private backyard pool drowning rates has demonstrated that all local municipalities, especially those in urban and suburban regions of Southern Ontario should enact and enforce the recommended pool enclosure legislation.

6.5 Areas for Future Research

Despite the contribution of this thesis to address gaps in our understanding of the epidemiology of drowning at the global, national, and local level, areas for future research remain. More work is needed to determine the true magnitude of the global drowning problem. Country-level studies that use community surveys to address the issue of underreporting of drowning deaths, especially in low- and middle-income countries would contribute to this effort. An estimate of the burden of non-fatal drowning is now established in Canada, but the results may not be generalizable to other contexts. Collection and reporting on non-fatal drowning incidents in other countries is needed. Moreover, non-fatal drowning studies that include more variables related to the incident would improve our understanding of the characteristics of non-fatal drowning. The observational studies conducted in this thesis are an important first step in addressing gaps in our understanding of the drowning problem. Obtaining exposure data to conduct analytical studies is a challenge in drowning prevention research. Analytical studies that report the relative risk of fatal and non-fatal drowning in various circumstances would make an

important contribution to the field. Additionally, more research is needed to identify drowning prevention strategies for vulnerable populations in Canada, including Indigenous peoples and new immigrants. Future research should include a focus on reducing disparities in drowning risk for populations of low socio-economic status in all areas of the world.

6.6 Conclusion

This thesis provides a comprehensive examination of the epidemiology of drowning at the global, national, and local level. Each of the studies contributes to the existing evidence related to drowning epidemiology, prevention, and policy. Further, the results of this body of research provide comprehensive information for policy-makers, advocates, public health practitioners and prevention programmers to inform their drowning prevention efforts.

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APPENDIX A: ICD-10 CODES FOR IDENTIFYING DROWNING CASES

Code	Description	Includes
V90	**Accident to watercraft causing drowning and submersion**	Drowning and submersion due to: - Boat: Overturning, sinking - Falling or jumping from burning ship - Other accident to watercraft - Falling or jumping from crushed watercraft
V92	**Water-transport related drowning and submersion without accident to watercraft**	Drowning and submersion as a result of an accident, such as: - Fall: from gangplank, ship, overboard - Thrown overboard by motion of ship - Washed overboard
V94	**Other and unspecified water transport accident**	- Accident to nonoccupant of watercraft - Hit by boat while water-skiing
W65	**Drowning and submersion while in bath-tub**	
W66	**Drowning and submersion following fall into bath-tub**	
W67	**Drowning and submersion while in swimming-pool**	
W68	**Drowning and submersion following fall into swimming-pool**	
W69	**Drowning and submersion while in natural water**	Including: - Lake, Open sea, River, Stream
W70	**Drowning and submersion following fall into natural water**	
W73	**Other specified drowning and submersion**	-Quenching tank - Reservoir
W74	**Unspecified drowning and submersion**	-Drowning not specified -Fall into water not specified

APPENDIX B: BACKYARD POOL DROWNING DATA COLLECTION FORM

IDENTIFIERS

i. Coroner's Report #:_____
ii. Coroner's Inquest File #:_____
iii. Police Report #:_____

DEMOGRAPHIC INFORMATION AND INCIDENT DATE

1. Age of Victim:_____
2. Sex of Victim: ___ Male ___Female ___Unknown
3. Date of Incident: ___/___/___ (YY/MM/DD)

LOCATION INFORMATION

4. Municipality
5. Type of Private Pool:
    a. In-ground pool
    b. Above-ground pool – fixed installation
    c. Above-ground pool – small portable, wading type pool
    d. Private pool – specific type unknown
6. Was pool directly linked to home by patio/terrace?: _____

CONTRIBUTING FACTORS

7. Swimming ability of victim
    a. Non-Swimmer
    b. Weak Swimmer
    c. Average/Intermediate Swimmer
    d. Strong Swimmer
    e. Swimmer – Skill level not identified
    f. Unknown
8. Supervision and/or accompaniment at the time of the incident
    a. Alone or not witnessed
    b. With at least one adult
    c. With minors only
    d. With bystanders only
    e. With others, details not specified
    f. Unknown
9. Adult/caregiver supervision of children less than 10 years old
    a. Irrelevant
    b. No supervision present
    c. Supervision present
    d. Supervision present but distracted

e. Caregiver died during incident
f. Unknown

10. Private pool access
    a. Pool entry achieved through gate in four sided fence
    b. Pool entry achieved directly from single unit residence
    c. Pool entry achieved through side gate into the immediate pool area
    d. Pool entry achieved by climbing over/under secure fence
    e. Unknown
11. Fence information
    a. Fence present which met bylaw standards
    b. Fence present but did not meet bylaw standards
    c. Fence present, but not identified whether it met standards or was sub-standard
    d. Fence not present – specifically identified in file
    e. Unknown
12. Type of fence
    a. Irrelevant, fence not present
    b. Four sided fencing present
    c. Three sided fencing present, house acted as fourth side
    d. Unknown
13. Height of fence: _____
14. Gate access to pool
    a. No gate present
    b. Gate was both self-closing and self-latching
    c. Gate was neither self-closing nor self-latching; or self-closing, but not self-latching; or self-latching but not self-closing
    d. Type of gate not identified in file
    e. Unknown
15. Synopsis:

