Lifeboats

RNLI | Research Project ID: 12-8

The impact of riding up on lifejacket performance

Sponsor: Peter Chennell – RNLI Coastal Safety
Department: RNLI Operations Research Unit
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Contractor: University of Portsmouth
Principal researchers: Professor Mike Tipton and Dr Heather Lunt

This research project sought to test whether crotch straps improve lifejacket performance. Our findings are the first conclusive evidence of their effectiveness.

Summary

Photo: RNLI/Nathan Williams

In 2007, a fatal accident inquiry report was the trigger for the RNLI's Marine Safety Manager, Peter Chennell, to instigate a programme of research that would ultimately provide the first conclusive evidence of the effectiveness of crotch straps and be used to influence global standards for lifejacket design.

In August 2006 the yacht *Ouzo* was involved in an incident off the Isle of Wight in which all three crew died. The fatal accident inquiry considered it likely that all three crew members would have been able to survive for far longer in the water if they had crotch straps attached to their lifejackets (MAIB Report No.7/2007).

The Marine Accident Investigation Bureau (MAIB) also made an important recommendation that the British Standards Institute should consider whether a crotch strap should be supplied as standard with every lifejacket sold in this country.

In response to the MAIB report, the RNLI asked sea survival expert Professor Mike Tipton at the University of Portsmouth to conduct a literature review to establish whether there was any pre-existing research regarding the effectiveness of crotch straps. His review found almost no pre-existing robust evidence regarding the effects of crotch straps on lifejacket performance.

The RNLI's Operations Research Unit therefore commissioned the University of Portsmouth's Extreme Environments Laboratory to conduct the first full-scale practical trials into the performance of crotch straps.

A practical trial using volunteers and an anthropometric manikin was designed to establish if lifejacket performance is improved by using a retention system (crotch strap) when entering the water from a height and when exposed to wave conditions for a prolonged time. The RNLI's sea survival pool was used for the trials.

The research concluded that the use of a crotch strap improves lifejacket performance across a number of measures. In addition, wearing a crotch strap fitted tightly (but so that it does not cause any discomfort) improves lifejacket performance more than wearing the crotch strap more loosely. It also improves airway protection both when stepping into water from height and during prolonged wave exposure.

The research recommended that the RNLI should:

- encourage lifejacket manufacturers to provide a retention system on lifejackets
- promote the use of lifejacket retention systems
- educate lifejacket users on the fitting of crotch straps to maximise lifejacket performance.

Research aims and objectives

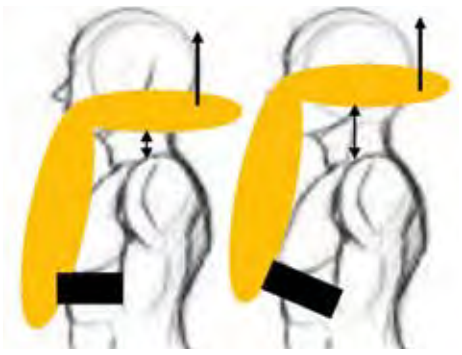
The aims of the research were to assess the impact of wearing crotch straps on lifejacket performance and to offer practical advice to the RNLI on using the resulting evidence.

The objectives for the project were:

1. Assess the efficacy of wearing crotch straps and their optimal fit.
2. Evaluate the effect that extended exposure to waves has on lifejacket performance when wearing crotch straps tightened to different extents.
3. Offer impartial and objective advice to the RNLI regarding how to use the findings.

Photos and illustration: University of Portsmouth

Method and approach



The aim of a retention system (such as a crotch strap) is to improve performance by maintaining the lifejacket around the torso of the user, in order to provide better airway protection.

We therefore designed the trials to measure the following:

- airway freeboard – the distance of the wearer's airway from the waterline
- flotation angle – the angle at which the torso floats in the water (45° is optimal)
- vertical displacement – the distance the lifejacket can be moved up the torso
- waist and crotch strap slippage – the amount the straps slip.

