Informing policy on open water drowning prevention: an observational survey of life jacket use in Washington state

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ABSTRACT

Objective To assess life jacket use among Washington State boaters and to examine the relationship between life jacket use and boating laws.

Methods A statewide observational survey of boaters was conducted between August 2010 and September 2010. Data collection included age, sex, life jacket use, boat type, and weather and water conditions.

Results Among 5157 boaters, 30.7% wore life jackets. Life jacket use was highest among groups required by state law: personal watercraft users (96.8%), people being towed (eg, water-skiers) (95.3%) and children 0–12 years old (81.7%). Children and youth were more likely to use a life jacket if any adult in the boat wore a life jacket: 100% versus 87.2% for 0–5 years, 92.8% versus 76.7% for 6–12 years and 81.4% versus 36.1% for 13–17 years. Adult role modelling was particularly beneficial for adolescents aged 13–17 years, who were not covered by a life jacket law. In multivariable analysis, the presence of at least one adult wearing a life jacket was associated with a 20-fold increased likelihood that adolescents were also wearing a life jacket.

Conclusions Highest life jacket use was strongly associated with laws requiring use and with adult role modelling. Legislation requiring life jackets for ages 13–17 years and social marketing encouraging adult life jacket wear in the company of children and youth are promising strategies to increase life jacket use in Washington State.

INTRODUCTION

Drowning is a significant public health problem in the USA and many countries around the world.[1–3] Life jackets, or personal flotation devices, may prevent one in two boating-related drowning deaths,[4] yet in the USA in 2010, 88% of boating-related drowning victims did not wear a life jacket.[5] In Washington State, boating without a life jacket was associated with a 60% increased risk of death between 2003 and 2009.[6] Three out of every four people under 20 years of age who drowned in a boating incident in Washington State between 2000 and 2009 were not wearing a life jacket.[7]

Despite US Coast Guard (USCG) recommendations,[8] a recent longitudinal survey of US boaters demonstrated that overall life jacket use has remained low and relatively unchanged between 1999 (14%) and 2010 (16%).[9] Prior observations in Washington State mirror these national trends. In 2000 an estimated 29% of Washington State boaters wore a life jacket,[10] a slight increase from 25% in 1995.[11]

National increases in life jacket use have been observed among specific subpopulations. Mangione *et al*[9] noted that life jacket use from 1999 to 2010 was highest among individuals on personal watercraft (PWC), boaters being towed on water skis or tubes and children. In the USA, these groups are legally mandated to wear life jackets. The national longitudinal study also demonstrated increased life jacket use by adolescents.

In Washington State life jacket use has been required for people being towed by boats, such as water-skiers, people on PWCs and children on boats.[12–14] We hypothesised that life jacket use by these groups in Washington State would be associated with higher life jacket use than the general population of Washington boaters. We further hypothesised that parental role modelling life jacket use would be associated with higher child life jacket use.

Our study sought to estimate prevalence of life jacket use among Washington State boaters, to examine the association between adult and child life jacket use and to evaluate the association between legally mandated and observed life jacket use. We are unaware of any study that examines the association between age groups and state laws and the association between adult life jacket use and adolescent and child life jacket use.

METHODS

Setting

From a list of 46 potential observation sites, we selected 14 sites based on a mix of boating activity, higher numbers of drownings, high boater volume during prior observations; geographical distribution and recommendations from the boating and law enforcement community. From the remaining 32 potential observation sites, 19 sites were chosen using a stratified random selection algorithm designed to ensure a mix of lake, river and salt water sites, all of which are common in Washington State. A total of 33 sites in 18 Washington State counties were selected.

Observations were conducted on two weekends during summer 2010. At most sites, observations occurred over a 90-min period on subsequent days. At two remote sites, a 3-h observation was held on 1 day. All observations were conducted between 12:00 and 18:00. Observations included all non-commercial boats and PWCs. Inner tubes were excluded from analysis.

Data collection

Observations were conducted by two-person teams. Each observer underwent a 2-h standardised

training adapted from the JSI Research and Training Institute,[15] an organisation that conducts USCG funded national life jacket observation studies. The training included a simulation of practice observations. Each team observed boating activity from the shore to avoid double counting of boats and to facilitate data entry and reliability. One person observed life jacket use through high-powered binoculars; the second observer recorded relayed data. Observers measured air and water temperature at the time of the observations.

