



Circumstances surrounding drowning in those under 25 in New Zealand (1980-2002)

CHILD AND YOUTH MORTALITY REVIEW COMMITTEE
Te Röpü Arotake Auau Mate o te Hunga Tamariki, Taiohi

In collaboration with
Water Safety New Zealand

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ABSTRACT

Objective: To describe the epidemiology of drowning in 0-24 year olds in New Zealand (NZ) with a view to identifying where appropriate interventions might decrease child and youth mortality.

Design: Detailed reports of all drowning related deaths in New Zealand from 1980 to 2002 obtained by the New Zealand Mortality Review Data Group from Water Safety New Zealand were reviewed retrospectively.

Results: There were 1,334 drowning related deaths over the 23 year study period. Most involved males (76%). The age groups of 1-4 years and 15-24 years had the highest rates of drowning of 6.9 and 5.9 per 100,000 respectively. Accidental immersions were the most common activity prior to drowning (37%) followed by swimming (18%) and motor vehicle accidents (MVAs) (14%). Infants most commonly drown in the bathtub (67%). The 1-4 year age group predominantly drown in home pools (42%). The number of toddler deaths in home pools has reduced coinciding with legislation requiring fencing of domestic pools. Those aged 15-19 years drowned predominantly in MVAs and in natural bodies of water. Twenty eight percent of deaths in this age group involved alcohol.

Conclusions: There has been a significant reduction in the incidence of drowning related deaths ($p < 0.001$) over the specified time period. Areas which need further attention are pre-school drownings and drownings of males aged 15-19. Attention needs to be paid to enforcing pool fencing legislation, and to further education regarding water safety.

Key Words: Child, Youth, Drown, Pool, Pool-fencing, Alcohol

Key Points:

1. All children under the age of three years should be constantly supervised in the bath by an adult.
2. Children under the age of five years should not be left to supervise younger children in the bath
3. All home pools need to be fenced in regulation with the Fencing of Swimming Pools Act 1987, with attention to ongoing compliance. Gates should never be propped open.
4. Adults need to closely supervise toddlers while they are near any body of water.
5. Adolescents, particularly males, need to be educated about water safety:
 - a. Adequate swimming ability is vital.
 - b. Alcohol use when engaged in water based recreation should be discouraged.
 - c. Attention to weather conditions, safety equipment and skill level need to be considered prior to engaging in water based recreation.
 - d. The appropriate use of buoyancy aids is essential.

INTRODUCTION

Unintentional injury is the leading cause of death for 1-24 year olds in New Zealand.¹ In the 1-14 year age group drowning is the second leading cause of injury death after motor vehicle accidents.^{2, 3} Deaths amongst 0-24 year olds in 1996 alone accounted for 33,762 years of potential life lost⁴ and each year approximately 20,000 children and teenagers receive hospital inpatient treatment for injury.⁵ There is also tremendous emotional toll on families, especially parents, caused by death and disability.⁶

When compared to other OECD countries New Zealand has a high incidence of injury related death in children and youths.⁷ International Collaborative Effort (ICE) injury statistics showed New Zealand had the highest average annual injury death rate of 11 OECD countries in the study at 17 per 100,000 in 1-14 year olds and 86 per 100,000 in 15-24 year olds. Our drowning rate is also the highest in the 1-14 year age group at 3 per 100,000.⁷ In the 1-4 year age group, this rate is 5.1 per 100,000.⁸ Of all OECD countries, New Zealand compares poorly with the fifth highest injury death rate in 1-14 year olds of 13.7 per 100,000 for the period 1991-1995.⁹

The actual number of drownings is small compared to the number of immersion incidents and their associated morbidity. In the United States it has been estimated that immersion incidents occur 500-600 times more commonly than immersion fatalities, and that admissions for near drowning occur between 3.5^{10,11} to five¹² times more frequently than death from drowning. Persisting morbidity from near drowning cases is estimated at 5%.¹³ This implies that actual drowning figures are merely the tip of the iceberg, therefore the purpose of this report is to explore the circumstances around drowning in more detail.

