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Measuring Australian Children's Water Safety Knowledge: The National Water Safety Quiz

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Cover Page Footnote

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Abstract

Water safety knowledge levels of Australian children are poorly understood. Royal Life Saving developed an online National Water Safety Quiz (NWSQ) as an interactive means of determining water safety knowledge amongst Australian primary school children (ages 5 to 12 years). Over a period of 8 months, a total of 4,215 children participated in the NWSQ. The NWSQ identified areas of water safety where knowledge was poor including the topics of cardio pulmonary resuscitation (CPR), swimming, and river safety. Children achieved a better result as they aged. Females out-performed males overall and specifically from ages 10-12 years. Children from independent schools performed better. This research is the first of its kind to measure water safety knowledge at a population level for primary school children, using an online web-based tool. Understanding children's water safety knowledge is important as it enables the tailoring, delivery and evaluation of programs which help to reduce the burden of drowning.

Keywords: water safety knowledge, children, water safety, child drowning, drowning prevention

Drowning is one of the leading causes of unintentional death internationally (World Health Organization, 2014) as well as in Australia (Kreisfeld, 2008). Although drowning prevention strategies for children under five are well understood, particularly in private swimming pools (Bugeja & Franklin, 2012; Wallis, Watt, Franklin, Taylor, Nixon, & Kimble, 2015), there has been little research into drowning in children aged five to fourteen years (Queiroga & Peden, 2013).

In Australia, an average of 15 children aged five to fourteen years drowned every year for the decade 2004/05-2013/14 (Royal Life Saving Society - Australia, 2015). This was a fatal drowning rate of 0.63 and 0.46 for children aged 5-9 years and 10-14 years, respectively (Australian Bureau of Statistics, 2014a). In Australia children aged five to seventeen years commonly drowned in inland waterways such as rivers and lakes across this five-year period (Franklin, Scarr, & Pearn, 2010; Wallis, Watt, Franklin, Nixon, & Kimble, 2015). While the rate of drowning of 5-14 year olds is low (Franklin, Pearn, & Peden, 2017) the rate of drowning rises steeply in late adolescence and the early years of adulthood (Queiroga & Peden, 2013). We postulate that this is due to young adults gaining more independence as they move out of the family home, recreating with peers rather than family, having access to the licensed use of motor vehicles to explore less familiar waterways, undertaking risker activities, and experimenting with drugs and alcohol.

To prevent drowning globally the World Health Organization (WHO) has identified 10 actions. Action three is 'Teach school-aged children basic swimming and water safety skills' and action four is 'train bystanders in safe rescue and resuscitation' (World Health Organization, 2014).

Drowning prevention is complex and has commonly been recognised as requiring more than simply acquiring swimming skills (Moran, 2008). Holistic swimming and water safety education is vital during the school years to provide lifelong skills as well as knowledge to reduce one's risk of drowning (Royal Life Saving Society - Australia, 2012). Water safety knowledge (e.g., understanding dangers, rules for behaviour, safely helping others) has been proposed as a foundational aquatic skill alongside water confidence, survival skills, safe water entry and exit, and elementary swimming skills (Royal Life Saving Society - Australia, 2010). The reduction of drowning involves community education, improved facility design (including

safety barriers), legislation (and enforcement), and rescue and resuscitation (Franklin, RC Scarr, J & Pearn, JH 2010; Peden and Franklin, 2009; Pearn, Nixon, Franklin, & Wallis, 2008).

The Australian Water Safety Council (AWSC) through its Australian Water Safety Strategy has identified the reduction of drowning in children aged 0-14 years of age as a key goal of a comprehensive strategy to reduce drowning in Australia by 50% by the year 2020 (Australian Water Safety Council, 2004; 2008; 2012; 2016). The current strategy (2016-2020) (Australian Water Safety Council, 2016) and previous strategies have also identified that knowledge, as well as swimming and water safety skills, of Australian children are key to drowning prevention (Australian Water Safety Council, 2008).

Very little is known about children's water safety knowledge. Unlike reading, writing and arithmetic which have a series of tests comparing levels across Australia, to date there has been no way of knowing what children do and don't know about water safety. To address this challenge, Royal Life Saving Society – Australia (RLSSA) developed an online National Water Safety Quiz (NWSQ) as an interactive means of determining a level of water safety knowledge amongst Australian primary school children (ages 5 to 12). This paper reports the results of the NWSQ by age, gender, location of residence (state or territory), remoteness classification of home postcode, school type, and water safety topic area.