Observers recorded demographic information for each person on the boat, including estimated age (<5 years, 6–12 years, 13–17 years, 18–64 years, 65+ years) and sex. Data were collected on type of boat (canoe, kayak, inflatable/raft, motorised boat, paddleboard/sailboard, PWC, rowboat/dinghy and sailboat) and boat length (<16 ft, 16–20 ft, 21–25 ft and >25 ft). Life jacket use was recorded for each passenger (traditional life jacket, inflatable life jacket, none, unknown). If observers could not determine life jacket use with reasonable certainty, life jacket use was marked as unknown. Observers also collected data on the site, including type of body of water (bay/inlet or sound, river, lake or reservoir, harbour), water conditions (no waves, calm waves <6″, choppy waves ≥6″–2′, rough waves over 2′), current strength (strong, moderate, weak/none), weather conditions (sunny, partly cloudy, cloudy, rainy, stormy), visibility (good, fair, poor), air temperature and water temperature.

Data analysis

Bivariate analyses were conducted to examine life jacket use (yes/no) by site characteristics, vessel characteristics, activity and occupant demographics. χ^2 Analyses were conducted for bivariate analyses, with $p<0.05$ indicating a statistically significant result. Robust Poisson regression analyses were used to examine risk ratios and corresponding 95% CIs. The primary outcome variable was observed life jacket use. The primary covariate of interest was age group. We initially considered the following secondary covariates in a hypothesis-driven model: sex of boat occupant, boat type, boat size, boating activity, air temperature, water temperature, weather conditions and water conditions. Covariates were dropped from analytical models if they exhibited a greater than 10% impact on the primary risk ratio estimates, and if they had statistically significant values less than $p=0.05$.

All multivariable regression models controlled for occupant clustering by boat, as correlation might be expected between life jacket use among passengers in the same boat. Site selection included purposively sampled sites (eg, previously included sites) as well as randomly selected sites. Regression models were built to incorporate nested clustering by boat and site type to account for the sampling design, which included previously chosen sites and randomly chosen sites; reported CIs reflected nested clustering.[16]

We also examined life jacket use using multivariable Poisson regression, and adjusted for occupant age, boat type, boat size, boating activity, weather conditions and water conditions. The association between child life jacket use and any adult life jacket use was tested using a dataset restricted to child occupants, and tested for interaction effects between adult use and child age group. Covariates included in the final model were boat type, boat size and boating activity. The association between life jacket use and child age laws was also tested using a dataset restricted to child occupants, and tested for the effect of state

Table 1 Boater, boat and site characteristics, 2010

Characteristics	Percent observed	N
Boater characteristics		5157
Age (years)		5016
0–5	2.0	
6–12	8.5	
13–17	8.9	
18–64	78.1	
≥65	2.5	
Sex		5050
Male	63.8	
Boating activity		5095
Fishing/intent to fish	17.7	
Pleasure	68.3	
Racing/high speed	3.8	
Swimming off boat	0.3	
Water skiing	9.5	
Other activity	0.4	
Boat characteristics		2045
Boat type		2045
Canoe	3.1	
Kayak	8.1	
Motorised boat	67.9	
Paddleboard/sailboard	0.5	
PWC	11.6	
Inflatable/raft	1.3	
Rowboat/dinghy	1.3	
Sailboat	3.2	
Other vessel	0.4	
Boat length		2040
<16 ft	37.3	
16–20 ft	41.6	
21–25 ft	15.3	
>25 ft	5.9	
Site characteristics		71
Water conditions		71
No waves	42.2	
Calm (<6″)	40.9	
Choppy (6″–2′)	16.9	
Water temperature (°F)		71
50–59	16.2	
60–69	57.4	
70–79	22.1	
80–89	4.4	
Weather conditions		71
Sunny	47.9	
Partly cloudy	36.6	
Cloudy	12.7	
Raining	2.8	
Visibility		71
Good	95.8	
Fair	4.2	
Poor	0.0	
Air temperature (°F)		71
50–59	4.2	
60–69	33.8	
70–79	42.3	
80+	19.7	

PWC, personal watercraft.

life jacket laws (required for children under 13 years of age while on boats under 19 ft in length). Covariates in this model were boat type, boat size and boating activity.