_____
_____
_____
_____
_____
_____
_____
_____
_____

APPENDIX C: ONTARIO MUNICIPALITIES

Municipality	Municipal Status	Geographic Area	Contact Number
A			
Addington Highlands, Township of	Lower Tier	Lennox and Addington	613-336-2286
Adelaide-Metcalfe, Township of	Lower Tier	Middlesex	519-247-3687
Adjala-Tosorontio, Township of	Lower Tier	Simcoe	705-434-5055
Admaston/Bromley, Township of	Lower Tier	Renfrew	613-432-2885
Ajax, Town of	Lower Tier	Durham	905-683-4550
Alberton, Township of	Single Tier	Rainy River	807-274-6053
Alfred and Plantagenet, Township of	Lower Tier	Prescott and Russell	613-673-4797
Algonquin Highlands, Township of	Lower Tier	Haliburton	705-489-2379
Alnwick/Haldimand, Township of	Lower Tier	Northumberland	905-349-2822
Amaranth, Township of	Lower Tier	Dufferin	519-941-1007
Amherstburg, Town of	Lower Tier	Essex	519-736-0012
Armour, Township of	Single Tier	Parry Sound	705-382-3332 or705-382-2954
Armstrong, Township of	Single Tier	Timiskaming	705-563-2375
Arnprior, Town of	Lower Tier	Renfrew	613-623-4231
Arran-Elderslie, Municipality of	Lower Tier	Bruce	519-363-3039
Ashfield-Colborne-Wawanosh, Township of	Lower Tier	Huron	519-524-4669
Asphodel-Norwood, Township of	Lower Tier	Peterborough	705-639-5343
Assiginack, Township of	Single Tier	Manitoulin	705-859-3196
Athens, Township of	Lower Tier	Leeds and Grenville	613-924-2044
Atikokan, Town of	Single Tier	Rainy River	807-597-1234
Augusta, Township of	Lower Tier	Leeds and Grenville	613-925-4231
Aurora, Town of	Lower Tier	York	905-727-1375
Aylmer, Town of	Lower Tier	Elgin	519-773-3164
B			
Baldwin, Township of	Single Tier	Sudbury	705-869-0225

Municipality	Municipal Status	Geographic Area	Contact Number
Bancroft, Town of	Lower Tier	Hastings	613-332-3331
Barrie, City of	Single Tier	Simcoe	705-726-4242
Bayham, Municipality of	Lower Tier	Elgin	519-866-5521
Beckwith, Township of	Lower Tier	Lanark	613-257-1539
Belleville, City of	Single Tier	Hastings	613-968-6481
Billings, Township of	Single Tier	Manitoulin	705-282-2611
Black River-Matheson, Township of	Single Tier	Cochrane	705-273-2313
Blandford-Blenheim, Township of	Lower Tier	Oxford	519-463-5347
Blind River, Town of	Single Tier	Algoma	705-356-2251
Bluewater, Municipality of	Lower Tier	Huron	519-236-4351
Bonfield, Township of	Single Tier	Nipissing	705-776-2641
Bonnechere Valley, Township of	Lower Tier	Renfrew	613-628-3101
Bracebridge, Town of	Lower Tier	Muskoka	705-645-5264
Bradford West Gwillimbury, Town of	Lower Tier	Simcoe	905-775-5366
Brampton, City of	Lower Tier	Peel	905-874-2000
Brant, County of	Single Tier	Brant	519-449-2451
Brantford, City of	Single Tier	Brant	519-759-4150
Brethour, Township of	Single Tier	Timiskaming	705-647-7632
Brighton, Municipality of	Lower Tier	Northumberland	613-475-0670
Brock, Township of	Lower Tier	Durham	705-432-2355
Brockton, Municipality of	Lower Tier	Bruce	519-881-2223
Brockville, City of	Single Tier	Leeds and Grenville	613-342-8772
Brooke-Alvinston, Municipality of	Lower Tier	Lambton	519-898-2173
Bruce, County of	Upper Tier	Bruce	519-881-1291
Bruce Mines, Town of	Single Tier	Algoma	705-785-3493
Brudenell, Lyndoch and Raglan, Township of	Lower Tier	Renfrew	613-758-2061
Burk's Falls, Village of	Single Tier	Parry Sound	705-382-3138
Burlington, City of	Lower Tier	Halton	905-335-7600
Burpee and Mills, Township of	Single Tier	Manitoulin	705-282-0624
C			
Caledon, Town of	Lower Tier	Peel	905-584-2272
Callander, Municipality of	Single Tier	Parry Sound	705-752-1410

