



Evidence Summary: Drowning

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Evidence synthesis tool

SPORT:	Water activity	Target Group:	All users in water-based activities	
Injury Mechanisms:	Unintentional drowning or submersion injury			
Incidence/Prevalence	Risk/Protective Factors	Interventions	Implementation/Evaluation	Resources
<p>Global Incidence (WHO): 372,000 people die from drowning every year. 91% occur in low- and middle-income countries. Global incidence for all ages is 5.2 per 100,00 (7 per 100,000 in males; 3.4 per 100,000 in females), ranging from 2.3 (high-income countries) to 7.9 (low- and middle-income countries) per 100,000.¹</p> <p>Canada ranks 11th lowest (out of 60 countries) for mortality rate for drowning amongst all age groups (0.9 per 100,000 (95% CI 0.9 to 1.0)).²</p> <p>The overall global rate for drowning among children (0-19 years) is 7.2 deaths per 100,000 population. The drowning rate in low-income and middle-income countries is six times higher than in high-income countries (with rates of 7.8 per 100,000 and 1.2 per 100,000, respectively). Global data show that approximately 28% of all unintentional injury deaths</p>	<p>Non-modifiable risk factors</p> <p><u>Age</u> Children under 5 years of age have the highest drowning mortality rates worldwide, with rates among all age groups peaking in 1–4-year-olds.^{1,3,5,6}</p> <p><u>Sex</u> Boys are at higher risk in all age groups (except infants <1 year).^{3,5-8}</p> <p><u>Income</u> Low income or poverty at greatest risk.³</p> <p><u>Underlying conditions</u> Presence of epilepsy, autism, cardiac arrhythmias increases risk.^{3,8}</p> <p>Modifiable risk factors</p> <p><u>Unsafe surroundings</u> Lack of safe equipment, unsafe vessels, lack of physical barriers between water and people, lack of safe water crossings, poor water</p>	<p>The World Health Organization has identified six evidence-based interventions to prevent drowning.¹⁰</p> <p>Provide safe places away from water for pre- school children</p> <p>Children in Bangladesh participating in a village-based, supervised child-care programme had lower fatal drowning rates than those who did not participate.¹¹ This programme is projected to prevent 70 490 (CI: 47 892-76 567) drowning deaths (89% of total drowning deaths; CI: 60%–97%). The cost per death averted is \$12 596 (CI: \$8110–\$47 038), and the cost per disability-adjusted life years (DALY) averted is \$362 (CI: \$232–\$1364).¹¹</p> <p>Install barriers controlling access to water</p> <p>Pool fences are effective in reducing drowning risk and should have a dynamic and secure gate and should isolate</p>	<p>Evaluation:</p> <p>In New Zealand, there has been a 65% increase in the proportion of pools reported as complying with the Fencing Swimming Pools Act since 1997. In order for pool fencing legislation to be effective, enforcement must be maintained.¹⁴</p> <p>Implementation:</p> <p>The WHO has identified four strategies to support and implement drowning prevention interventions:</p> <ol style="list-style-type: none"> 1. Promote multisectoral collaboration 2. Strengthen public awareness of drowning through strategic communications 3. Establish national water safety (drowning prevention) plan 4. Research: advance drowning prevention 	<p>WHO Report 2017 Preventing drowning: an implementation guide Contains a step-by-step approach for implementing prevention programs in different settings. http://apps.who.int/iris/bitstream/10665/255196/1/9789241511933-eng.pdf</p> <p>Parachute Canada Drowning Prevention http://www.parachutecanada.org/injury-topics/topic/C3 http://www.parachutecanada.org/child-injury-prevention/item/drowning-prevention1</p> <p>Partnerships:</p> <ul style="list-style-type: none"> • Lifesaving Society • Red Cross • Public Health Units • Community members/Caregivers