In 2001 the Child and Youth Mortality Review Committee (CYMRC) was established by the Ministry of Health under the New Zealand Public Health and Disability Act (2000) to review child and youth deaths with the aim of being able to prevent further deaths by the same cause. The Mortality Review Data Group is currently based in the Department of Women's and Children's Health, University of Otago.

The following is a description of data from 1980-2002, for 0-24 year olds in New Zealand.

METHODS

DrownBase™ is a Water Safety New Zealand (WSNZ) database that maintains nation wide surveillance of drownings. Deaths are included in DrownBase™ if the primary cause of death was drowning, or if drowning was a contributing cause of death and the primary cause of death was potentially survivable. Set up in 1990, data was entered retrospectively based on detailed paper reports since 1980. WSNZ collect information from police reports, coroners files and media clippings. They match their data with that from the New Zealand Health Information Service, Maritime Safety Authority records and the Injury Prevention Research Unit (University of Otago Medical School) with an estimated detection rate of 95% of all drowning related deaths [personal correspondence]. WSNZ have sent an investigator to all but two of the public pool drownings since June 1999.

WSNZ provided details to the Data Group of all known drowning related deaths for 0-24 year olds since 1980. This age range was chosen as this is the age range covered by the CYMRC. The data was in the form of an Excel spreadsheet with 21 fields for each person. Information was recorded under the following headings: date of death, inquest number, family and given names, age (in years), residence region and location, drowning region and location, site of drowning, activity prior to drowning, ethnicity, gender, residential status, medical condition, number of fatalities, involvement of alcohol, rescue attempt, resuscitation, use of buoyancy aid and a short synopsis with a brief description of events preceding drowning. Data was looked at under the above headings and further examined by year, age and gender.

Drownings in private swimming and spa pools were coded by the first author, based on the synopsis of free text in DrownBase™. They were categorised as to whether the pools they occurred in were fenced, unfenced, had incomplete or inadequate fencing, if the gate was inadequate or open, if access was obtained through the house, if the ladder was left in place (above ground pools only), if the victim climbed over the fence with aid (blocks etc), if the child was known to be in the pool area and lacked supervision, or if there was no information regarding the fencing state of the pool. These deaths were then grouped with unfenced and incomplete fencing together, and pools with the gate open, access through the house, ladder left in place, climbed over fence with aid and lack of supervision in a second group. This was done to reflect the number of deaths that were potentially preventable by legislation (group 1), and those which occurred despite legislation (group 2). All but one category in group 2 (lack of supervision) reflects non compliance with the Fencing of Swimming Pools Act 1987 (FSPA).

The Fencing of Swimming Pools Act 1987 in conjunction with The New Zealand Building Code, requires access to swimming pools by children under six years of age to be restricted where the depth of water exceeds 400mm.¹⁵ For this reason drownings of children six years and over were excluded from analysis of pool fencing trends, as the drownings of older children and youth were primarily due to other factors, for example epilepsy, rather than immersion incidents after gaining unintended access to the pool.

Population data provided by Statistics New Zealand was used to calculate rates per 100,000 where applicable. For 2002 population data, the estimated population of New Zealand was used.¹⁶

Where stated, deaths due to motor vehicle accidents (MVAs), suicide and homicide have been excluded from the analysis as the death was not primarily due to the site of drowning, but due to the activity causing death.

RESULTS

A total of 1,334 people aged 0–24 years drowned in New Zealand from January 1980 – December 2002 inclusive. Of these drownings, 1,280 (96%) were unintentional, 44 were suicide, and ten homicide.

