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Differences in Drowning Rates Between Rural and Non-Rural Residents of Ontario, Canada

Michael Fralick, Zane R. Gallinger, and Stephen W. Hwang

The objective of our study was to determine if rural residence was associated with an increased risk of drowning in Ontario, Canada. We conducted a retrospective cohort study of all unintentional drowning deaths in Ontario, Canada from 2004 to 2008. Age-adjusted mortality rates for males and females living in rural and non-rural areas were calculated using direct standardization, with non-rural residents as the reference population. We identified a total of 564 unintentional drowning deaths. The majority (89%) of fatal drowning victims were male, and 75% percent of victims were from non-rural areas. Excluding bathtub drowning deaths, the age-adjusted drowning mortality rate was significantly higher for both males (rate ratio 2.8; 95% CI, 2.3–3.4) and females (rate ratio 2.8; 95% CI, 1.5–5.0) from rural compared with non-rural areas. In Ontario, rural residence was associated with an increased risk of unintentional drowning.

Keywords: drowning/near drowning, water safety, aquatic risk management

Drowning is the second leading cause of unintentional injury death worldwide, after motor vehicle injuries (World Health Organization, 2012). In Ontario, Canada's most populous province, approximately 150 drownings occur each year (Lifesaving Society, 2013). In 2004, drowning deaths and hospitalizations for drownings in Ontario resulted in approximately 33 million dollars in direct and indirect costs (Smartrisk, 2009).

There are a number of established risk factors for drowning, including aboriginal status, male sex, alcohol use, low socioeconomic status, and epilepsy (Chochinov, 1998; Minister of Public Works and Government Services Canada, 2001; Lifesaving Society, 2013; Quan & Cummings, 2003; Szpilman, Bierens, Handley, & Orłowski, 2012). There is significant heterogeneity on the relationship between swimming skill and drowning risk in the scientific literature (Brenner, Saluja, &

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Smith, 2003). Recent studies, however, have demonstrated that poor swimming skills are a risk factor for both fatal and nonfatal drowning among children (Brenner et al., 2009; Ma et al., 2010). Similar data are lacking in the adult population and often inconsistent (Gulliver & Begg, 2005; Morgan, Ozanne-Smith, & Triggs, 2008). Regardless, major drowning prevention groups continue to advocate for the importance of swimming instruction for all age groups to decrease drowning risk (Centers for Disease Control & Prevention, 2009; International Life Saving Federation, 2009).

Studies of pediatric drowning deaths in Asia have found that rural residency is associated with higher drowning rates (Fang et al., 2007; Ma et al., 2010; Rahman, Giashuddin, Svanström, & Rahman, 2006; World Health Organization, 2012). Data from North America, specifically the United States, are conflicting. Two studies found rural residency to be associated with increased pediatric drowning rates (Hammig & Weatherly, 2003; Svenson, Spurlock, & Nypaver, 1996), while a third study did not support this association (Quan, Gore, Wentz, Allen, & Novack, 1989). A fourth study, also from the U.S., found that drowning deaths at the extremes of age (ages 0–4 and 65 and over) occurred more often in urban areas (Quan & Cummings, 2003). In summary, higher pediatric drowning rates have been observed in rural compared with urban parts of Asia, but data from North America are conflicting and data in the nonpediatric population are scarce. We are unaware of any Canadian studies that have analyzed drowning deaths by rural versus non-rural place of residence.

The objective of this study was to determine whether place of residence was associated with drowning risk in Ontario. This study used comprehensive data on all drowning deaths in Ontario over a 5-year period to determine age- and sex-specific drowning rates for persons living in rural and non-rural areas. Our hypothesis was that persons living in rural areas of Ontario would be at significantly increased risk of drowning.

Methods

Study Setting

Ontario is the largest province in Canada by population (12.1 million) and second largest by land mass (1 million km²). Ontario has over 250,000 freshwater lakes, four of which make up the Great Lakes Basin (Ministry of Natural Resource, 2008). The Great Lakes Basin comprises an area of 750,000 square kilometers and includes vast rural areas as well as some of the province's largest urban areas (e.g., Toronto, Windsor, Mississauga, and Hamilton; Ministry of Natural Resource, 2008). Approximately 86% of Ontarians live in cities and other non-rural areas, whereas 14% live in rural areas (Government of Ontario, 2012). Ontario's climate varies drastically based on location. Subarctic temperatures prevail in the far north, while warm humid summers and cold winters occur throughout the most populated southernmost areas. Typically, in the large southern urban areas, the summer begins in June and ends in September and the winter begins in December and ends in March (Government of Ontario, 2012).