This study was reviewed and approved by the Seattle Children's Hospital institutional review board.

RESULTS

Setting

Seventy-one observations were conducted at 16 lakes, 9 rivers and 8 salt water locations in 18 Washington counties. Weather conditions at the observation sites were mostly sunny or partly cloudy and visibility was good (table 1). During most observations air and water temperatures were 60°F or higher and water conditions were calm.

A total of 5306 boaters were initially observed. Of these, 149 were excluded for missing or unknown life jacket use, for a total sample size of 5157.

Boat and boater characteristics

Most boaters were over 18 years (80.6%), male (63.8%), on motorised boats (67.9%) and boating for pleasure (68.3%) (table 1). Of the 2045 boats observed, most boats were ≤20 ft in length (78.9%).

Life jacket use

Overall life jacket use was low (30.7%). Life jacket use did not significantly differ by sex (27.8% male and 33.8% female) in multivariable analysis (table 2). Life jacket use varied by type of

Table 2 Observed life jacket use in Washington State, 2010, by individual boater, boat and environmental factors*

Category	Life jacket use No. (%)	Bivariate model		Multivariable model	
		Risk ratio (RR)	95% CI	Risk ratio (RR)	95% CI
Age (years)					
0–5	89 (89.0)	**4.1**	**(3.2 to 5.2)**	**5.0**	**(4.4 to 5.7)**
6–12	340 (80.0)	**3.7**	**(3.3 to 4.1)**	**4.2**	**(3.9 to 4.6)**
13–17	221 (49.5)	**2.3**	**(2.0 to 2.6)**	**2.1**	**(1.8 to 2.3)**
18–64	854 (21.8)	–		–	–
>65	23 (18.3)	0.8	(0.69 to 1.0)	1.1	(0.84 to 1.5)
Sex					
Male	899 (27.8)	–			
Female	618 (33.8)	**1.3**	**(1.1 to 1.5)**		
Boat type					
Motorised boat	877 (21.1)	–		–	
PWC	333 (96.8)	**4.6**	**(2.7 to 7.9)**	**3.7**	**(2.9 to 4.7)**
Kayak	166 (79.8)	**3.8**	**(2.5 to 5.7)**	**4.4**	**(4.0 to 4.9)**
Canoe	88 (59.9)	**2.8**	**(1.6 to 4.9)**	**2.3**	**(2.1 to 2.4)**
Rowboat/dinghy	23 (45.1)	2.1	(0.93 to4.9)	**1.8**	**(1.5 to 2.2)**
Paddleboard/sailboard	31 (62.0)	**2.9**	**(1.9 to 4.6)**	**2.2**	**(2.1 to 2.3)**
Sailboat	39 (31.7)	**1.5**	**(1.4 to 1.6)**	**2.3**	**(2.3 to 2.3)**
Inflatable/raft	26 (43.3)	**2.1**	**(1.5 to 2.7)**	1.2	(0.57 to 2.4)
Boat length					
<16 ft	762 (56.8)	–		–	
16–20 ft	556 (22.9)	**0.40**	**(0.18 to 0.91)**	0.73	(0.48 to 1.1)
21–25 ft	194 (19.7)	**0.35**	**(0.16 to 0.73)**	0.65	(0.37 to 1.1)
>25 ft	58 (15.4)	**0.27**	**(0.11 to 0.65)**	**0.46**	**(0.26 to 0.80)**
Boating activity					
Fishing/intent to fish	191 (21.2)	–		–	
Water-skiing (all persons in boat with water-ski)	214 (44.3)	**2.1**	**(1.4 to 3.1)**	**1.5**	**(1.1 to 2.0)**
Racing/high speed	111 (56.9)	**2.7**	**(2.6 to 2.8)**	1.0	(0.81 to 1.3)
Swimming	8 (50.0)	**2.4**	**(1.5 to 3.8)**	2.1	(0.88 to 5.2)
Pleasure	1038 (29.8)	**1.4**	**(1.0 to 2.0)**	0.87	0.68 to 1.1)
Other activity	16 (72.7)	1.3	(0.3 to 5.7)	0.95	(0.27 to 3.4)
Weather					
Sunny	765 (32.7)	–		–	
Partly cloudy	591 (29.3)	**0.9**	**(0.84 to 0.96)**	**0.95**	**(0.94 to 0.97)**
Cloudy	219 (32.7)	1.0	(0.97 to 1.0)	1.0	(0.90 to 1.1)
Raining	10 (7.8)	**0.2**	**(0.15 to 0.38)**	**0.39**	**(0.33 to 0.46)**
Water					
Not choppy	1405 (29.9)	–		–	
Choppy (waves >6″)	180 (38.4)	1.3	(0.7 to 2.4)	**1.3**	**(1.0 to 1.7)**