<p>among children are due to drowning and 1.1% of all disability-adjusted life years (DALYs) lost for children under 15 years of age in low-income and middle-income countries are from non-fatal drowning. The overall fatality rate for boys under the age of 20 years was 9 per 100,000 population, nearly twice as high as the rate for girls (5.2 per 100,000 population). Children under five years of age appear to have the highest drowning mortality rates worldwide, with rates among all age groups peaking in 1–4-year-olds (11.8 and 7.6 per 100,000 for infant boys and girls respectively).³</p> <p>Nonfatal drowning rate in the US amongst 0-19 year old is 5 per 100,000. The highest rates were among children 1 to 4 years of age (14 per 100,000) and among children less than 1 year of age (12 per 100,000).⁴</p> <p>Crude rates for fatal river drowning were calculated for 12 papers in a systematic review, ranging from 0.20 to 1.89 per 100,000 people per annum.⁵</p>	<p>quality are all risk factors for drowning.^{1,3,5,8}</p> <p><u>Alcohol consumption</u>^{1,3,5,8}</p> <p><u>Swimming skill</u></p> <p>Lack of swimming skill is a modifiable risk factor for drowning in adults and children.^{6,8,9}</p> <p><u>Supervision</u></p> <p>Lack of adequate adult supervision is a risk factor for drowning in children.^{1,6,8,9}</p>	<p>the pool from the house (four-sided fencing).^{1,3,10,12,13} A Cochrane review found that the OR for the risk of drowning or near drowning in a fenced pool compared to an unfenced pool is 0.27 (95% CI 0.16 to 0.47). Isolation fencing (enclosing pool only) is superior to perimeter fencing (enclosing property and pool); the OR for the risk of drowning in a pool with isolation fencing compared to a pool with three-sided fencing is 0.17 (95% CI 0.07 to 0.44).¹³</p> <p>Teach school-age children (aged over 6 years) swimming and water safety skills</p> <p>A 2015 systematic review reported some evidence to show that swimming lessons improve swimming ability in children aged 2–4 years and most importantly do not place a child at increased risk of drowning. However, there is no evidence as to whether this is a sustained or enduring skill nor whether it is transferable to various aquatic settings. It is also not a viable intervention for children under 2 years old as swimming lessons in this age group is unproven.¹²</p> <p>Train bystanders in safe rescue and resuscitation</p> <p>Rescue and resuscitation have</p>	<p>through data collection and well-designed studies.¹⁰</p>	
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		<p>limited impact on reducing drowning mortality and morbidity (resources are more cost-effective when applied to drowning prevention⁶) but bystander rescue and resuscitation can nevertheless make the difference between life and death in individual drowning situations.¹⁰</p> <p>Build resilience and manage flood risks and other hazards</p> <p>Despite the increasing frequency of flood disasters, in some regions deaths due to sudden floods and cyclones have declined. This is thought to be the result of improvements in development conditions in low- and middle- income countries, and in early warning, disaster preparedness and response.¹⁰</p> <p>Set and enforce safe boating, shipping and ferry regulations</p> <p>There are few rigorous studies to guide many of the activities in this section, though there is clear evidence that compulsory, government-approved lifejacket-wearing regulations are successful in reducing drowning deaths.^{1,3,10}</p>		
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Review of Sport Injury Burden, Risk Factors and Prevention

Unintentional Drowning or Submersion Injury

Incidence and Prevalence

According to the World Health Organization (WHO), drowning is the 3rd leading cause of unintentional injury-related deaths worldwide, accounting for 372,000 deaths each year. Ninety-one percent of these deaths occur in low- and middle-income countries. The global incidence of drowning for all ages is 5.2 deaths per 100,000 (7 per 100,000 in males; 3.4 per 100,000 in females), ranging from 2.3 (high-income countries) to 7.9 (low- and middle-income countries) per 100,000 (Meddings, Hyder, Ozanne-Smith, & Rahman, 2014). Canada ranks 11th lowest (out of 60 countries) for unintentional drowning mortality rates for all age groups (0.9 per 100,000 (95% CI 0.9 to 1.0) (Lin, Wang, Lu, & Kawach, 2015).