Sample

Data on drowning deaths in Ontario were obtained from the Office of the Chief Coroner, which investigates all drowning deaths in the province. Unintentional drowning deaths occurring during the 5-year period from January 1, 2004 through December 31, 2008 were eligible for inclusion in the study. At the time of the study, the 2006 Canadian census was the most recent available. The five-year period 2004–2008 was selected to center around this census year. Drowning deaths were excluded if the victim was not a resident of Ontario or if the victim did not have a residential postal code recorded. Intentional drowning deaths, as determined by the investigating Coroner, were also excluded.

Ethics Statement

All recorded data were retrieved from the Office of the Coroner, which maintains a secure, locked facility. This study was approved by the St. Michael's Hospital Research Ethics Board as well as the Office of the Chief Coroner.

Demographic Information

Demographic information, including each drowning victim's age, sex, and residential postal code, were obtained from the Office of the Chief Coroner. When the Coroner attends the scene of a drowning, the postal code of the drowning victim is collected from the victim's driver's license or another available form of identification. Age was grouped based on Census Canada data into the following categories: 0–4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, and 75+ years. Data on medical comorbidities, autopsy findings, and toxicology results were also obtained from the Coroner's records. Toxicology testing is routinely performed on all drowning victims.

Residential postal codes were used to classify decedents as residents of rural or non-rural areas of Ontario. This process used a previously validated algorithm, the Postal Code Conversion File Plus (PCCF+; Wilkins, 1993). The PCCF+ uses the population density of census blocks to define the urban and rural status of a postal code. Community size is then subclassified by Statistics Canada's census metropolitan area (CMA) or census agglomeration (CA). According to Statistics Canada's classification recommendation, rural and small town Canada includes any CMA or CA, which are places within an urban area with a population less than about 10,000, plus any rural areas. Using this method, the majority of individuals living in towns or municipalities outside the commuting zone of large urban areas are classified as living in rural locations (Wilkins, 1993).

Statistical Analysis

Data on the total population of Ontario, stratified by sex, age group, and place of residence (rural vs. non-rural), were obtained from the 2006 Canadian Census. Drowning rates for rural and non-rural place of residence were calculated by sex, age group, and place of residence and were expressed as deaths per 100,000 person-years. Rate ratios with 95% confidence intervals were calculated comparing

drowning rates among the rural and non-rural groups in each sex and age group. Age-adjusted mortality rates for males and females living in rural and non-rural areas were calculated using direct standardization, with non-rural residents as the reference population. Age-adjusted mortality rates are defined as a mortality rate that has been statistically modified to eliminate the effect of different age distributions in the different populations. Drowning rates, rate ratios, and age-adjusted mortality rates also were calculated for drowning victims with bathtub drowning deaths excluded. Previous studies have excluded bathtub drowning deaths since bathtub drowning deaths are unlikely to be related to swimming or water safety skill (Brenner et al., 2009; Browne, Lewis-Michl, & Stark, 2003). As noted above, recent literature has demonstrated the importance of swimming and water safety skills in drowning prevention. Basic demographic and drowning risk factor data (i.e., age, sex, alcohol use, medical comorbidities, and area of residence) were compared using a Chi-square test of independence. Statistical significance was defined as a p-value less than 0.05. Data on swimming skill of the deceased was not available.

Results

Drowning Cases

Between 2004 and 2008, a total of 564 Ontario residents died of unintentional drowning and met study inclusion criteria. The majority (89%) of drowning victims were male. The highest proportion of all drowning deaths was among individuals aged 15–24 years. Seventy-five percent of victims lived in a non-rural area. The majority (74%) of drowning deaths occurred in open water.

Comparison of Drowning Environment and Contributing Factors

Table 1 provides a comparison of key demographic, environmental, and contributing factors to drowning risk among victims from rural and non-rural areas. There were no significant differences among either the age group or gender distributions of drowning victims from rural versus non-rural Ontario. Rural drowning victims were more likely to drown outdoors than victims from non-rural areas. Swimming was the most common activity at the time of drowning for both rural and non-rural drowning deaths.

Coroner's Office data on personal flotation devices were available for 37% of all drowning deaths, while toxicology data were available for 85% of drowning deaths. There was no significant difference in the absence of a personal flotation device or alcohol use as a contributing factor among victims from rural areas compared with non-rural areas (Table 1).