The project adopted a dual method to answer the core research aims:

1. testing using volunteers stepping into the water from height
2. using an anthropometric manikin, exposed to both calm water and wave conditions.

Each method is briefly described below:

1. **Volunteers**

Practical trials using the sea survival pool at RNLI College were carried out using 10 hardy volunteers (five males and five females) from RNLI staff and local Maritime and Coastguard Agency teams. Volunteers were between 18–39 years old and were recruited to ensure there were participants from across a predetermined set of height and weight bands.

Each volunteer tested three 150N ISO 12402-3 compliant lifejackets from different price ranges, wearing a standard set of clothing. The volunteers wore each lifejacket:

- without a crotch strap
- with a crotch strap for comfort fit
- with a crotch strap as tight as possible (while still comfortable).

Each volunteer stepped from 1m and 4m height into the pool. The step from 4m without a crotch strap was not performed for safety reasons. Each test was repeated twice, providing data from a total of 300 tests.

2. **Anthropometric manikin testing**

The second element to the trials used an anthropometric marine manikin to simulate an unconscious casualty in calm water for 30 minutes and then in wave conditions for 3 hours per test. Three 150N and three 275N lifejackets were used, with and without crotch straps (including single and double crotch straps), and with the standard clothing and foul-weather clothing. This made for a total of 36 tests, each lasting 3.5 hours.

Additionally, the time taken for the manikin to take in (aspirate) 1.54 litres of water was measured during this element of the research. This volume is the lethal dose of seawater for drowning a person weighing 70kg and indicates the amount of time that a lifejacket provides protection to the wearer's airway.

Key findings

The findings were striking:

Without a crotch strap

- Lifejackets consistently rode up much more. They also became uncomfortable to wear and performance was reduced across almost all of our measures.
- After the 3.5-hour wave test, the lifejackets rode up much more when our manikin was not wearing a crotch strap, and its airway was frequently submerged.

With a crotch strap

- Wearing a crotch strap improved performance in the volunteer tests, compared with the no-crotch-strap conditions, across almost all of our tests.
- Wearing a tightly fitted crotch strap improves lifejacket performance the most (airway freeboard improved by an average of 30% compared to the no-crotch-strap condition in the volunteer tests).
- Wearing a crotch strap *doubled* the amount of time it took the manikin to aspirate 1.54 litres of water.

How the RNLI is using the evidence

For the first time, the benefit of wearing a crotch strap with a lifejacket has been proven through rigorous academic research.

In February 2014 the RNLI took these results to the International Standards Organization (ISO) committee on lifejackets with the hope of persuading them to add 'a means for retention' to their standard (BS/EN/ISO12402-1:2005 – *Personal Flotation Devices*).

The RNLI was commended for its tenacity and commitment to improving the Standard so the work now starts to incorporate retention systems into the future standard for all lifejackets worldwide.

As part of the RNLI's ongoing work with lifejacket manufacturers and British Standards our Coastal Safety team are now helping to plan and implement the proposed change to the ISO standards.

Acknowledgements and thanks

This ground-breaking research would not have been possible without the dedication of the research team at the University of Portsmouth and the commitment of the RNLI and Coastguard volunteers who repeatedly took to the sea survival pool to provide the data for the study.

If you are interested in finding out more about the study, please contact Tom Walters, Research Manager for the Operations Department: Thomas_Walters@rnli.org.uk.

Further reading

1. RNLI Safety and Education rnli.org/safetyandeducation/stayingsafe/seasafety/Pages/Sea-safety-advice.aspx
2. University of Portsmouth Extreme Environments Laboratory: port.ac.uk/department-of-sport-and-exercise-science/research/extreme-environmental-medicine-and-science/
3. MAIB *Report on the investigation of the loss of the sailing yacht Ouzo and her three crew South of the Isle of Wight during the night of the 20/21 August 2006*: maib.gov.uk/publications/investigation_reports/2007/ouzo.cfm