Method

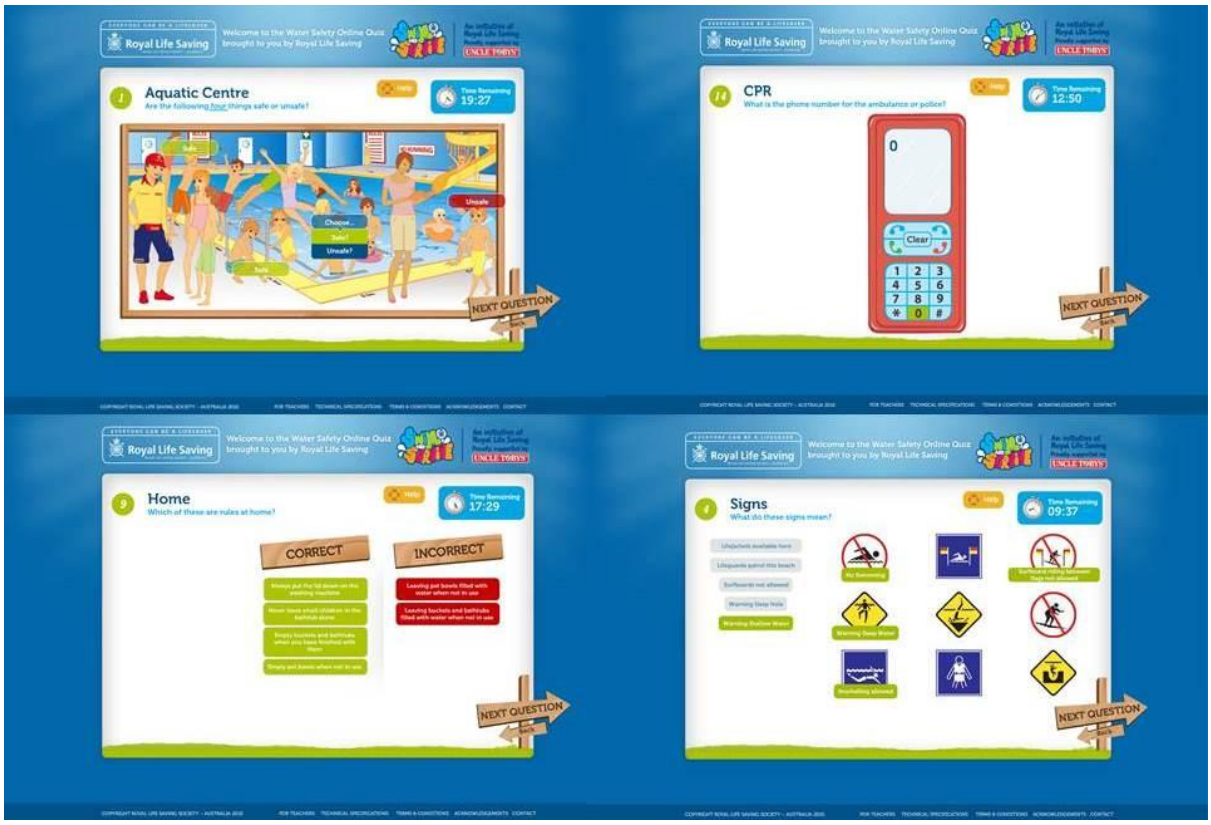
The NWSQ was developed as an on-line measure of water safety knowledge which aimed to be fun and interactive for children aged 5 to 12 years (primary school age in Australia). It is accessible online (www.watersafetyquiz.com.au). A data collection tool was part of the website, which recorded child's first name (this was used in the certificate they received at the end), postcode of residence, age, grade, school, state, their answers to the water safety questions, and the time they spent on the NWSQ.

Question Development

The NWSQ consists of 41 questions covering a range of water safety topics; children had a maximum of 20 minutes within which to complete the 27 questions shown to them. The questions for the NWSQ and the overall conceptual development were created in-house by Royal Life Saving Society – Australia National Office. Questions were drawn from the Swim and Survive program, the Swimming and Lifesaving Manual (Royal Life Saving Society - Australia, 2010), the AquaCode, and staff. Questions were written for children with a reading and water safety knowledge age of 10 years.

Questions were developed using three style formats: scene-based questions, rules-based questions, and multiple choice questions. Each child was asked to answer 27 questions out of a pool of 41 possible questions of which 20 were always included. The options within these questions were drawn from a larger pool of questions, meaning for example, images activated within the aquatic environment scenes would differ each time the NWSQ was loaded and the types of rules shown also varied within the category of home or aquatic centre (Figure 1).

Figure 1 Examples of question types



Key: Top Left - Aquatic Centre Scene based question; Top right - Mobile Phone Interactive Question; Bottom left - Rules Based Questions for the Home Environment; Bottom right - Drag and Drop Safety Signs Question.

There were 12 different categories of questions in the NWSQ: Aquatic Centre, Signs, Beach, Home, Backyard Pool, Boating, CPR, Farm, Lake, Personal Awareness (which includes questions on topics such as emergency procedures, flooding and cold water awareness), Rescues, Rivers, and Swimming (including survival strokes). Each category had at least 2 questions with some categories drawing questions at random from a larger pool to ensure the NWSQ was never the same if a child took it more than once (Table 1).