Municipality	Municipal Status	Geographic Area	Contact Number
Calvin, Municipality of	Single Tier	Nipissing	705-744-2700
Cambridge, City of	Lower Tier	Waterloo	519-623-1340
Carleton Place, Town of	Lower Tier	Lanark	613-257-6200
Carling, Township of	Single Tier	Parry Sound	705-342-5856
Carlow/Mayo, Township of	Lower Tier	Hastings	613-332-1760
Casey, Township of	Single Tier	Timiskaming	705-647-5439
Casselman, Village of	Lower Tier	Prescott and Russell	613-764-3139
Cavan Monaghan, Township of	Lower Tier	Peterborough	705-932-2929
Central Elgin, Municipality of	Lower Tier	Elgin	519-631-4860
Central Frontenac, Township of	Lower Tier	Frontenac	613-279-2935
Central Huron, Municipality of	Lower Tier	Huron	519-482-3997
Central Manitoulin, Municipality of	Single Tier	Manitoulin	705-377-5726
Centre Hastings, Municipality of	Lower Tier	Hastings	613-473-4030
Centre Wellington, Township of	Lower Tier	Wellington	519-846-9691
Chamberlain, Township of	Single Tier	Timiskaming	705-544-8088
Champlain, Township of	Lower Tier	Prescott and Russell	613-678-3003
Chapleau, Township of	Single Tier	Sudbury	705-864-1330
Chapple, Township of	Single Tier	Rainy River	807-487-2354
Charlton and Dack, Municipality of	Single Tier	Timiskaming	705-544-7525
Chatham-Kent, Municipality of	Single Tier	Chatham-Kent	519-360-1998
Chatsworth, Township of	Lower Tier	Grey	519-794-3232
Chisholm, Township of	Single Tier	Nipissing	705-724-3526
Clarence-Rockland, City of	Lower Tier	Prescott and Russell	613-446-6022
Clarington, Municipality of	Lower Tier	Durham	905-623-3379
Clearview, Township of	Lower Tier	Simcoe	705-428-6230
Cobalt, Town of	Single Tier	Timiskaming	705-679-8877
Cobourg, Town of	Lower Tier	Northumberland	905-372-4301
Cochrane, Town of	Single Tier	Cochrane	705-272-4361
Cockburn Island, Township of	Single Tier	Manitoulin	705-842-3739
Coleman, Township of	Single Tier	Timiskaming	705-679-8833
Collingwood, Town of	Lower Tier	Simcoe	705-445-1030
Conmee, Township of	Single Tier	Thunder Bay	807-475-5229

Municipality	Municipal Status	Geographic Area	Contact Number
Cornwall, City of	Single Tier	Stormont, Dundas and Glengarry	613-930-2787
Cramahe, Township of	Lower Tier	Northumberland	905-355-2821
D			
Dawn-Euphemia, Township of	Lower Tier	Lambton	519-692-5148
Dawson, Township of	Single Tier	Rainy River	807-852-3529
Deep River, Town of	Lower Tier	Renfrew	613-584-2000
Deseronto, Town of	Lower Tier	Hastings	613-396-2440
Dorion, Township of	Single Tier	Thunder Bay	807-857-2289
Douro-Dummer, Township of	Lower Tier	Peterborough	705-652-8392
Drummond/North Elmsley, Township of	Lower Tier	Lanark	613-267-6500
Dryden, City of	Single Tier	Kenora	807-223-1147
Dubreuilville, Township of	Single Tier	Algoma	705-884-2340 ex. 21
Dufferin, County of	Upper Tier	Dufferin	519-941-2816
Durham, Regional Municipality of	Upper Tier	Durham	905-668-7711
Dutton/Dunwich, Municipality of	Lower Tier	Elgin	519-762-2204
Dysart, Dudley, Harcourt, Guilford, Harburn, Bruton, Havelock, Eyre and Clyde, United Townships of	Lower Tier	Haliburton	705-457-1740
E			
Ear Falls, Township of	Single Tier	Kenora	807-222-3624
East Ferris, Township of	Single Tier	Nipissing	705-752-2452
East Garafraxa, Township of	Lower Tier	Dufferin	519-941-1007
East Gwillimbury, Town of	Lower Tier	York	905-478-4282
East Hawkesbury, Township of	Lower Tier	Prescott and Russell	613-674-2170
East Zorra-Tavistock, Township of	Lower Tier	Oxford	519-462-2697
Edwardsburgh/Cardinal, Township of	Lower Tier	Leeds and Grenville	613-658-3055
Elgin, County of	Upper Tier	Elgin	519-631-1460
Elizabethtown-Kitley, Township of	Lower Tier	Leeds and Grenville	613-345-7480
Elliot Lake, City of	Single Tier	Algoma	705-848-2287

Municipality	Municipal Status	Geographic Area	Contact Number
Emo, Township of	Single Tier	Rainy River	807-482-2378
Englehart, Town of	Single Tier	Timiskaming	705-544-2244
Enniskillen, Township of	Lower Tier	Lambton	519-882-2490
Erin, Town of	Lower Tier	Wellington	519-855-4407
Espanola, Town of	Single Tier	Sudbury	705-869-1540
Essa, Township of	Lower Tier	Simcoe	705-424-9770
Essex, County of	Upper Tier	Essex	1-877-624-4832
Essex, Town of	Lower Tier	Essex	519-776-7336
Evanturel, Township of	Single Tier	Timiskaming	705-544-8200
F			
Faraday, Township of	Lower Tier	Hastings	613-332-3638
Fauquier-Strickland, Township of	Single Tier	Cochrane	705-339-2521
Fort Erie, Town of	Lower Tier	Niagara	905-871-1600
Fort Frances, Town of	Single Tier	Rainy River	807-274-5323
French River, Municipality of	Single Tier	Sudbury	705-898-2294
Front of Yonge, Township of	Lower Tier	Leeds and Grenville	613-923-2251
Frontenac, County of	Upper Tier	Frontenac	613-548-9400
Frontenac Islands, Township of	Lower Tier	Frontenac	613-385-2216
G			
Gananoque, Town of	Single Tier	Leeds and Grenville	613-382-2149
Gauthier, Township of	Single Tier	Timiskaming	705-568-8951
Georgian Bay, Township of	Lower Tier	Muskoka	705-538-2337
Georgian Bluffs, Township of	Lower Tier	Grey	519-376-2729
Georgina, Town of	Lower Tier	York	905-476-4301
Gillies, Township of	Single Tier	Thunder Bay	807-475-3185
Goderich, Town of	Lower Tier	Huron	519-524-8344
Gordon/Barrie Island, Municipality of	Single Tier	Manitoulin	705-282-2702
Gore Bay, Town of	Single Tier	Manitoulin	705-282-2420
Grand Valley, Town of	Lower Tier	Dufferin	519-928-5652
Gravenhurst, Town of	Lower Tier	Muskoka	705-687-3412
Greater Madawaska, Township of	Lower Tier	Renfrew	613-752-2222
Greater Napanee, Town of	Lower Tier	Lennox and Addington	613-354-3351