Bolded figures indicate statistical significance at p≤0.05.
*Multivariable risk ratios adjusted for age group, boat type, boat length, activity, weather, water conditions. Total numbers in each factor vary because of missing data for any of the variables included in the multivariable analysis.
PWC, personal watercraft.

watercraft. The highest use was among people on PWCs (eg, jet skis), as required by law. Those on motor boats had the lowest wear rates (21.1%). Those on non-motorised boat types had significantly higher wear rates when compared with motorised boats (table 2). Life jacket use was more common on smaller boats (<16 ft) compared with larger boats.

Age

Life jacket use varied significantly by age group (table 2). Life jacket use was highest among children 0–5 years (89.0%) and 6–12 years (80.0%). For adolescents 13–17 years, life jacket use was less frequent (49.5%). Among boaters age 18 years and older, life jacket use was lowest (21.8% for 18–64 years and 18.3% for 65+ years).

In bivariate analyses, children 0–5 years were four times more likely to wear a life jacket relative to adult boaters (RR 4.1, 95% CI 3.2 to 5.2) and children 6–12 years were nearly four times more likely to wear a life jacket (RR 3.7, 95% CI 3.3 to 4.1) (table 2). Adolescents 13–17 years, an age group not covered by mandatory life jacket rules, were twice as likely to wear a life jacket relative to adult boaters (RR 2.3, 95% CI 2.0 to 2.6).

Adult role modelling

Life jacket use by at least one adult in the boat was strongly associated with life jacket use among child and adolescent passengers. When at least one adult wore a life jacket, all children and adolescents were more likely to wear a life jacket than those in boats where no adult wore one: 100% versus 87.2% for 0–5 years, 92.8% versus 76.7% for 6–12 years and 81.4% versus 36.1% for 13–17 years (figure 1). In multivariable analysis, adjusting for age, boat type, boat size and activity, weather and water conditions, the presence of at least one adult wearing a life jacket was associated with a sixfold increased likelihood that the child was also wearing a life jacket (0–5 years: RR 6.6; 6–12 years: RR 6.2) (table 3), though these did not reach statistical significance. The beneficial impact of an adult role model was particularly pronounced for adolescents, for whom life jacket use was not required by law (RR 20.0) (table 3).

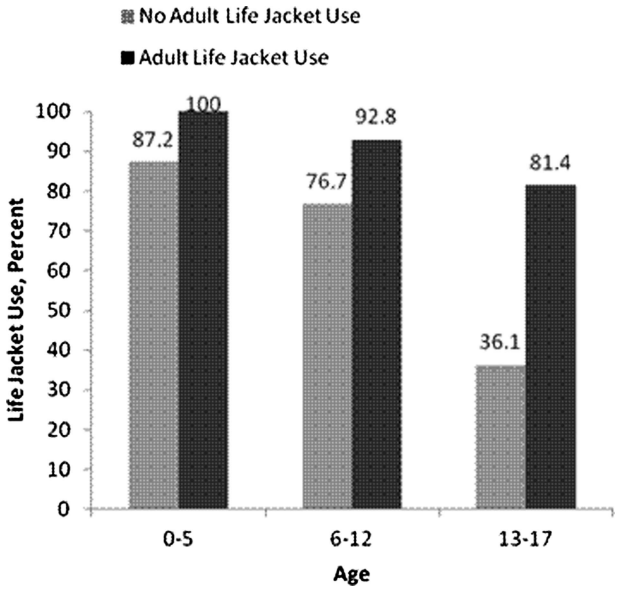

Figure 1 Observed child and adolescent life jacket use when adults wore life jackets (excludes personal watercrafts (PWCs), where life jacket use is required by law of all PWC occupants).