Over the study period, there has been a significant decrease in the number of drownings ($p < 0.001$), with an average reduction of 4.1% per year. *See figure 1.*

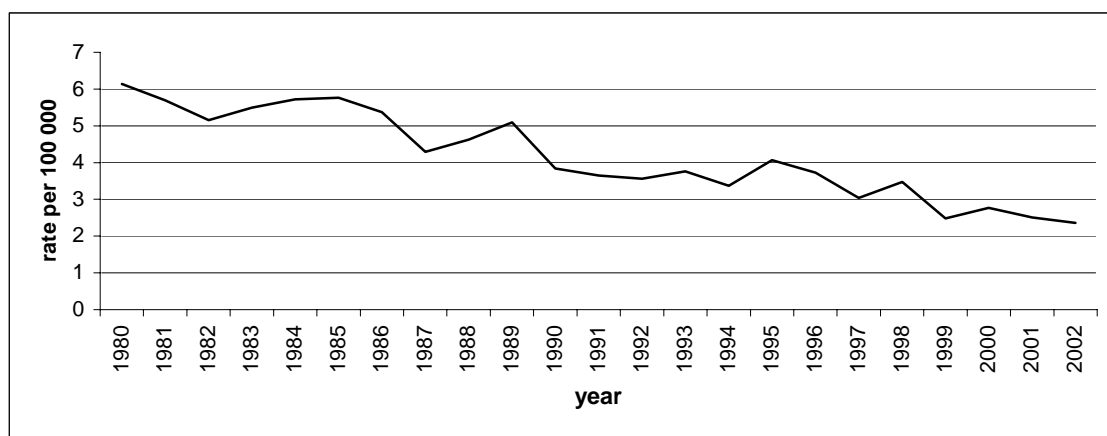


Figure 1. Drowning rates 1980 to 2002

There is a marked drop in the number of drownings between the ages of 1 and 2 years which continues until age 5. The numbers of drownings between the ages of 7 and 12 is low, which rises again, peaks at age 20 and remains high. *See figure 2.*

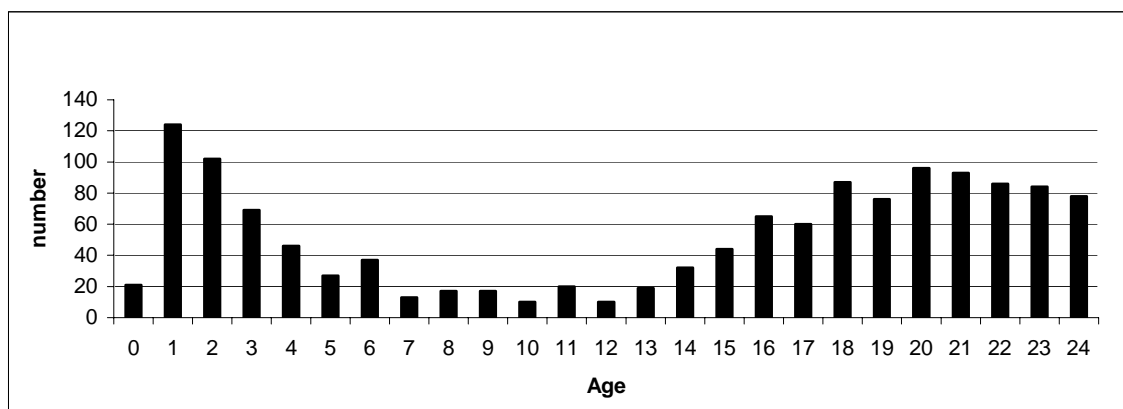


Figure 2. Total drownings by age

There is a peak incidence in drowning for both male and female in pre-school years. The drowning incidence in males rises dramatically in 15-22 year olds, however, females peak only in pre-school years. It is noteworthy that 76% of all drownings were male. See figure 3.