Drowning Rates

Drowning rates stratified for sex, age-group, and place-of-residence are shown for all drowning deaths in Table 2 and for drowning deaths excluding those occurring in a bathtub in Table 3. Drowning rates tended to be higher among males

Table 1 Characteristics of Unintentional Drowning Victims in Ontario, 2004–2008, by Rural vs. Non-Rural Place of Residence (n = 564)

Characteristic	Rural (n = 140)	Non-Rural (n = 424)	p-value
	n (%)	n (%)	
Sex			0.07
Male	124 (89)	348 (82)	
Female	16 (11)	76 (18)	
Age group			0.20
0–4	5 (4)	20 (5)	
5–14	8 (6)	24 (6)	
15–24	21 (15)	68 (16)	
25–34	14 (10)	63 (15)	
35–44	22 (16)	49 (12)	
45–54	25 (18)	65 (15)	
55–64	18 (13)	50 (12)	
65–74	15 (11)	28 (7)	
75+	9 (8)	57 (13)	
Setting of drowning			0.0006
Open water	122 (87)	294 (69)	
Public pool	2 (1)	12 (3)	
Private pool	5 (4)	40 (9)	
Pond/quarry/casual water	6 (4)	8 (2)	
Unspecified/other	1 (1)	2 (1)	
Bathtub	4 (3)	68 (16)	
Outdoor drowning	124 (88)	332 (78)	0.007
Indoor drowning	16 (12)	92 (22)	
Absence of personal floatation device	24 (17)	62 (15)	0.89
Alcohol use as contributing factor	52 (37)	126 (30)	0.11
Comorbid conditions†			0.12
None	105 (75)	280 (65)	
One present	26 (19)	113 (27)	
Two or more present	9 (6)	31 (7)	

†Comorbid conditions that were deemed to potentially contribute to drowning were diabetes, epilepsy, cerebrovascular accident, psychiatric conditions, trauma, acute drug intoxication, respiratory diseases, and myocardial infarction.

A significant value was defined as $p < 0.05$ using the chi square test for all statistical analyses.

Table 2 Drowning Rates (Deaths Per 100,000 Person-Years) Among Residents of Rural and Non-Rural Areas of Ontario, by Sex and Age Group for All Drowning Deaths

Sex	Age Group	Drowning Rate		Rate Ratios (95% Confidence Interval)
		Rural	Non-Rural	
Male	0–4	2.65	0.85	3.1 (1.1, 8.7)
	5–14	1.25	0.58	2.2 (0.9, 5.4)
	15–24	4.22	1.69	2.5 (1.5, 4.1)
	25–34	3.32	1.61	2.1 (1.1, 4.0)
	35–44	4.02	1.06	3.8 (2.2, 6.4)
	45–54	3.77	1.33	2.8 (1.7, 4.7)
	55–64	3.45	1.54	2.3 (1.3, 3.9)
	65–74	4.32	1.35	3.2 (1.7, 6.2)
	75+	4.46	3.01	1.5 (0.7, 3.1)
	All ages	3.47	1.35	2.6 (2.1, 3.2)
Female	0–4	0.00	0.48	0.0
	5–14	0.44	0.12	3.6 (0.7, 19.8)
	15–24	0.23	0.17	1.4 (0.2, 11.2)
	25–34	0.88	0.25	3.5 (1.0, 13.1)
	35–44	0.39	0.11	3.4 (0.7, 17.4)
	45–54	0.51	0.31	1.6 (0.5, 5.8)
	55–64	0.21	0.24	0.9 (0.1, 7.1)
	65–74	0.32	0.26	1.2 (0.1, 10.4)
	75+	1.15	1.11	1.0 (0.3, 3.5)
	All ages	0.45	0.28	1.6 (0.9, 2.7)

Note: Rate ratios express drowning rates among residents of rural areas compared with residents of non-rural areas.

and among residents of rural areas, regardless of age group (Table 2). The highest drowning rate was among men over the age of 75 from rural Ontario (4.46 per 100,000 person-years).

Drowning Rate Ratios

Rate ratios and corresponding 95% confidence intervals for the risk of drowning among people from rural compared with non-rural areas are shown in Table 2 and Table 3, by sex, age-group, and place-of-residence. Rate ratios tended to be higher for males than for females, but this was not tested statistically.