Table 1. Total pool of questions across category and question type, points available, and whether the question was randomised or always shown

Question Number	Category	Type	Possible Correct Answers	Bank of Questions	Appearance
Q1	Aquatic Centre	SC - deep end	4	15	Random with Q2
Q2	Aquatic Centre	SC -Shallow end	4	17	Random with Q1
Q3	Aquatic Centre	Rules	6	15	Always
Q4	Signs	P – categories	3	3	Always
Q5	Signs	P - signs	9	45	Always
Q6	Beach	SC	4	22	Always
Q7	Beach	R	6	26	Always
Q8	Beach	Rip Picture	1	1	Always
Q9	Home	SC	3	14	Always
Q10	Home	R	6	8	Always
Q11	Backyard Pool	SC	4	21	Always
Q12	Backyard Pool	R	6	11	Always
Q13	Boating	Things to take	6	13	Always
Q14	Boating	R	6	10	Always
Q15	CPR	000	1	1	Always
Q16	CPR	Actions in correct order	6	6	Always
Q17	CPR	M	1	4	1 out of Random 17-21
Q18	CPR	M	1	4	1 out of Random 17
Q19	CPR	M	1	4	1 out of Random 17
Q20	CPR	M	1	4	1 out of Random 17
Q21	CPR	M	1	4	1 out of Random 17
22	Farm	SC	4	16	Always
23	Farm	R	6	15	Always
24	Lake	SC	4	23	Always
25	Lake	R	6	20	Always
26	PA - Aquacode	M	1	4	1 of Random 26-29
27	PA - Help position	M	1	4	1 of Random 26-29
28	PA - Help position	M	1	4	1 of Random 26-29
29	PA - Floods	M	1	4	1 of Random 26-29
30	PA - Emergencies	M	1	4	1 of Random 30-32
31	PA - Survival skills	M	1	4	1 of Random 30-32
32	PA - Cold Water	M	1	4	1 of Random 30-32
33	Rescues	Images	4	8	Always
34	River	SC	4	22	Always
35	River	R	6	15	Always

36	SW - survival stroke	M	1	4	Random 1 out of 36-38
37	SW - survival sculling	M	1	4	Random 1 out of 36-38
38	SW -freestyle	M	1	4	Random 1 out of 36-38
39	SW - breaststroke	M	1	4	Random 1 out of 36-38
40	SW - tread water	M	1	4	Random 1 out of 40 and 41
41	SW - distance clothed	M	1	4	Random 1 out of 40 and 41
Total			110 / 127	419	

Key: PA = Personal Awareness; SW= Swimming; Question Type; P=Picture; SC= Scene; R= Rules; M= Multiple Choice

Illustrations

The images for the NWSQ were developed by an external illustrator based on a brief given by the RLSSA team. The brief was to ensure that the images were fun, friendly, engaging, easy to understand, and appealing to children of primary school age (i.e. 5 to 12 years). The NWSQ was largely picture-based to ensure that it was appealing to children and fun to use.

Website development (www.watersafetyquiz.com.au)

The website and the data collection tool that sat behind it were built by a web development company, NetStarter. The data collection tool collected the de-identified data of students (first name was used to populate a certificate of achievement that children received at the end of the NWSQ, which they could print or save and was not stored on the site). Data were collected in a password-secured online site.

Piloting & Promotion

Once the website was up and running, the NWSQ was piloted with eight schools across five Australian States and Territories. Teachers provided their feedback and the feedback of their students via email or by completing an evaluation form.

Based on the feedback minor changes (e.g., clarification of language, improving instructions, and improvement of images) were made before the NWSQ was launched nationally in mid-November 2010. The data collection component of the research project closed on 30 June 2011. After June 2011, the website was transitioned to an educational game and opened to all to participate as many times as they liked. The changes resulting from feedback included making slight modifications to the words used to ask several questions, providing instruction on how the questions were to be completed, confirming the timer paused when a child taking the NWSQ clicked on the HELP icon, and ensuring illustrated scenes fit within the dimensions of the NWSQ template when used on different sized screens and within different browsers.

The NWSQ was promoted directly to schools as well as through the Royal Life Saving State and Territory Member Organisations' networks using a combination of email, paper-based invitation letters, and promotional posters.

Data Cleaning & Coding

The data were downloaded from the NWSQ site in a tab-delimited file and included the fields of age, gender, grade, state, school, postcode and responses to each question. This information was then saved as a MS Excel© spreadsheet file for cleaning before being imported into IBM SPSS statistical program (SPSS Inc., 2012) for analysis.

Because the NWSQ was hosted online, a number of techniques were used to remove cases which were captured by the data collection tool from the website that 1) were not undertaken by a child aged 5 to 14 or 2) were deemed not to be genuine attempts. This included removing responses with a postcode of 9999 which teachers, parents, and those piloting the NWSQ had used to assist us in identifying non-genuine attempts. An additional 25 entries were removed on the basis that the state, school name, and postcode entered did not match (i.e. were from different states or territories). These were deemed to be dummy results and removed from the dataset prior to analysis.

Once the cases were removed, postcode was coded into Australian Standard Geographical Classifications (ASGC) and grouped into one of five remoteness classification categories: major cities, inner regional, outer regional, remote, and very remote (Australian Bureau of Statistics, 2006). Remoteness classification categories were determined based on physical remoteness from goods and services (Australian Bureau of Statistics, 2003).