The overall global incidence of drowning among children (0-19 years) is higher, at 7.2 deaths per 100,000 population, compared to adults (M. Peden et al., 2008). The drowning rate for children in low-income and middle-income countries is six times higher compared to high-income countries (with rates of 7.8 per 100,000 and 1.2 per 100,000, respectively) (M. Peden et al., 2008). Global data show that approximately 28% of all unintentional injury deaths among children are due to drowning and 1.1% of all disability-adjusted life years (DALYs) lost for children under 15 years of age in low-income and middle-income countries are from non-fatal drowning. The overall fatality rate for boys under the age of 20 years was 9 per 100,000 population; a rate nearly twice as high compared to girls (5.2 per 100,000 population). Children under five years of age appear to have the highest drowning mortality rates worldwide, with rates at 11.8 and 7.6 per 100,000 for boys and girls ages 1- 4, respectively) (M. Peden et al., 2008).

The non-fatal drowning rate in the US amongst 0-19 year old is 5 per 100,000. The highest rates were among children 1 to 4 years of age (14 per 100,000) and among children less than 1 year of age (12 per 100,000) (Borse et al., 2008). Crude rates for fatal river drowning were calculated in 12 papers as part of a systematic review, ranging from 0.20 to 1.89 per 100,000 people per annum (A. E. Peden, Franklin, & Leggat, 2016).

Worldwide incidence/prevalence data for drowning and particular, non-fatal submersion injury is limited since data collection in low- and middle-income countries is not always complete. In addition, the way deaths are classified means the full extent of the world's drowning problem is underrepresented – statistics currently exclude intentional drowning (for example, suicide and homicide), as well as drowning deaths resulting from flood disasters and water transport incidents.

Risk and Protective Factors

Risk factors for drowning can be divided by non-modifiable and modifiable factors. A limitation of these reported risk factors is inconsistent data collection methods between studies, particularly in defining age ranges.

Non-modifiable Risk Factors

Non-modifiable risk factors for drowning include age, sex, location, income and underlying conditions. Children under 5 years of age have the highest drowning mortality rates worldwide, with rates among all age groups peaking in 1–4-year-olds (Hossain, Mani, Sidik, Hayati, & Rahman, 2015; Meddings et al., 2014; A. E. Peden et al., 2016; M. Peden et al., 2008; Tyler et al., 2017). Boys are at higher risk in all age groups (except infants <1 year) (Hossain et al., 2015; A. E. Peden et al., 2016; M. Peden et al., 2008; Shenoi et al., 2016; Tyler et al., 2017; WHO, 2006). Rural areas in low to middle income countries pose a significantly greater risk for drowning compared to urban areas, particularly for children (Tyler et al., 2017). There is almost equal risk of drowning in a small body of water (ponds, ditches, streams, wells versus a large body of water (lakes, rivers, sea, ocean) in low to middle income countries, whereas swimming pools are the main setting for drowning in high-income countries such as Canada (Tyler et al., 2017). Low income or poverty put individuals at greatest risk for drowning (M. Peden et al., 2008). Additionally, the presence of epilepsy, autism and cardiac arrhythmias in an individual increases risk (M. Peden et al., 2008; WHO, 2006).

Modifiable Risk Factors

Modifiable risk factors for drowning include unsafe surroundings, alcohol consumption, swimming skill and supervision. The lack of safe equipment, unsafe vessels, lack of physical barriers between water and people, lack of safe water crossings, poor water quality are all risk factors for drowning (Meddings et al., 2014; A. E. Peden et al., 2016; M. Peden et al., 2008; WHO, 2006). Alcohol consumption around water is an important risk factor for drowning in many countries, especially for adolescents and adults (Ahlm, Saveman, & Björnstig, 2013; Meddings et al., 2014; A. E. Peden et al., 2016; M. Peden et al., 2008; WHO, 2006). Lack of swimming skill is a modifiable risk factor for drowning that may be addressed in adults and children (Hossain et al., 2015; Ma et al., 2010; Tyler et al., 2017; WHO, 2006) and the lack of adequate adult supervision is a risk factor for drowning in children (Hossain et al., 2015; Ma et al., 2010; Meddings et al., 2014; Tyler et al., 2017; WHO, 2006).