Table 3 Drowning Rates (Deaths Per 100,000 Person-Years) Among Residents of Rural and Non-Rural Areas of Ontario, by Sex and Age Group

Sex	Age Group	Drowning Rate		Rate Ratios (95% Confidence Interval)
		Rural	Non-Rural	
Male	0–4	2.65	0.46	5.8 (1.8, 18.2)
	5–14	1.04	0.58	1.8 (0.7, 4.8)
	15–24	4.22	1.64	2.6 (1.6, 4.3)
	25–34	3.32	1.49	2.2 (1.2, 4.3)
	35–44	4.02	1.01	4.0 (2.3, 6.8)
	45–54	3.60	1.17	3.1 (1.8, 5.1)
	55–64	3.25	1.50	2.2 (1.2, 3.9)
	65–74	4.32	1.17	3.7 (1.9, 7.3)
	75+	4.46	2.12	2.1 (1.0, 4.5)
	All ages	3.38	1.21	2.8 (2.3, 3.4)
Female	0–4	0.00	0.27	0.0
	5–14	0.44	0.09	4.8 (0.8, 28.9)
	15–24	0.23	0.08	2.7 (0.3, 26.0)
	25–34	0.88	0.17	5.3 (1.3, 21.2)
	35–44	0.39	0.09	4.2 (0.8, 23.1)
	45–54	0.34	0.24	1.4 (0.3, 6.5)
	55–64	0.21	0.10	2.0 (0.2, 19.6)
	65–74	0.32	0.10	3.0 (0.3, 33.6)
	75+	1.15	0.44	2.6 (0.7, 9.8)
	All ages	0.42	0.16	2.7 (1.5, 4.8)

Note: Bathtub drowning deaths excluded. Rate ratios express drowning rates among residents of rural areas compared with residents of non-rural areas.

Mortality Rates

Excluding bathtub drowning deaths (which are unlikely to be related to swimming skill or water safety skills), the age-adjusted drowning mortality rate was significantly higher for both males (rate ratio 2.8; 95% CI, 2.3–3.4) and females (rate ratio 2.8; 95% CI 1.5–5.0) living in rural compared with non-rural areas (Figure 1). With bathtub drowning deaths included, the age-adjusted drowning mortality rate for males remained significantly higher among residents from rural compared with non-rural areas of Ontario (rate ratio 2.6; 95% CI, 2.1–3.2). For females, the age-adjusted drowning mortality rate among rural compared with non-rural residents was not statistically significant (rate ratio 1.7; 95% CI, 1.0–2.9).

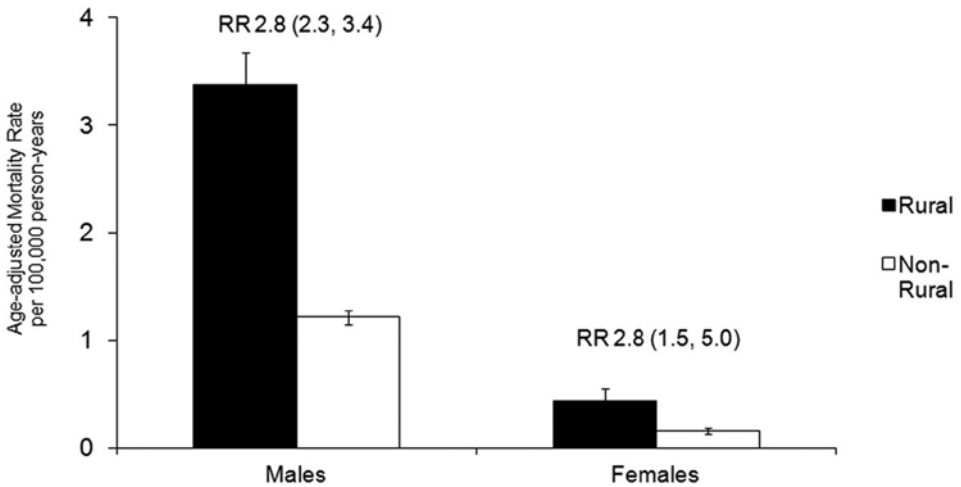


Figure 1 — Age-adjusted mortality rates for men and women in rural and non-rural Ontario.

Discussion

In this retrospective study of drowning deaths in Ontario over a 5-year period, the risk of all drowning types was significantly higher for males, but not females, living in rural areas compared with non-rural areas based upon per capita population. After excluding bathtub drowning deaths to analyze drownings possibly related to swimming and/or water safety skills, men and women from rural areas had a significantly higher risk of drowning compared with their non-rural counterparts.