Table 3 Likelihood of child life jacket use if any adult in the boat wore a life jacket (n=865)*

Age category (years)	Multivariable model	
	Risk ratio	95% CI
0–5	6.6	(0.7 to 63.4)
6–12	6.2	(0.5 to 83)
13–17	20.0	(2.9 to 135)

*Multivariable incidence risk ratios of child life jacket use, adjusted for age group, any adult life jacket use, boat type, boat length, activity.

Life jacket laws

At the time of our study, Washington law required life jackets be worn by three groups of boaters: PWC users, people being towed on water skis or other devices, and children aged 12 years and less on boats <19 ft in length.[12–14] Life jacket use was highest among individuals who were required by law to wear a life jacket.

PWC users had higher life jacket use relative to motorised boat users, who were not required to wear a life jacket (96.8% vs 21.1%). In a multivariable regression controlling for age group, boat type, boat length, other boating activities, weather and water conditions, PWC users remained significantly more likely to wear a life jacket than were other boaters (RR 3.7, 95% CI 2.9 to 4.7) (table 2).

People being towed were also more likely to wear a life jacket, as required by law. Nearly every person being towed was wearing a life jacket compared with other individuals on the same boat (95.3% vs 26.0%). In a multivariable regression controlling for age, people being towed were nearly three times more likely to wear a life jacket compared with motorised boat passengers in the same boat (RR 2.9, 95% CI 2.5 to 3.3).

Children 0–12 years also had higher life jacket use. In a multivariable model controlling for boat type, boat size and boating activity, children covered by the mandatory life jacket law were four times as likely to wear a life jacket compared with adolescents 13–17 years (RR 4.2, 95% CI 3.7 to 5.4).

DISCUSSION

Our study and 12 years of national data demonstrate that new efforts to increase life jacket use among all individuals, particularly adults, are needed. Observed life jacket use was low (30.7%) and relatively unchanged compared with state observations from 2000 (29%) and 1995 (24%).[11] This lack of progress is consistent with USCG observations of life jacket use across the US. National life jacket use rates have hovered between 21% and 23% over a 12 year period,[9] unchanged by educational efforts. Many advocates of mandatory life jackets support regulation and enforcement for recreational boaters, particularly those on smaller boats.[9] Opponents of mandatory regulations often favour educational strategies, such as promoting life jacket use through mandatory boater education. Some opponents oppose regulatory approaches citing an individual's right to choose. However, there are no studies documenting the effectiveness of education alone on observed life jacket use.

Increasing life jacket use among users of small vessels, like kayaks and canoes, may be particularly important. In 2011, according to the USCG, 79% of people who drowned in a boating-related incident across the USA were in vessels less than 21 ft.[17] These vessels comprised 62% of all vessels observed in the USA during the same year.[15]

Despite the relatively high use of life jackets among children ages 0–12 years, 11% of children ages 0–5 years and 20% of children ages 6–12 years, were not wearing life jackets as required by law. Measures to increase life jacket use among this age group may reduce drowning. Enforcement of and education about the law are key factors in achieving higher life jacket use. However, many open water areas have little to no marine law enforcement present on most days. Washington State continues to ensure accessibility to life jackets by providing life jacket loaner sites around the state.[18]

In Washington State, where life jacket use decreases with age, measures are needed to increase life jacket use among adolescents. From 2003 to 2010, 89% of 13–19-year-olds who died in boating-related incidents were not wearing a life jacket.[7] Adolescents, particularly male adolescents, are at risk of drowning whether or not they are boating. Between 2008 and 2010, the highest drowning death rates were among youths between 15 and 24 years.[19]