Schools were coded into one of three categories based on school name: public (run by the government), independent (run as separate entities by private or religious entity) and Catholic (run by the Roman Catholic Church and administered by the Catholic Education Board). In 2010 when the study began, a total of 6,357 primary schools existed in Australia, of which 76.8% were public schools, 3.9% were independent, and 19.3% were Catholic schools (Australian Bureau of Statistics, 2010).

Data for the Australian population were sourced from the Australian Bureau of Statistics (ABS) database as of June 2011 (Australian Bureau of Statistics, 2014a). The Australian population aged 5-12 years was calculated according to remoteness classification categories using data sourced from the Community Profiles (Australian Bureau of Statistics, 2011).

Data Analysis

From the NWSQ results, a score was calculated as a percentage of the number of answers correct out of the possible maximum number of points (i.e., 41). IBM SPSS version 21.0 (SPSS Inc., 2012) was used for analysis; selected statistical tests included Chi-square, ANOVA, and logistic regression. Statistical significance was set at $p \leq 0.01$ for each analysis to control for experimentwise Type I errors.

Ethics

Ethics approval was granted by the QLD Children's Health Services (RCH) Human Research Ethics Committee, reference number HREC/10/QRCH/64.

Results

A total of 4,215 children participated in the NWSQ between November 2010 and June 2011. Of these, 52.4% were female. The majority (82.6%) of respondents were aged between 10 and 12 years with the average age of participants being 10.6 years (sd = 1.39).

When examining participants' ages by school grades, a strong linear progression was observed with higher grades associated with older children's ages. This is true for all ages and grades of participants responding to the NWSQ, except for a jump in age from Grade 1 to 2 (Table 2).

Table 2. Age by School Grade of NWSQ Participants

Age	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Total
5 years	47							47
6 years	25	6						31
7 years	8	33	8					49
8 years	2	30	112	24				168
9 years		8	125	264	40			437
10 years			3	254	652	29		938
11 years				8	852	372	25	1257
12 years					36	555	697	1288
Total	82	77	248	550	1580	956	722	4215

The survey was representative of the overall Australian population for sex, state, and territory. The data were skewed towards older ages (i.e., children aged 5 to 8 years were underrepresented) which was not surprising because the NWSQ was targeted at 10-year-old children. Almost half of all respondents (46.2%) came from areas deemed to be major cities, with a further 35.3% from areas classified as inner regional. The school type also was not surprisingly skewed with majority of participants from public schools (88.9%). Respondents from Catholic schools were significantly ($p<0.001$) underrepresented in the NWSQ data, accounting for only 4.1% of responses, compared to the 19.3% of Catholic Schools represented in the primary school system in Australia (Table 3).

Table 3. Demographics by NWSQ responses and Australian population 5-12 years old in June 2011

Demographics	Quiz responses		Australian population	
	N	%	N	%
Sex ($p=0.459$)				
Male (ages 5-12)	2008	47.6	1137171	51.3
Female	2207	52.4	1080059	48.7
Age ($p<0.001$)				
5	47	1.1	288653	13.0
6	31	0.7	279838	12.6
7	49	1.2	275180	12.4
8	168	4.0	272217	12.3
9	437	10.4	271746	12.3
10	938	22.3	275686	12.4
11	1257	29.8	276441	12.5
12	1288	30.6	277469	12.5
School Type ($p<0.001$)				
Public	3746	88.9	4879	76.8
Independent	297	7.0	248	3.9
Catholic	172	4.1	1230	19.3

State / Territory (p=0.063)				
Australian Capital Territory (ACT)	25	0.6	34362	1.5
New South Wales (NSW)	1889	44.8	714908	32.2
Northern Territory (NT)	25	0.6	27657	1.2
Queensland (Qld)	458	10.9	469334	21.2
South Australia (SA)	254	6.0	153436	6.9
Tasmania (Tas)	180	4.3	50794	2.3
Victoria (Vic)	860	20.4	529514	23.9
Western Australia (WA)	524	12.4	236937	10.7
Remoteness * (p<0.001)				
Major City	1949	46.2	1472154	67.9
Inner Regional	1489	35.3	424085	19.6
Outer Regional	593	14.1	213519	9.8
Remote	132	3.1	34408	1.6
Very Remote	52	1.2	24197	1.1
Total	4215	100.0	2217230*	100.0

**Note*: *Total d*oes not add up to population numbers since Method for categorizing remoteness didn't add up to the population because 2 different data sources were used and the difference was 2.2%.

Average overall achievement

The overall mean score across all participants on the NWSQ was 72.5%; however, the median or mid-point was 77.3% indicating the overall distribution was slightly non-normal. Results significantly improved as the participants got older (F=35.4; p<0.001) with the highest results being achieved in the 12-year-old age group, an average of 76.3%. Females achieved a significantly higher average scores (74.0%) when compared to males (70.8%) (p<0.001), outperforming males significantly from age 10 years and older (Table 4).