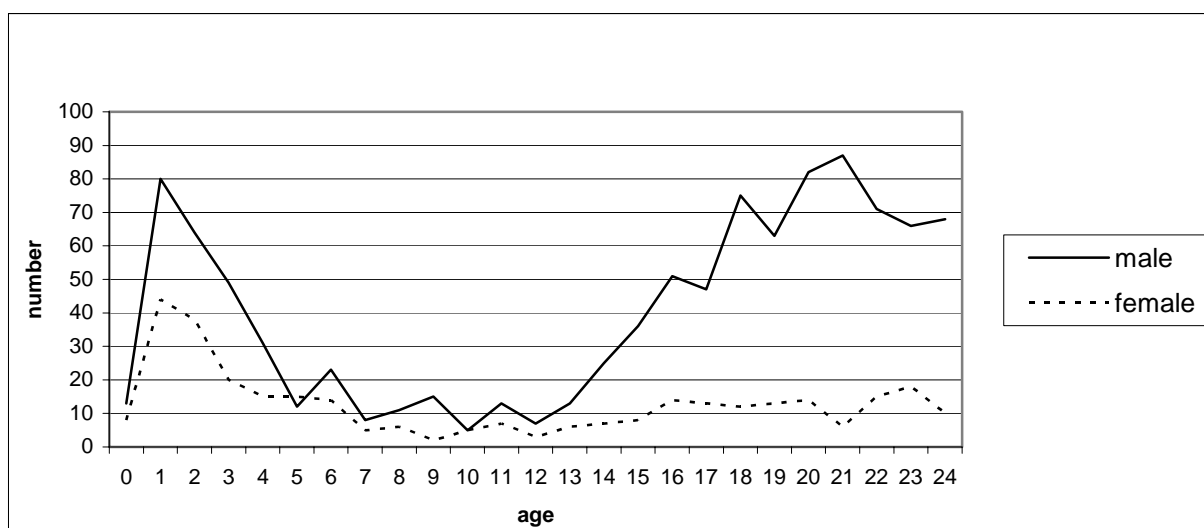


Figure 3. Number of drownings by age and gender

In the 1-4 year age group the male to female ratio is 2:1, whereas in the 20-24 year age group it is 6:1.

For the 0-24 year age group, the most common activity prior to drowning was accidental immersion (eg a child falling into a swimming pool, or a youth falling off a bridge into a river) with 496 (37%) drownings. The leading recreational cause of drowning was swimming (242 deaths (18%)). This was in contrast to drownings over all ages in New Zealand where boating was the leading recreational cause of drowning.¹⁷ There were 193 (14%) drownings following MVAs.

Site and Activity Related to Drowning

There were 21 drownings in the 0-12 month age group over the 23 year study period with a rate of 1.6 per 100,000. Fourteen infants drowned in the bathtub (67%), with the remaining drownings in a bucket (1), a home pool (2), transport accidents (3), and there was one homicide.

Table 1. Site of drowning

Site	<1 year	1-4 years	5-9 years	10-14 years	15-19 years	20-24 years
Domestic sites ¹	15	44	4	5	4	9
Pools ²	2	168	27	9	7	11
Still Water ³	0	50	14	10	28	34
Waterways ⁴	0	38	23	31	84	95
Inshore Still ⁵	0	13	10	13	27	40
Inshore	0	4	12	12	50	49
Moving ⁶						
Off Shore	0	5	14	4	38	81

¹ baths, buckets, garden

² home, paddling, public, thermal, institution and school pools

³ ponds, creeks, drains, lakes

⁴ rivers, streams, tidal currents, floods

⁵ calm water beach, harbour, estuary, marinas

⁶ river/harbour bar, surf beach, rocky foreshore

* deaths due to MVAs, suicide and homicide excluded (n=248)

In the 1-4 year age group there were 342 drownings, with a rate of 6.9 per 100,000. Most of these were due to immersion accidents (90%). The most common site of drowning was the domestic swimming pool (37%), with a further 17 (5%) spa pool deaths. Fifty deaths (15%) were in still water (ponds, creeks, drains, lakes) and 38 (11%) in waterways (rivers, streams).

There were 111 deaths in the 5-9 year age group, with a rate of 1.8 per 100,000. Forty-four children (40%) drowned in accidental immersions. A further 38 (34%) drowned while swimming. The remainder drowned in a variety of activities. The most common sites of drowning were pools, followed by rivers, off shore (0-1km) and surf beaches.