Municipality	Municipal Status	Geographic Area	Contact Number
Greater Sudbury, City of	Single Tier	Sudbury	705-671-2489
Greenstone, Municipality of	Single Tier	Thunder Bay	807-854-1100
Grey, County of	Upper Tier	Grey	519-372-0219
Grey Highlands, Municipality of	Lower Tier	Grey	519-986-2811
Grimsby, Town of	Lower Tier	Niagara	905-945-9634
Guelph, City of	Single Tier	Wellington	519-822-1260
Guelph/Eramosa, Township of	Lower Tier	Wellington	519-856-9951
H			
Haldimand County	Single Tier	Haldimand	905-318-5932
Haliburton, County of	Upper Tier	Haliburton	705-286-1333
Halton, Regional Municipality of	Upper Tier	Halton	905-825-6000
Halton Hills, Town of	Lower Tier	Halton	905-873-2601
Hamilton, City of	Single Tier	Hamilton	905-546-2489
Hamilton, Township of	Lower Tier	Northumberland	905-342-2810
Hanover, Town of	Lower Tier	Grey	519-364-2780
Harley, Township of	Single Tier	Timiskaming	705-647-5439
Harris, Township of	Single Tier	Timiskaming	705-647-5094
Hastings, County of	Upper Tier	Hastings	613-966-1319
Hastings Highlands, Municipality of	Lower Tier	Hastings	613-338-2811
Havelock-Belmont-Methuen, Township of	Lower Tier	Peterborough	705-778-2308 Ext 221
Hawkesbury, Town of	Lower Tier	Prescott and Russell	613-632-0106
Head, Clara and Maria, Township of	Lower Tier	Renfrew	613-586-2526
Hearst, Town of	Single Tier	Cochrane	705-362-4341
Highlands East, Municipality of	Lower Tier	Haliburton	705-448-2981
Hilliard, Township of	Single Tier	Timiskaming	705-563-2563
Hilton, Township of	Single Tier	Algoma	705-246-2472
Hilton Beach, Village of	Single Tier	Algoma	705-246-2554
Hornepayne, Township of	Single Tier	Algoma	807-868-2020
Horton, Township of	Lower Tier	Renfrew	613-432-6271
Howick, Township of	Lower Tier	Huron	519-335-3208
Hudson, Township of	Single Tier	Timiskaming	705-647-5439
Huntsville, Town of	Lower Tier	Muskoka	705-789-1751
Huron, County of	Upper Tier	Huron	519-524-8394

Municipality	Municipal Status	Geographic Area	Contact Number
Huron East, Municipality of	Lower Tier	Huron	519-527-0160
Huron Shores, Municipality of	Single Tier	Algoma	705-843-2033
Huron-Kinloss, Township of	Lower Tier	Bruce	519-395-3735
I			
Ignace, Township of	Single Tier	Kenora	705-497-0373
Ingersoll, Town of	Lower Tier	Oxford	519-485-0120
Innisfil, Town of	Lower Tier	Simcoe	705-436-3710
Iroquois Falls, Town of	Single Tier	Cochrane	705-232-6357
J			
James, Township of	Single Tier	Timiskaming	705-678-2237
Jocelyn, Township of	Single Tier	Algoma	705-246-2025
Johnson, Township of	Single Tier	Algoma	705-782–6601
Joly, Township of	Single Tier	Parry Sound	705-384-5428
K			
Kapuskasing, Town of	Single Tier	Cochrane	705-335-2341
Kawartha Lakes, City of	Single Tier	Kawartha Lakes	705-324-9411
Kearney, Town of	Single Tier	Parry Sound	705-636-7752
Kenora, City of	Single Tier	Kenora	807-467-2000
Kerns, Township of	Single Tier	Timiskaming	705-647-5439
Killaloe, Hagarty and Richards, Township of	Lower Tier	Renfrew	613-757-2300
Killarney, Municipality of	Single Tier	Sudbury	705-287-2424
Kincardine, Municipality of	Lower Tier	Bruce	519-396-3468
King, Township of	Lower Tier	York	905-833-5321
Kingston, City of	Single Tier	Frontenac	613-546-0000
Kingsville, Town of	Lower Tier	Essex	519-733-2305
Kirkland Lake, Town of	Single Tier	Timiskaming	705-567-9361
Kitchener, City of	Lower Tier	Waterloo	519-741-2345
L			
La Vallee, Township of	Single Tier	Rainy River	807-486-3452
LaSalle, Town of	Lower Tier	Essex	519-969-7770
Laird, Township of	Single Tier	Algoma	705-248-2395
Lake of Bays, Township of	Lower Tier	Muskoka	705-635-2272
Lake of the Woods, Township of	Single Tier	Rainy River	807-852-3529
Lakeshore, Town of	Lower Tier	Essex	519-728-2700
Lambton, County of	Upper Tier	Lambton	519 845-0801