Previous studies have found rural residency to be associated with an increased risk of drowning, but the majority of these studies were restricted to pediatric drowning deaths (Fang et al., 2007; Hammig & Weatherly, 2003; Kim, Ozegovic, & Voaklander, 2012; Ma et al., 2010; Rahman et al., 2006; Svenson et al., 1996; World Health Organization, 2012). Our study is unique in that we included all ages of drowning victims. Our study also recorded data on risk factors known to increase drowning risk in an attempt to explain the observed increased drowning risk for rural individuals. Personal floatation device use, alcohol use, and presence of a medical comorbidity known to increase drowning risk did not differ significantly among rural and non-rural drowning victims, suggesting these factors likely do not account for the difference in drowning rates we observed. Previous studies have suggested that increased access to open water compounded with decreased access to swimming lessons in rural areas may explain the difference in drowning rates (Fang et al., 2007). A systematic review from North America of drowning deaths and other preventable injuries suggested that socioeconomic status and access to medical care might also explain the higher rates of injury in rural areas (Kim et al., 2012). Further, aboriginal people are at increased risk of drowning and aboriginal groups are more likely to live in rural Ontario (Frohlich, Ross, & Richmond, 2006). In our

study, we did not have access to whether the victims were aboriginal or not, but this may have been part of the reason for the increased drowning risk in rural Ontario.

An important finding from our study was that males in rural Ontario had the highest drowning rates, often 2–4 times higher than non-rural males, depending on the age group. Men in rural Ontario also had the highest drowning rate ratios, suggesting a large magnitude in the difference of drowning rates compared with their non-rural counterparts. It is well known that men are at a greater risk of drowning compared with women (Lifesaving Society, 2013; Quan & Cummings, 2003; Smartrisk, 2009). Previous studies have shown that men are more likely to engage in risk-taking behavior once on the water and are also more likely to be under the influence of alcohol than women (Howland, Hingson, Mangione, Bell, & Bak, 1996; Lapa, Turgut, & Turgut, 2012). Further, men are more likely to overestimate their swimming skill and underestimate drowning risk (McCool, Moran, Ameratunga, & Robinson, 2008; Moran et al., 2012). Less well known, however, is our finding that males from rural areas drown at significantly higher rates than age-matched males living in non-rural areas. This is possibly related to increased access to unsupervised swimming areas in rural Ontario or increased use of aquatic environments for recreational activities (Howland et al., 1996). Although not analyzed in our study, it is known that SES tends to be lower in rural areas compared with urban areas and thus lower SES may be another reason for the increased drowning risk (Statistics Canada, 2010). Regardless, the exact reason why males from rural Ontario were distinctly more likely drown is unknown and is an area for future research.

Previous studies from the U.S., Australia, and Bangladesh found the highest rates of drowning among children aged 1–4 (Mackie, 1999; Quan et al., 1989; Rahman et al., 2006). More recent data from China found that children aged 5–14 had the highest risk of drowning (Fang et al., 2007). In sharp contrast to the aforementioned studies, the two highest drowning rates in our study pertained to men 65–74 years of age and men over the age of 74 from rural Ontario. It is unclear why these age groups had the highest drowning rates, especially considering the results from Australia and U.S., two countries of similar geography, wealth, and development. In the Australian and U.S. studies, the analysis was not subdivided for rural and non-rural drowning deaths, but had they been, a similar trend might have been observed. Given the small sample size of drowning deaths over the age of 65 in rural Ontario, further research is required to determine whether this observation persists in subsequent studies.

It is unclear why bathtub drowning deaths accounted for a much larger proportion of drowning deaths among non-rural victims compared with rural victims. One previous study of drowning deaths in the U.S. found that rates of bathtub drowning increased with age, but their analysis did not take into account place of residency (i.e., rural versus urban; Quan & Cummings, 2003). Further research using multivariate analysis of larger drowning cohorts may be required to confirm this observation.

Limitations

This study has limitations that should be considered when interpreting our results. First, our study is based on data from a single Canadian province, and it is unknown whether our results can be generalized to the rest of Canada or to other countries. Second, our data set was restricted to drowning deaths and thus did not include

nonfatal drowning events. Since nonfatal drowning events occur approximately five times more often than fatal drownings, our study substantially underestimates the absolute risks (Henderson & Wilson, 2006; World Health Organization, 2012). Third, both low socioeconomic status and being aboriginal are known risk factors for drowning. Both are also more likely in rural parts of Ontario and thus may represent potentially lurking variables accounting for the differences in drowning rates observed in our study. In future studies, it will be important to record both to determine the importance each carry in drowning risk.

Conclusion

Our study demonstrated two key findings. First, for unintentional drowning deaths possibly related to swimming skill and water safety, men and women from rural areas had a significantly increased risk of drowning compared with their non-rural counterparts. It is unclear why men and women from rural Ontario were more likely to drown than their non-rural counterparts, and further research is required to determine how much of this risk is due to socioeconomic status, increased access to unsupervised water, swimming skill, or aboriginal status. Further research is necessary before specific drowning prevention initiatives can be launched, but one consideration would be to initiate educational campaigns about basic water safety skills for rural areas of Ontario. Drowning prevention organizations also may consider increasing the use of outreach programs that work specifically with high-risk populations.

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