Adolescent life jacket use was strongly associated with greater life jacket use when adults also wore life jackets. This is a particularly compelling finding because current law does not require life jacket use by adolescents. In a prior survey of boating behavioural risk factors conducted at Washington boat docks, the authors found that adults reported higher life jacket use when boating with children.[20 21] An earlier report from four Australian states noted that when the boat operator wore a life jacket, passenger life jacket use was higher (50–74%) than when the boat operator was not wearing a life jacket (4–17%).[22] Neither report analysed the age groups of the passengers. A recent qualitative study of life jacket practices among adult boaters identified behavioural themes which might be incorporated into social marketing approaches.[20]

Life jacket use was strongly associated with laws requiring life jacket use. Boaters were two to three times more likely to wear life jackets when required by law, even after accounting for differences in boat type and size, activity, weather conditions and water conditions. Our findings mirror other observations from the USA and Australia. In the USA, all states require life jackets on PWCs. Between 1999 and 2010, the overall life jacket use among PWC users was 96% compared with 4% for all motorised boats.[9] In a report from four Australian states, where life jackets are required for PWC users, authors described a similar association between mandated use and observed wear rates.[23] A recent Washington study found that reported life jacket use was higher when boaters were in the presence of USCG officials, highlighting the role of enforcement in supporting legislative requirements.[20 21]

There are a number of limitations to this study. There is the potential for misclassification of life jacket use and user characteristics. Because life jackets may have been worn under clothing or incorporated into a jacket, observations may have underestimated life jacket use. To address this concern, we used trained observers with marine experience to minimise the risk of misclassification. Additionally, 149 observations were excluded from analysis because life jacket use could not be ascertained. Non-differential misclassification would have biased estimates of associations towards the null hypothesis. This study was conducted on only two summer weekend afternoons, including a busy holiday weekend when certain types of boaters may have affected boater composition. While some of the findings are similar to other national studies, the results of this study may not be generalisable to other areas or regions where conditions, customs, laws and enforcement differ.

IMPLICATIONS

Adult role modelling and life jacket laws may increase life jacket use and prevent drowning among adolescents and adults. The importance of adult role modelling and its effect on life jacket use should be considered in educational efforts. A social marketing campaign emphasising parent and caregiver life jacket use could be an effective strategy, particularly if combined with legislative changes and enforcement.[20 23] Extending the life jacket law from age 12 years to 17 years is a promising approach to increase life jacket use among adolescents and to reduce open water drownings in this high risk age group. Requiring all ages to wear life jackets on small crafts, particularly on high risk waterways, is another promising approach to increase life jacket use and reduce open water drownings.

Washington State has developed statewide policy strategies, which includes life jacket observations as a surveillance tactic, to reduce open water drowning among children and adolescents.[24] This study represents a framework for ongoing statewide life jacket observational studies and provides detailed data on statewide life jacket use. This data complements the annual national life jacket data collected by JSI and can be used to compare state data with national data. This surveillance system proved valuable in the evaluation of educational and advocacy efforts to increase life jacket use, and will provide the basis for the development of data-driven interventions.

What is already known on the topic

- Overall life jacket use among US boaters is low.
- In 2011, 88% of boating-related drowning death victims did not wear a life jacket.
- Life jackets may prevent one in two boating-related drowning deaths.

What this study adds

- Life jacket use was highest among groups required to wear a life jacket: personal watercraft users, people being towed and children 0–12 years.
- Adult life jacket use was associated with a 20-fold increased likelihood that an adolescent wore a life jacket.
- Life jacket laws and social marketing on the importance of adult life jacket use are promising strategies to increase life jacket use and reduce open water drownings.

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Contributors LQ was the principal investigator of this study. LQ and EB developed the study design. EB oversaw data collection. MAK provided initial data analysis and BEE provided additional data analysis. All authors assisted with the interpretation of the data. CC, LQ, and EB codeveloped the original study report and recommendations for Washington State. CC drafted the manuscript. All coauthors reviewed and revised the manuscript.

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Data sharing statement All study data is summarised and published in this manuscript. Interested parties are welcome to request access to disaggregated and deidentified data from the corresponding author.

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Mass shootings in America

Since 1982, there have been 67 mass shootings in the USA, and 30 since 2006. Most guns used were obtained legally and include assault weapons and semiautomatic handguns. Most shooters were mentally troubled. *Editor's comment*: Especially troubling is that recently, many states laws have rolled back gun restrictions. (noted by IBP).