Municipality	Municipal Status	Geographic Area	Contact Number
Lambton Shores, Municipality of	Lower Tier	Lambton	519-786-2335
Lanark, County of	Upper Tier	Lanark	613-267-4200
Lanark Highlands, Township of	Lower Tier	Lanark	613-259-2398
Larder Lake, Township of	Single Tier	Timiskaming	705-643-2158
Latchford, Town of	Single Tier	Timiskaming	705-676-2416
Laurentian Hills, Town of	Lower Tier	Renfrew	613-584-3114
Laurentian Valley, Township of	Lower Tier	Renfrew	613-735-6291
Leamington, Municipality of	Lower Tier	Essex	519-326-5761
Leeds and Grenville, United Counties of	Upper Tier	Leeds and Grenville	613-342-3840
Leeds and the Thousand Islands, Township of	Lower Tier	Leeds and Grenville	613-659-2415
Lennox and Addington, County of	Upper Tier	Lennox and Addington	613-354-4883
Limerick, Township of	Lower Tier	Hastings	613-474-2863
Lincoln, Town of	Lower Tier	Niagara	905-563-8205
London, City of	Single Tier	Middlesex	519-661-4500
Loyalist, Township of	Lower Tier	Lennox and Addington	613-386-7351
Lucan Biddulph, Township of	Lower Tier	Middlesex	519-227-4491
M			
Macdonald, Meredith and Aberdeen Additional, Township of	Single Tier	Algoma	705-248-2441
Machar, Township of	Single Tier	Parry Sound	705-386-7741
Machin, Township of	Single Tier	Kenora	807-227-2633
Madawaska Valley, Township of	Lower Tier	Renfrew	613-756-2747
Madoc, Township of	Lower Tier	Hastings	613-473-2677
Magnetawan, Municipality of	Single Tier	Parry Sound	705-387-3947
Malahide, Township of	Lower Tier	Elgin	519-773-5344
Manitouwadge, Township of	Single Tier	Thunder Bay	807-826-3227
Mapleton, Township of	Lower Tier	Wellington	519-638-3313
Marathon, Town of	Single Tier	Thunder Bay	807-229-1340
Markham, City of	Lower Tier	York	905-477-5530
Markstay-Warren, Municipality of	Single Tier	Sudbury	705-853-4536

Municipality	Municipal Status	Geographic Area	Contact Number
Marmora and Lake, Municipality of	Lower Tier	Hastings	613-472-2629
Matachewan, Township of	Single Tier	Timiskaming	705-565-2274
Mattawa, Town of	Single Tier	Nipissing	705-744-5611
Mattawan, Township of	Single Tier	Nipissing	705-744-5680
Mattice-Val Côté, Township of	Single Tier	Cochrane	705-364-6511
McDougall, Township of	Single Tier	Parry Sound	705-342-5252
McGarry, Township of	Single Tier	Timiskaming	705-634-2145
McKellar, Township of	Single Tier	Parry Sound	705-389-2842
McMurrich/Monteith, Township of	Single Tier	Parry Sound	705-685-7901
McNab/Braeside, Township of	Lower Tier	Renfrew	613-623-5756
Meaford, Municipality of	Lower Tier	Grey	519-538-1060
Melancthon, Township of	Lower Tier	Dufferin	519-925-5525
Merrickville-Wolford, Village of	Lower Tier	Leeds and Grenville	613-269-4791
Middlesex, County of	Upper Tier	Middlesex	519-434-7321
Middlesex Centre, Municipality of	Lower Tier	Middlesex	519-666-0190
Midland, Town of	Lower Tier	Simcoe	705-526-4275
Milton, Town of	Lower Tier	Halton	905-878-7252
Minden Hills, Township of	Lower Tier	Haliburton	705-286-1260
Minto, Town of	Lower Tier	Wellington	519-338-2511
Mississauga, City of	Lower Tier	Peel	905-615-4311
Mississippi Mills, Municipality of	Lower Tier	Lanark	1-888-779-8666
Mono, Town of	Lower Tier	Dufferin	519-941-3599
Montague, Township of	Lower Tier	Lanark	613-283-7478
Moonbeam, Township of	Single Tier	Cochrane	705-367-1110
Moosonee, Town of	Single Tier	Cochrane	705-336-2993
Morley, Township of	Single Tier	Rainy River	807-483-5455
Morris-Turnberry, Municipality of	Lower Tier	Huron	519-887-6137
Mulmur, Township of	Lower Tier	Dufferin	705-466-3341
Muskoka, District Municipality of	Upper Tier	Muskoka	705-645-2231
Muskoka Lakes, Township of	Lower Tier	Muskoka	705-765-3156
N			