Children from independent schools achieved significantly higher average results (F=27.9; p<0.001) than from public and Catholic schools while females outperformed males across all three school types. The most noticeable sex difference occurred within the results seen between girls and boys in Catholic schools (Table 4). Significant differences by age were only seen between 11 and 12 year olds (Table 5). No significant differences existed among participants based on remoteness of residence (F=0.3; p=0.867).

Table 4. Overall average percentage correct achieved by sex and by age, school type, and remoteness classification of home postcode

	Average Percentage Score	**Male (%)**	**Female (%)**	**Statistical Significance**
Average overall score	72.5	70.8	74.0	F=38.2; p<0.001
Age				[F=35.4; p<0.001]*
5 (n=47)	51.6	55.6	47.7	F=0.7; p=0.411
6 (n=31)	62.6	63.0	62.3	F=0.0; p=0.942
7 (n=49)	68.3	73.0	66.5	F=0.7; p=0.397
8 (n=168)	64.2	61.0	66.9	F=3.7; p=0.052
9 (n=437)	67.1	65.3	68.8	F=3.8; p=0.051
10 (n=938)	71.4	68.8	73.6	F=20.9; p<0.001*

11 (n=1257)	73.6	72.2	75.0	F=10.2; p<0.01*
12 (n=1288)	76.3	74.5	77.9	F=14.7; p<0.001*
School Type				[F=27.9; p<0.001]*
Public (n=3746)	71.8	70.5	73.1	F=22.4; p<0.001*
Independent (n=297)	79.3	76.1	81.7	F=12.5; p<0.001*
Catholic(n=172)	74.8	68.7	77.9	F=11.2; p<0.01*
Remoteness Classification of Home Postcode				[F=0.03; p<0.867]
Major Cities (n=1949)	72.6	70.5	74.4	F=22.9; p<0.001*
Inner Regional (n=1489)	72.5	71.2	73.7	F=9.2; p<0.01*
Outer Regional (n=593)	71.9	70.0	73.6	F=6.4; p=0.012
Remote (n=132)	73.4	72.4	74.1	F=0.2; p=0.618
Very Remote (n=52)	73.0	71.8	74.1	F=0.3; p=0.558

Table 5. Age by school type by mean percentage correct

Age	School Type									Total			Statistical Significance
	Public			Independent			Catholic						
	M	N	SD	M	N	SD	M	N	SD	M	N	SD	
5	51.7	37	32.8	52.6	6	33.6	49.3	*	-	51.6	47	32.4	F=0.0; p=0.988
6	65.1	28	23.5	22.7	*	-	72.7	*	-	62.6	31	25.2	F=3.1; p=0.061
7	68.2	44	24.2	91.8	*	-	64.1	*	-	68.3	49	24.0	F=0.5; p=0.592
8	64.2	158	19.9	67.7	*	-	62.2	8	26.8	64.2	168	20.1	F=0.1; p=0.932
9	66.9	427	19.3	81.7	7	6.8	72.4	*	14.7	67.1	437	19.2	F=2.2; p=0.115
10	71.2	903	16.1	79.2	21	12.4	72.1	14	13.7	71.4	938	16.0	F=2.6; p=0.076
11	73.1	1128	15.5	79.8	92	9.6	74.2	37	15.7	73.6	1257	15.3	F=8.4; p<0.001
12	75.4	1021	16.3	80.7	166	12.4	78.0	101	15.1	76.3	1288	15.9	F=8.7; p<0.001
Total	71.8	3746	17.4	79.3	297	13.7	74.8	172	17.3	72.5	4215	17.2	F=27.8; p<0.001

M=Mean; SD=Standard Deviation; * Cell count <5

Achievement by topic

When examining percentage correct by topic, the knowledge categories of boating safety (average of 83.8% correct), beach safety (average 79.5%) and home water safety (average 79.3%) were reasonably well-answered overall. Knowledge categories such as swimming (average of 51.5% correct), CPR (51.1%), and personal awareness (54.4%) were answered at low levels of correctness.

When analysing topics by sex of respondents, females outperformed males in all categories, with sex found to be significant on all topics apart from water safety signs, personal awareness, rescues and swimming (Table 6). The most notable differences in knowledge occurring on topics such as CPR (4.6% difference) and home water safety (4.0% difference). Areas where knowledge was most similar when analysed by sex of respondent were the categories of swimming (1.2% difference) and rescues (1.4%), both of which were not significantly different.