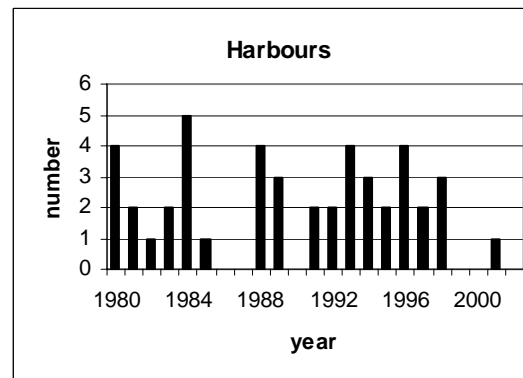
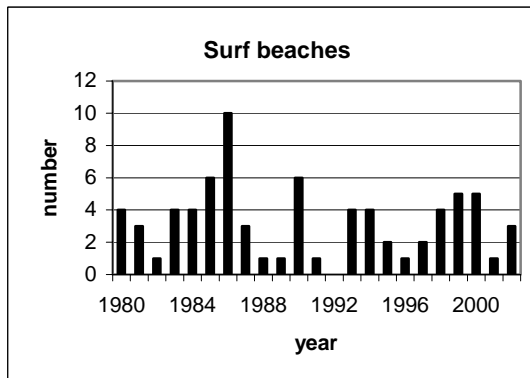
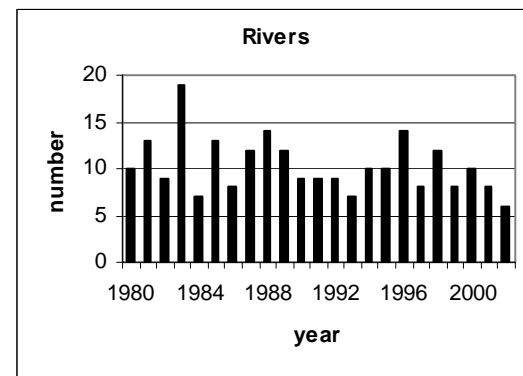
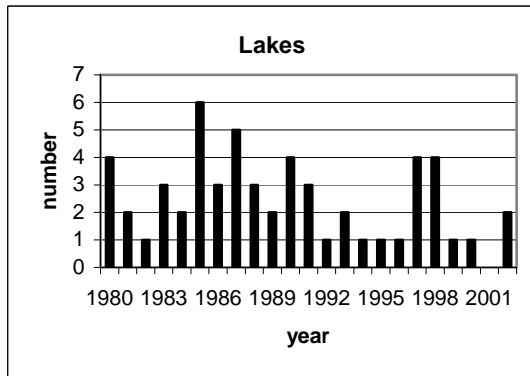
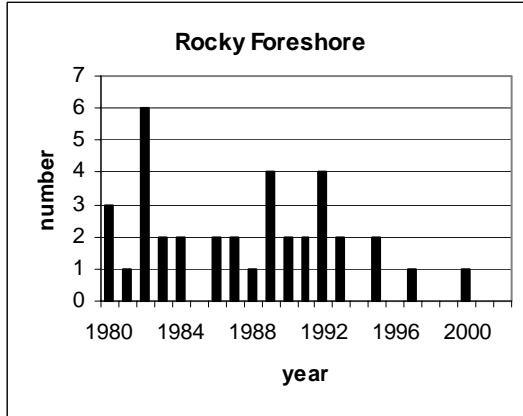
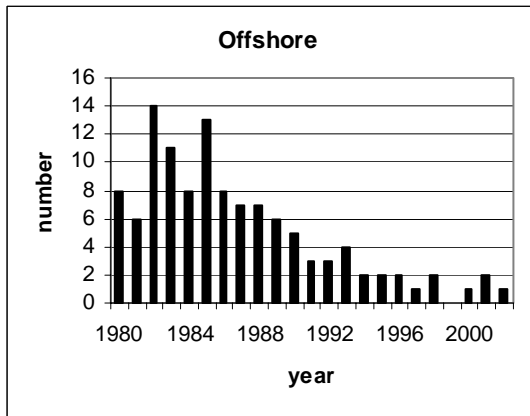
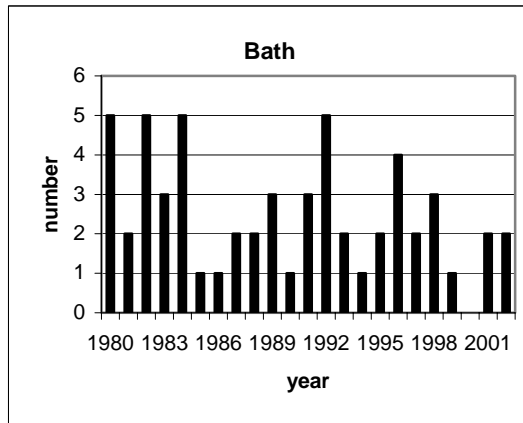
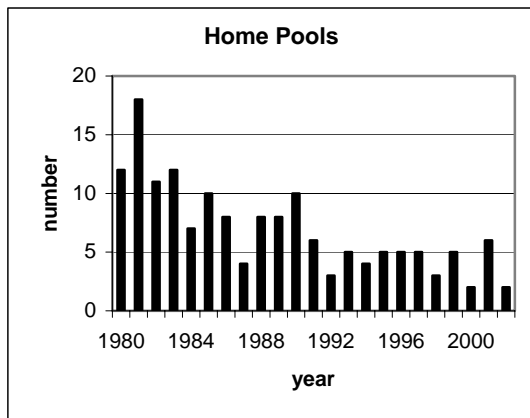
There were 91 drownings in the 10-14 year age group, with a rate of 1.4 per 100,000. Activities prior to drowning were similar to the 5-9 year age group. Thirty-six (40%) children drowned while swimming, 23 (25%) in accidental immersions. Twenty-eight (31%) drowned in rivers, with 25 (27%) deaths at beaches and surroundings (eg harbour, estuary and surf beach).