Municipality	Municipal Status	Geographic Area	Contact Number
Nairn and Hyman, Township of	Single Tier	Sudbury	705-869-4232
Neebing, Municipality of	Single Tier	Thunder Bay	807-474-5331
New Tecumseth, Town of	Lower Tier	Simcoe	705-435-6219
Newbury, Village of	Lower Tier	Middlesex	519-693-4941
Newmarket, Town of	Lower Tier	York	905-895-5193
Niagara, Regional Municipality of	Upper Tier	Niagara	905-685-1571
Niagara Falls, City of	Lower Tier	Niagara	905-356-7521
Niagara-on-the-Lake, Town of	Lower Tier	Niagara	905-468-3266
Nipigon, Township of	Single Tier	Thunder Bay	807-887-3135
Nipissing, Township of	Single Tier	Parry Sound	705-724-2144
Norfolk County	Single Tier	Norfolk	519-426-5870
North Algona Wilberforce, Township of	Lower Tier	Renfrew	613-628-2080
North Bay, City of	Single Tier	Nipissing	705-474-0400
North Dumfries, Township of	Lower Tier	Waterloo	519-621-0340
North Dundas, Township of	Lower Tier	Stormont, Dundas and Glengarry	613-774-2105
North Frontenac, Township of	Lower Tier	Frontenac	613-479-2231
North Glengarry, Township of	Lower Tier	Stormont, Dundas and Glengarry	613-525-1110
North Grenville, Municipality of	Lower Tier	Leeds and Grenville	613-258-9569
North Huron, Township of	Lower Tier	Huron	519-357-1208
North Kawartha, Township of	Lower Tier	Peterborough	705-656-4445
North Middlesex, Municipality of	Lower Tier	Middlesex	519-294-6244
North Perth, Municipality of	Lower Tier	Perth	519-291-2950
North Stormont, Township of	Lower Tier	Stormont, Dundas and Glengarry	613-984-2821
Northeastern Manitoulin and The Islands, Town of	Single Tier	Manitoulin	705-368-3500
Northern Bruce Peninsula, Municipality of	Lower Tier	Bruce	519-793-3522
Northumberland, County of	Upper Tier	Northumberland	905-372-3329
Norwich, Township of	Lower Tier	Oxford	519-863-2709
O			
O'Connor, Township of	Single Tier	Thunder Bay	807-476-1451
Oakville, Town of	Lower Tier	Halton	905-845-6601

Municipality	Municipal Status	Geographic Area	Contact Number
Oil Springs, Village of	Lower Tier	Lambton	519-834-2939
Oliver Paipoonge, Municipality of	Single Tier	Thunder Bay	807-935-2613
Opasatika, Township of	Single Tier	Cochrane	705-369-4531
Orangeville, Town of	Lower Tier	Dufferin	519-941-0440
Orillia, City of	Single Tier	Simcoe	705-325-1311
Oro-Medonte, Township of	Lower Tier	Simcoe	705-487-2171
Oshawa, City of	Lower Tier	Durham	905-436-3311
Otonabee-South Monaghan, Township of	Lower Tier	Peterborough	705-295-6852
Ottawa, City of	Single Tier	Ottawa	613-580-2400
Owen Sound, City of	Lower Tier	Grey	519-376-1440
Oxford, County of	Upper Tier	Oxford	519-539-9800
P			
Papineau-Cameron, Township of	Single Tier	Nipissing	705-744-5610
Parry Sound, Town of	Single Tier	Parry Sound	705-746-2101
Peel, Regional Municipality of	Upper Tier	Peel	905-791-7800
Pelee, Township of	Single Tier	Essex	519-724-2931
Pelham, Town of	Lower Tier	Niagara	905-892-2607
Pembroke, City of	Single Tier	Renfrew	613-735-6821
Penetanguishene, Town of	Lower Tier	Simcoe	705-549-7453
Perry, Township of	Single Tier	Parry Sound	705-636-5941
Perth, Town of	Lower Tier	Lanark	613-267-3311
Perth, County of	Upper Tier	Perth	519-271-0531
Perth East, Township of	Lower Tier	Perth	519-595-2800
Perth South, Township of	Lower Tier	Perth	519-271-0619
Petawawa, Town of	Lower Tier	Renfrew	613-687-5536
Peterborough, County of	Upper Tier	Peterborough	705-743-0380
Peterborough, City of	Single Tier	Peterborough	705-742-7777
Petrolia, Town of	Lower Tier	Lambton	519-882-2350
Pickering, City of	Lower Tier	Durham	905-420-2222
Pickle Lake, Township of	Single Tier	Kenora	800-565-9189
Plummer Additional, Township of	Single Tier	Algoma	705-785-3479
Plympton-Wyoming, Town of	Lower Tier	Lambton	519-845-3939

Municipality	Municipal Status	Geographic Area	Contact Number
Point Edward, Village of	Lower Tier	Lambton	519-337-3021
Port Colborne, City of	Lower Tier	Niagara	905-835-2900
Port Hope, Municipality of	Lower Tier	Northumberland	905-885-4544
Powassan, Municipality of	Single Tier	Parry Sound	705-724-2813
Prescott, Town of	Single Tier	Leeds and Grenville	613-925-2812
Prescott and Russell, United Counties of	Upper Tier	Prescott and Russell	613-675-4661
Prince, Township of	Single Tier	Algoma	705-779-2992
Prince Edward, County of	Single Tier	Prince Edward	613-476-2148
Puslinch, Township of	Lower Tier	Wellington	519-763-1226
Q			
Quinte West, City of	Single Tier	Hastings	613-392-2841
R			
Rainy River, Town of	Single Tier	Rainy River	807-852-3244
Ramara, Township of	Lower Tier	Simcoe	705-484-5374
Red Lake, Municipality of	Single Tier	Kenora	807-735-2096
Red Rock, Township of	Single Tier	Thunder Bay	807-886-2245
Renfrew, County of	Upper Tier	Renfrew	613-735-7288
Renfrew, Town of	Lower Tier	Renfrew	613-432-4848
Richmond Hill, Town of	Lower Tier	York	905-771-8800
Rideau Lakes, Township of	Lower Tier	Leeds and Grenville	613-928-2251
Russell, Township of	Lower Tier	Prescott and Russell	613-443-3066
Ryerson, Township of	Single Tier	Parry Sound	705-382-3232
S			
Sables-Spanish Rivers, Township of	Single Tier	Sudbury	705-865-2646
Sarnia, City of	Lower Tier	Lambton	519-332-0330
Saugeen Shores, Town of	Lower Tier	Bruce	519-832-2332
Sault Ste. Marie, City of	Single Tier	Algoma	705-759-2500
Schreiber, Township of	Single Tier	Thunder Bay	807-824-2711
Scugog, Township of	Lower Tier	Durham	905-985-7346
Seguin, Township of	Single Tier	Parry Sound	705-732-4300
Selwyn, Township of	Lower Tier	Peterborough	705-292-9507
Severn, Township of	Lower Tier	Simcoe	705-325-2315
Shelburne, Town of	Lower Tier	Dufferin	519-925-2600
Shuniah, Municipality of	Single Tier	Thunder Bay	807-683-4545