Table 6. Average percentage correct overall and by sex by NWSQ topic

Topic	Overall Average (%)	Male (%)	Female (%)	Statistical Significance
Aquatic Centre	77.2	75.1	79.0	F=31.8; p<0.001
Water Safety Signs	73.5	73.2	73.9	F=1.1; p=0.270
Beach Safety	79.5	77.7	81.2	F=27.7; p<0.001
Home Water Safety	79.3	77.2	81.2	F=35.4; p<0.001
Backyard Swimming Pool	73.4	71.2	75.5	F=45.0; p<0.001
Boating Safety	83.8	81.8	85.6	F=28.5; p<0.001
CPR	51.1	48.7	53.4	F=25.6; p<0.001
Farm Water Safety	75.7	73.8	77.5	F=23.8; p<0.001
Lake Water Safety	75.8	73.9	77.4	F=18.4; p<0.001
Personal Awareness	54.4	53.2	55.5	F=3.8; p=0.050
Rescues	60.3	59.6	61.0	F=1.6; p=0.200
River	69.5	67.9	71.0	F=11.4; p<0.001
Swimming	51.5	50.5	51.7	F=0.85; p=0.356
Overall Score	**72.5%**	**70.8%**	**74.0%**	**F=38.2; p<0.001**

Time spent

The database developed from the NWSQ also recorded data on time spent taking each NWSQ attempt. The average time taken to complete the NWSQ was 14.4 minutes out of a possible 20 minutes allowed. Males spent significantly less time than females (14.2 compared to 14.6 minutes for females, F=12.5; p<0.001). Children 5-years-old spent the least amount of time on the NWSQ at 11.6 minutes on average. While there was a statistically significant difference among all ages, this was due to the fact that 5-year-olds and 12 years spent significantly less time than other ages completing an attempt. No statistically significant difference was found between 6-11 year olds with respect to time taken (Table 7).

Table 7. Average time taken to complete the NWSQ by sex and age

Demographics	Average time taken (in minutes)	Statistical Significance
Overall	14.4	
Sex		
Male	14.2*	F=12.5; p<0.001
Female	14.6	
Age		
5	11.6*	F=17.9; p<0.001
6	15.2	
7	16.3	
8	15.7	
9	15.0	
10	14.8	
11	14.5	
12	13.7*	
School Type		
Public	14.5	F=17.9; p<0.001
Independent	13.2	
Catholic	14.1	
State		
ACT	14.3	F=14.5; p<0.01
NSW	14.1	
NT	16.1	
QLD	14.4	
SA	14.5	
TAS	12.9	
VIC	15.3	
WA	14.6	
Remoteness		
Major Cities	14.1	F=6.7; p<0.001
Inner Regional	14.5	
Outer Regional	14.8	
Remote	15.5	
Very Remote	14.3	

* p<0.01

Achievement by school type and remoteness

When examining percentage correct by topic and school type of participant, there were large gaps in knowledge on CPR between participants attending public school and those attending independent or Catholic Schools (49.7% correct for public school students compared to 64.2% for independent school students and 60.0% for Catholic school students). Participants from public schools did outperform children from Catholic schools on the topic of Rivers (69.0% compared to 68.4% for participants from Catholic schools which may indicate a higher number of public school participants from inland areas.

School type was found to be statistically significant for average achievement on all the knowledge topics (Table 8). There was no statistically significant difference by remoteness (F=0.32; p=0.867) for percentage correct.

Table 8. Average percentage correct by school type and NWSQ topic

TOPIC	Public (%)	Independent (%)	Catholic (%)	Statistical Significance
Aquatic Centre	76.6	82.2	80.8	F=11.1; p<0.001
Water Safety Signs	72.9	78.6	78.8	F=13.9; p<0.001
Beach Safety	78.8	86.5	83.7	F=21.0; p<0.001
Home Water Safety	78.8	84.7	80.4	F=10.0; p<0.001
Backyard Swimming Pool	73.0	78.1	75.1	F=9.1; p<0.001
Boating Safety	83.2	90.0	84.7	F=11.7; p<0.001
CPR	49.7	64.2	60.0	F=40.0; p<0.001
Farm Water Safety	75.1	82.2	77.5	F=11.9; p<0.001
Lake Water Safety	75.3	82.3	75.5	F=9.7; p<0.001
Personal Awareness	53.6	65.0	54.1	F=12.5; p<0.001
Rescues	59.7	68.4	59.7	F=8.7; p<0.001
Rivers	69.0	77.1	68.4	F=10.7; p<0.001
Swimming	49.6	69.0	54.1	F=34.1; p<0.001
Overall score	**71.8**	**79.3**	**74.8**	**F=27.8; p<0.001**

The authors calculated a multiple linear regression to evaluate total percent correct based on age, school type, class, remoteness of home postcode, state and also by gender. A significant regression equation was found (F (6,4208) = 50.16; p<0.001), with an R^2 of 0.067. Participants predicted total percentage correct was equal to 42.43 + 1.57 (age) + 1.48 (school type) + 1.45 (class) – 0.18 (remoteness) – 0.14 (state) + 3.23 (gender) where age was measured in years; school type was coded as 1= public, 2=independent, 3= Catholic; class was measured in grade years (starting at grade 1 through to grade 7); remoteness was coded from 1= major cities, 2=inner regional, 3=outer regional, 4=remote, 5=very remote; state was coded as 1= ACT/NT/Tas, 2=NSW, 3=Qld, 4=SA, 5=Victoria, 6=WA; and gender was coded as 1= Male and 2= Female (Table 9).