Opportunities for Prevention: Effective Interventions, Cost-Effectiveness, Implementation and Evaluation

The World Health Organization has identified six evidence-based interventions to prevent drowning (Meddings et al., 2017).

1. Provide safe places away from water for pre- school children

Children in Bangladesh participating in a village-based, supervised child-care programmes had lower fatal drowning rates compared to those who did not participate (Rahman et al., 2012). This programme is projected to prevent 70,490 (95% CI 47,892 to 76,567) drowning deaths, which equates to 89% of total drowning deaths (95% CI 60% to 97%). The cost per death averted is \$12,596 (95% CI \$8110 to \$47 038), and the cost per disability-adjusted life years (DALY) averted is \$362 (95% CI \$232 to \$1364) (Rahman et al., 2012).

2. Install barriers controlling access to water

Pool fences are effective in reducing drowning risk and should have a dynamic and secure gates that isolate the pool from the house or dwelling (four-sided fencing) (Meddings et al., 2017, 2014; M. Peden et al., 2008; Thompson & Rivara, 1998; Wallis et al., 2015). A Cochrane review found that the odds of drowning or suffering a near drowning event in a fenced pool was significantly lower, compared to an unfenced pool [Odds Ratio (OR)=0.27, 95% CI 0.16 to 0.47]. Isolation fencing (enclosing the pool only) is superior to perimeter fencing (enclosing the property and pool); the OR for the risk of drowning in a pool with isolation fencing compared to a pool with three-sided fencing is 0.17 (95% CI 0.07 to 0.44) (Thompson & Rivara, 1998).

3. Teach school-age children (aged over 6 years) swimming and water safety skills

A 2015 systematic review reported some evidence to show that swimming lessons improve swimming ability in children ages 2–4 years and most importantly, did not place children at an increased risk of drowning (Wallis et al., 2015). There was no evidence; however, demonstrating whether lessons provided sustainable skills, nor whether the skills were transferable to various aquatic settings. Swimming lessons was also not a viable intervention for children under 2 years of age, as the effectiveness of swimming lessons in this age group is unknown (Wallis et al., 2015).

4. Train bystanders in safe rescue and resuscitation

Evidence suggests that rescue and resuscitation efforts have limited impact on reducing drowning-related mortality and morbidity [resources are more cost-effective when applied to drowning prevention (Hossain et al., 2015)] but bystander rescue and resuscitation can nevertheless, make the difference between life and death in individual drowning situations (Meddings et al., 2017).

5. Build resilience and manage flood risks and other hazards

Despite the increasing frequency of flood disasters, deaths due to sudden floods and cyclones have declined in some regions. This is thought to be the result of improvements in development conditions in low- and middle- income countries, and in early warning disaster preparedness and response (Meddings et al., 2017).

6. Set and enforce safe boating, shipping and ferry regulations

There are few rigorous studies providing evidence toward the enforcement of safe boating, shipping and ferry regulations; however, there is clear evidence that compulsory, government-approved lifejacket-wearing regulations are successful in reducing drowning deaths (Meddings et al., 2017, 2014; M. Peden et al., 2008).

Implementation and Evaluation

Data collection in many low- and middle- income countries is limited, hampering the planning, implementation and monitoring of drowning prevention measures. The WHO; however, has identified four strategies to support and implement drowning prevention interventions: the promotion of multi-sectoral collaboration, strengthening public awareness of drowning through strategic communications, establishing national water safety (drowning prevention) plans, and through increased research efforts including enhanced data collection and well- designed studies (Meddings et al., 2017).

Efforts to evaluate the effectiveness of interventions should be increased. In New Zealand, there has been a 65% increase in the reported number of pools complying with the Fencing Swimming Pools Act since 1997. In order for pool fencing legislation to be effective; however, enforcement strategies must be maintained (Gulliver, Chalmers, & Cousins, 2009).

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