Municipality	Municipal Status	Geographic Area	Contact Number
Simcoe, County of	Upper Tier	Simcoe	705-735-6901
Sioux Lookout, Municipality of	Single Tier	Kenora	807-737-2700
Sioux Narrows-Nestor Falls, Township of	Single Tier	Kenora	807-226-5241
Smiths Falls, Town of	Single Tier	Lanark	613-283-4124
Smooth Rock Falls, Town of	Single Tier	Cochrane	705-338-2717
South Algonquin, Township of	Single Tier	Nipissing	613-637-2650
South Bruce, Municipality of	Lower Tier	Bruce	519-392-6623
South Bruce Peninsula, Town of	Lower Tier	Bruce	519-534-1400
South Dundas, Municipality of	Lower Tier	Stormont, Dundas and Glengarry	613-535-2673
South Frontenac, Township of	Lower Tier	Frontenac	613-376-3027
South Glengarry, Township of	Lower Tier	Stormont, Dundas and Glengarry	613-347-1166
South Huron, Municipality of	Lower Tier	Huron	519-235-0310
South River, Village of	Single Tier	Parry Sound	705-386-2573
South Stormont, Township of	Lower Tier	Stormont, Dundas and Glengarry	613-534-8889
South-West Oxford, Township of	Lower Tier	Oxford	519-877-2702
Southgate, Township of	Lower Tier	Grey	519-923-2110
Southwest Middlesex, Municipality of	Lower Tier	Middlesex	519-287-2015
Southwold, Township of	Lower Tier	Elgin	519-769-2010
Spanish, Town of	Single Tier	Algoma	705-844-2300
Springwater, Township of	Lower Tier	Simcoe	705-728-4784
St. Catharines, City of	Lower Tier	Niagara	905-688-5600
St. Clair, Township of	Lower Tier	Lambton	519-867-2021
St. Joseph, Township of	Single Tier	Algoma	705-246-2625
St. Marys, Town of	Single Tier	Perth	519-284-2340
St. Thomas, City of	Single Tier	Elgin	519-631-1680
St.-Charles, Municipality of	Single Tier	Sudbury	705-867-2032
Stirling-Rawdon, Township of	Lower Tier	Hastings	613-395-3380
Stone Mills, Township of	Lower Tier	Lennox and Addington	613-378-2475
Stormont, Dundas and Glengarry, United Counties of	Upper Tier	Stormont, Dundas and Glengarry	613-932-1515
Stratford, City of	Single Tier	Perth	519-271-0250

Municipality	Municipal Status	Geographic Area	Contact Number
Strathroy-Caradoc, Township of	Lower Tier	Middlesex	519-245-1070
Strong, Township of	Single Tier	Parry Sound	705-384-5819
Sundridge, Village of	Single Tier	Parry Sound	705-384-5316
T			
Tarbutt and Tarbutt Additional, Township of	Single Tier	Algoma	705-782-6776
Tay, Township of	Lower Tier	Simcoe	705-534-7248
Tay Valley, Township of	Lower Tier	Lanark	613-267-5353
Tecumseh, Town of	Lower Tier	Essex	519-735-2184
Tehkummah, Township of	Single Tier	Manitoulin	705-859-3293
Temagami, Municipality of	Single Tier	Nipissing	705-569-3421
Temiskaming Shores, City of	Single Tier	Timiskaming	705-672-3363
Terrace Bay, Township of	Single Tier	Thunder Bay	807-825-3315
Thames Centre, Municipality of	Lower Tier	Middlesex	519-268-7334
The Archipelago, Township of	Single Tier	Parry Sound	705-746-4243
The Blue Mountains, Town of	Lower Tier	Grey	519-599-3131
The Nation Municipality	Lower Tier	Prescott and Russell	613-764-5444
The North Shore, Township of	Single Tier	Algoma	705-849-2213
Thessalon, Town of	Single Tier	Algoma	705-842-2217
Thornloe, Village of	Single Tier	Timiskaming	705-563-8303
Thorold, City of	Lower Tier	Niagara	905-227-6613
Thunder Bay, City of	Single Tier	Thunder Bay	807-625-2230
Tillsonburg, Town of	Lower Tier	Oxford	519-688-3009
Timmins, City of	Single Tier	Cochrane	705-264-1331
Tiny, Township of	Lower Tier	Simcoe	705-526-4204
Toronto, City of	Single Tier	Toronto	416-392-2489
Trent Hills, Municipality of	Lower Tier	Northumberland	705-653-1900
Trent Lakes, Municipality of	Lower Tier	Peterborough	705-738-3800
Tudor and Cashel, Township of	Lower Tier	Hastings	613-474-2583
Tweed, Municipality of	Lower Tier	Hastings	613-478-2535
Tyendinaga, Township of	Lower Tier	Hastings	613-396-1944
U			
Uxbridge, Township of	Lower Tier	Durham	905-852-9181
V			
Val Rita-Harty, Township of	Single Tier	Cochrane	705-335-6146
Vaughan, City of	Lower Tier	York	905-832-2281