Percent correct increased by 1.57% for each year of age, 1.48% from public to private school, by 1.45% for each increase in class grade, and there was a 3.23% difference between females and males, whereas total percent correct declined for remoteness. Age, school type, class, and gender were all significant predictors of total percent correct. For males a significant regression equation was found (F (5,2002) = 18.17, p<0.001) with an R^2 of 0.43; however, only age was a significant predictor of total percent correct, increasing by 1.64 percentage points for each year. For females a significant regression equation was found (F (5,2201) = 39.42, p<0.001), with an R^2 of 0.082, with all variables except remoteness being significant predictors of total percent correct with an increase of 1.53 percentage points for each yearly increase in age (Table 9).

Table 9. Multiple Linear regression models for achievement in NWSQ (Total Percent Correct)

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
Overall	(F (6,4208) = 50.16; p < 0.001)				
Constant	42.43	3.03		13.99	0.00
Age	1.57	0.44	.13	3.60	0.00

School Type	1.48	0.58	.04	2.57	0.01
Class	1.45	0.47	.11	3.09	0.00
Remoteness of Home Postcode	-0.18	0.29	-.01	-0.60	0.55
State	-0.14	0.16	-0.1	-0.88	0.38
Gender	3.23	0.52	0.9	6.26	0.00
Males	(F (5,2002) = 18.17, p<0.001)				
Constant	44.90	4.60		9.76	0.00
Age	1.64	0.68	0.12	2.40	0.02
School Type	0.62	1.02	0.01	0.61	0.54
Class	1.30	0.72	0.09	1.79	0.07
Remoteness of Home Postcode	-0.03	0.46	0.00	-0.07	0.94
State	0.34	0.25	0.03	1.35	0.18
Females	(F (5,2201) = 39.42, p<0.001)				
Constant	49.93	3.64		13.71	0.00
Age	1.53	0.56	0.14	2.74	0.01
School Type	1.85	0.68	0.06	2.73	0.01
Class	1.56	0.60	0.13	2.61	0.01
Remoteness of Home Postcode	-0.24	0.37	-0.01	-0.66	0.51
State	-0.60	0.21	-0.06	-2.89	0.00

Discussion

This novel study was the first of its kind to attempt to quantify the water safety knowledge of Australian primary school children at a population level. Some of the results were to be expected (e.g., children achieved better results as age increases) while some were unexpected (e.g., differences between males and females; differences based on school types). The results of the NWSQ provided insights into the water safety knowledge levels of Australian primary school children.

The NWSQ has highlighted higher levels of knowledge in the categories of boating, beach, and home water safety amongst the participants; however, categories such as CPR, personal awareness, and swimming were answered with low levels of knowledge. Further work is required to improve rivers and rescue knowledge, areas in which our understanding has improved over the last few years (Franklin & Pearn, 2011; Pearn & Franklin, 2012; Peden, Franklin, & Leggat, 2016a). Overall, females demonstrated higher levels of knowledge on all categories when compared to males. This should be a serious concern to aquatic professionals because males are much more likely to drown than females (Franklin, Scarr, & Pearn, 2010; Royal Life Saving Society - Australia, 2015; Wallis, Watt, Franklin, Nixon, & Kimble, 2015; Peden, Franklin & Leggat, 2016b).

The authors noted a statistically significant gap between average total scores in public and independent schools with public school children scoring on average 71.8% compared to 79.3% for students at independent schools. Independent schools generally are better resourced and are more likely to have a swimming pool on school grounds which reduces the access to aquatic location barrier (Peden, Franklin, & Larsen, 2009). We suspect aquatic experience resulting from increased access to a pool for independent schools may improve water safety knowledge (Franklin et al., 2015) and independent schools may have fewer restraints than public schools when it comes to continuing to provide swimming and water safety education to their students (Peden et al., 2009). This difference needs further investigation to see whether a link exists between education delivery (amount, style, access and timing) and education outcomes. The predominance of public school participants (88.9% of sample) also may have produced unequal variances that influenced the statistics unevenly. A higher level of boating

safety knowledge noted among independent school students (90.0%) compared to Catholic schools (84.7%) and public schools (83.2%) may have indicated that independent schools had resources to provide boating as a physical education option for their students. Such increased boating experiences may have included safety education. Alternatively, the higher economic status of parents of students in independent schools may have lead them to own or have access to boats, experience with which could increase knowledge. Again, these hypotheses need to be explored.

Overall, the children in outer regional areas performed the lowest on water safety knowledge, scoring an average 71.9% correct compared to 73.4% among children from areas deemed to be remote. Very remote areas are normally classified as such due to being a long distance from goods and services in major Australian cities which generally are situated on the coasts. Ensuring the adequate acquisition of water safety knowledge to all children in Australia ought to be a priority. The use of educational technology to provide such knowledge is going to be important for students in remote and very remote areas of the country.

With respect to the length of time taken to complete the NWSQ, 5-year-old children spent the least amount of time completing their NWSQ session, using only 11.6 minutes on average out of the total 20 minutes allowed. This significantly shorter time may have indicated that these young students were just guessing at the answers rather than reading the questions thoroughly (which were designed for a 10-year-old-reading level). The reduced time taken by category as children progressed through a session of the NWSQ suggested some learning may have been taking place; however, further research needs to be conducted to determine whether children are learning about the content or whether they are becoming more comfortable with the format of the questions or whether the young students are losing interest due to the difficulty and are spending less time thinking about the answers. Randomising the order of categories and the questions within each category would test this assumption by providing children a different experience each time they take the NWSQ.