Municipality	Municipal Status	Geographic Area	Contact Number
W			
Wainfleet, Township of	Lower Tier	Niagara	905-899-3463
Warwick, Township of	Lower Tier	Lambton	519-849-3926
Wasaga Beach, Town of	Lower Tier	Simcoe	705-429-3844
Waterloo, Regional Municipality of	Upper Tier	Waterloo	519-575-4400
Waterloo, City of	Lower Tier	Waterloo	519-886-1550
Wawa, Municipality of	Single Tier	Algoma	705-856-2244
Welland, City of	Lower Tier	Niagara	905-735-1700
Wellesley, Township of	Lower Tier	Waterloo	519-699-4611
Wellington, County of	Upper Tier	Wellington	519-837-2600
Wellington North, Township of	Lower Tier	Wellington	519-848-3620
West Elgin, Municipality of	Lower Tier	Elgin	519-785-0560
West Grey, Municipality of	Lower Tier	Grey	519-369-2200
West Lincoln, Township of	Lower Tier	Niagara	905-957-3346
West Nipissing, Municipality of	Single Tier	Nipissing	705-753-6946
West Perth, Municipality of	Lower Tier	Perth	519-348-8429
Westport, Village of	Lower Tier	Leeds and Grenville	613-273-2191
Whitby, Town of	Lower Tier	Durham	905-668-5803
Whitchurch-Stouffville, Town of	Lower Tier	York	905-640-1900
White River, Township of	Single Tier	Algoma	807-822-2450
Whitestone, Municipality of	Single Tier	Parry Sound	705-389-2466
Whitewater Region, Township of	Lower Tier	Renfrew	613-646-2282
Wilmot, Township of	Lower Tier	Waterloo	519-634-8444
Windsor, City of	Single Tier	Essex	519-255-2489
Wollaston, Township of	Lower Tier	Hastings	613-337-5731
Woodstock, City of	Lower Tier	Oxford	519-539-1291
Woolwich, Township of	Lower Tier	Waterloo	519-669-1647
Y			
York, Regional Municipality of	Upper Tier	York	905-895-1231
Z			
Zorra, Township of	Lower Tier	Oxford	519-485-2490

APPENDIX D: ETHICS CERTIFICATE

YORK
UNIVERSITÉ
UNIVERSITY

OFFICE OF RESEARCH ETHICS (ORE)

5th Floor,
Kaneff Tower,
4700 Keele St.
Toronto ON
Canada M3J 1P3

Certificate #:	**STU 2014 – 071B**
Approval Period:	**12/10/14-12/10/15**

Memo

To**:** Tessa Clemens, Kinesiology and Health Sciences - Graduate Program

From**:** Alison M. Collins-Mrakas, Sr. Manager and Policy Advisor, Research Ethics
(on behalf of Denise Henriques, Chair, Human Participants Review Committee)

Date**:** **Wednesday, December 10, 2014**

Re: Ethics Approval

Passive Prevention in Private Backyard Pool Drownings

I am writing to inform you that the Human Participants Review Sub-Committee has reviewed and approved the above project.

Should you have any questions, please feel free to contact me.

Yours sincerely,

Alison M. Collins-Mrakas M.Sc., LLM
Sr. Manager and Policy Advisor,
Office of Research Ethics

RESEARCH ETHICS: PROCEDURES to ENSURE ONGOING COMPLIANCE

Upon receipt of an ethics approval certificate, researchers are reminded that they are required to ensure that the following measures are undertaken so as to ensure on-going compliance with Senate and TCPS ethics guidelines:

1. **RENEWALS:** Research Ethics Approval certificates are subject to annual renewal.
    a. Researchers are required to submit a request for renewal to the Office of Research Ethics (ORE) for review and approval.
    b. **Failure to renew an ethics approval certificate or** (to notify ORE that no further research involving human participants will be undertaken) **may result in suspension of research cost fund and access to research funds may be suspended/withheld** ;

2. **AMENDMENTS:** Amendments must be reviewed and approved **PRIOR** to undertaking/making the proposed amendments to an approved ethics protocol;

3. **END OF PROJECT**: ORE must be notified when a project is complete;

4. **ADVERSE EVENTS**: Adverse events must be reported to ORE as soon as possible;

5. **AUDIT:**
    a. More than minimal risk research may be subject to an audit as per TCPS guidelines;
    b. A spot sample of minimal risk research may be subject to an audit as per TCPS guidelines.

FORMS: As per the above, the following forms relating to on-going research ethics compliance are available on the Research website:

a. Renewal
b. Amendment
c. End of Project
d. Adverse Event

ETHICS EXEMPTION:

The following studies were granted ethics exemption by the York University Office of Research Ethics on the basis that they consisted of secondary analysis of existing data sources that were routinely collected in accordance with individual research agreements and did not contain any identifying information:

Underestimating the Global Burden of Drowning: Categorization and Classification of Drowning Fatalities using ICD-10 Codes

The Epidemiology of Non-Fatal Drowning in Canada

Characteristics of Bystander Rescue Attempts in Fatal Drowning Incidents