Collecting information about children's swimming and water safety knowledge is important for several reasons. These reasons include knowing what children do and don't know so programs can be targeted to emphasise areas with lower comprehension. In addition, this information can evaluate water safety education programs to identify changes in knowledge over time and allow the most efficient use of resources. The challenge lies in how this information is collected and monitored over time. The authors feel strongly that the use of an online tool such as we used in this study provides an optimal, efficient, and effective option for this activity. Further work in exploring changes over time is required, including the need for greater resources to ensure the questions and format are relevant and appropriate for different ages of primary school students. There are many positives for the future development and use of the NWSQ. Data should be collected year to year to measure increases or decreases in knowledge against the data collected in year one (2010-2011).

Concerns have been expressed about the decreasing availability of learn to swim programs within the primary school curriculum in Australia (Peden et al., 2009); these concerns are compounded by the challenges around facility access and presence of qualified staff (Peden et al., 2009). Tools such as the NWSQ which explore the provision of education in alternative ways could assist in increasing water safety knowledge; however, these tools are less likely to be effective without physical links to aquatic skills and environments. The NWSQ may have value as a classroom-based tool to further extend water safety knowledge discussed during swimming lessons or as a means of providing some form of water safety education to children within a school system lacking resources or access to a pool or other aquatic environment. A feedback loop could be added so that the children receive their results to each question rather than an overall score or results on class and individual achievement could be made available to the teacher.

Further work is needed to determine a national benchmark for water safety knowledge. At a minimum, we believe that Australian children should be able to achieve an overall knowledge score of 75% or more as well as 75% or more on each category by the time they leave primary school,. This score should be achievable as females by age 11 achieved a percentage correct score of 75%. Instead of using an arbitrary percentage, criterion-related measurement principles could be used to establish externally-validated achievement levels.

Limitations

There are a number of limitations which need to be taken into consideration when interpreting these results. Because the NWSQ was taken on-line there is a possibility that the results reflect those with access to a computer and not the wider community in Australia; however, in 2012-2013, 96% of households with children under the age of 15 years were reported to have had access to the internet at home (Australian Bureau of Statistics, 2014b).

Due to the ethical limitations (i.e., ensuring anonymity of results) as well as the way the quiz was set up, it was not possible to determine whether any child attempted the quiz more than once; however, due to the random nature of the questions, it is possible that children participating in the NWSQ multiple times were exposed to different questions for about half the items. It also is possible that a class may have participated collaboratively in the quiz, rather than as an individual (i.e., we were told that this occurred on some occasions) and as such a very small number of participants may represent class knowledge rather than an individual's. Such lack of independence in attempts may have some implications related to the statistical significance of results. We therefore note that data captured by the NWSQ and analysed in this paper might not be a representative sample and therefore caution is urged when making judgements about Australian children's water safety knowledge as a whole.

The authors were not able to collect any information on Intelligence Quotient (IQ) or other measures of academic achievement. We were unable to adjust for intelligence when exploring achievement on the NWSQ which may or may not be linked. On the other hand, as a "population study," intelligence may be assumed to be normally distributed similar to the distribution of the NWSQ scores. We also were not able to determine either how accurate (i.e., valid) or repeatable (i.e., reliable) the scores on NWSQ were (e.g., currently we do not know the degree to which retaking the NWSQ results in the same or similar scores. Further pilot work with a cross-sectional sample of children can provide estimates for the reliability and validity of the water safety knowledge scores on the NWSQ.

These data do not allow us to link water safety programs to children's knowledge at this point. This is an area which requires further exploration to understand their impact. It is also unclear about the links between knowledge and skills; further work is required to explore these relationships.

Conclusion

The development and implementation of the NWSQ was the first attempt of its kind to use an online, interactive platform to record levels of water safety knowledge among Australian primary school children. The results of this research project have identified areas of lower levels of knowledge across Australia, particularly in the areas of CPR, personal awareness, and swimming knowledge. Higher levels of comprehension were noted in areas of knowledge on beach safety among children from major cities (typically near the coast) and farm safety in children from very remote areas (typically inland). Exposure to an environment is likely to increase knowledge about the risk, thus making unfamiliar environments a greater risk for those not familiar with them. Also of some concern was the low level of knowledge on river safety among participants from very remote areas and the lower levels of overall knowledge among males given consistent research showing males are four times more likely to drown than women in adulthood.

Water safety knowledge is an important component of a holistic swimming and water safety education program and key for children of primary school age to keep drowning statistics among this age group low and hopefully provide lifelong skills and knowledge for safer interaction with the water as adolescents and adults. Further work is needed to establish national benchmarks for water safety knowledge. The NWSQ as a classroom-based tool presents an unique opportunity to supplement in-water instruction in school-based learn to swim programs.

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