Activities prior to drowning in the 15-19 (n=332) and 20-24 (n=437) year age groups were similar. In these groups activities that caused the most drownings were MVAs (21%) and swimming (21%). Accidental immersions were next most common with 103 (13%) drownings. The most common sites of drowning were rivers, off shore, surf beaches and lakes, in descending order of frequency. Twenty-eight percent of deaths in those aged 15-19 years involved alcohol. The average rate of drowning in males in this age was 9.8 per 100,000 and in females was 1.9 per 100,000.

Table 2. Activity prior to drowning

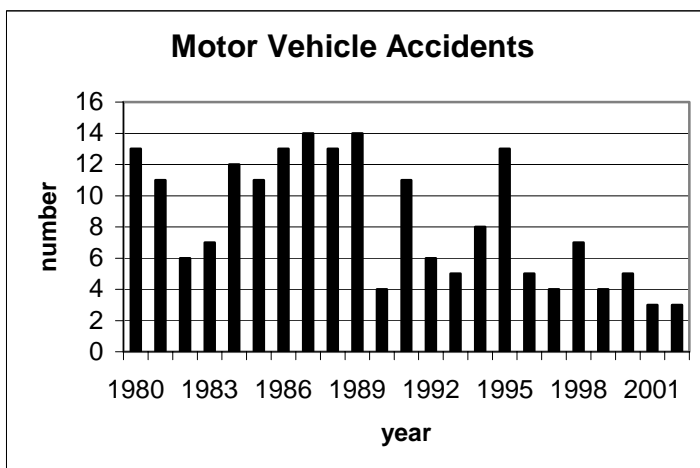
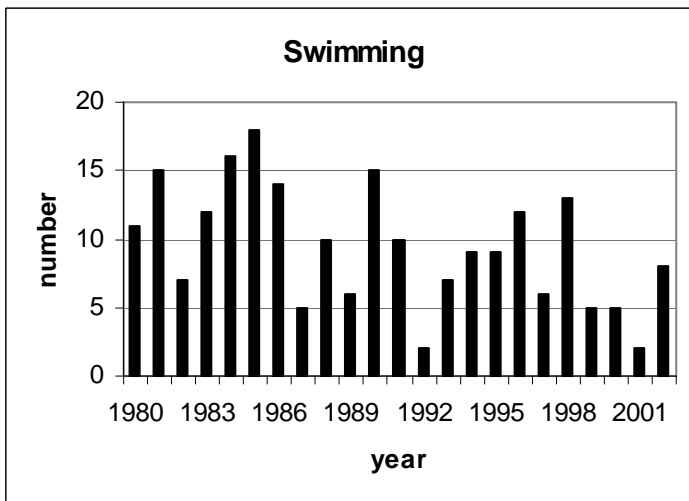
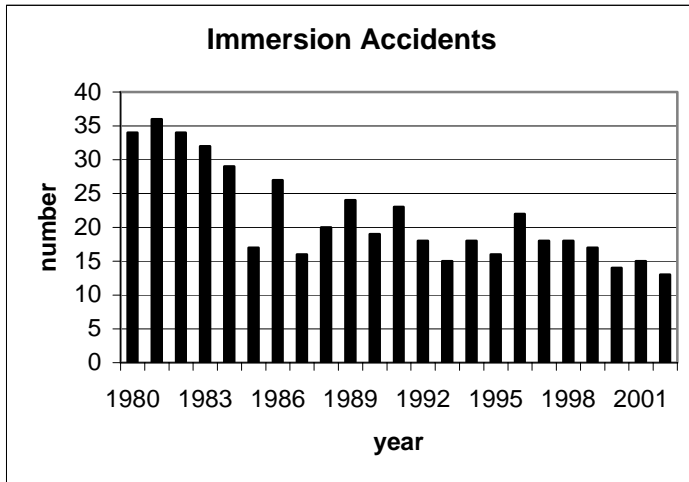
ACTIVITY	<1year	1-4 years	5-9 years	10-14 years	15-19 years	20-24 years
Power Boats	0	5	11	6	20	43
Sail Boats	0	1	2	0	3	16
Other Boats	0	0	2	7	14	16
Surfing	0	0	0	0	5	2
White Water Sports	0	0	1	2	7	11
Recreational Shore Line Fishing	0	0	1	2	10	18
Snorkelling/Scuba Diving	0	0	0	1	11	29
Swimming	0	6	38	36	87	75
Other Water Based Recreation	0	0	2	3	10	10
Non Water Based Recreation	0	0	1	1	3	9
Commercial Fishing	0	0	0	0	10	23
Other Commercial	0	0	0	0	3	4
Immersion Accidents	17	309	44	23	46	57
Transport	3	18	7	5	82	85
Civil Defence	0	0	0	0	1	1
Suicide	0	0	0	0	12	32
Homicide	1	3	2	2	1	1
Rescuing Others	0	0	0	3	7	5
Total	21	342	111	91	332	437

To determine which drowning sites have contributed to the overall reduction in drowning deaths, sites with the most drownings were examined by year. Drownings in rivers, home pools, off shore, surf beaches, baths, lakes, harbours and rocky foreshore were plotted. *See figures 4-11.*



Figures 4-11. Sites of drowning by year
 Note: Deaths due to MVAs, suicide and homicide excluded

These sites accounted for 90% of all drownings. Reductions were seen in home pools, off shore, lakes and rocky foreshore deaths, but not in rivers, surf beaches, baths or harbours. Activities prior to drowning were examined. *See figures 12-14.*



Figures 12-14. Activity prior to drowning by year

This showed there was a reduction in deaths following accidental immersions, swimming and motor vehicle accidents.

Bath Deaths

There were 57 drownings in bathtubs. The age range for bath fatalities was three weeks to 24 years. Thirty-one deaths were associated with disability. These were epilepsy (21), diabetes (1), intellectual impairment (1), cerebral palsy (1), gas leak (1), other (4), and unknown (2).

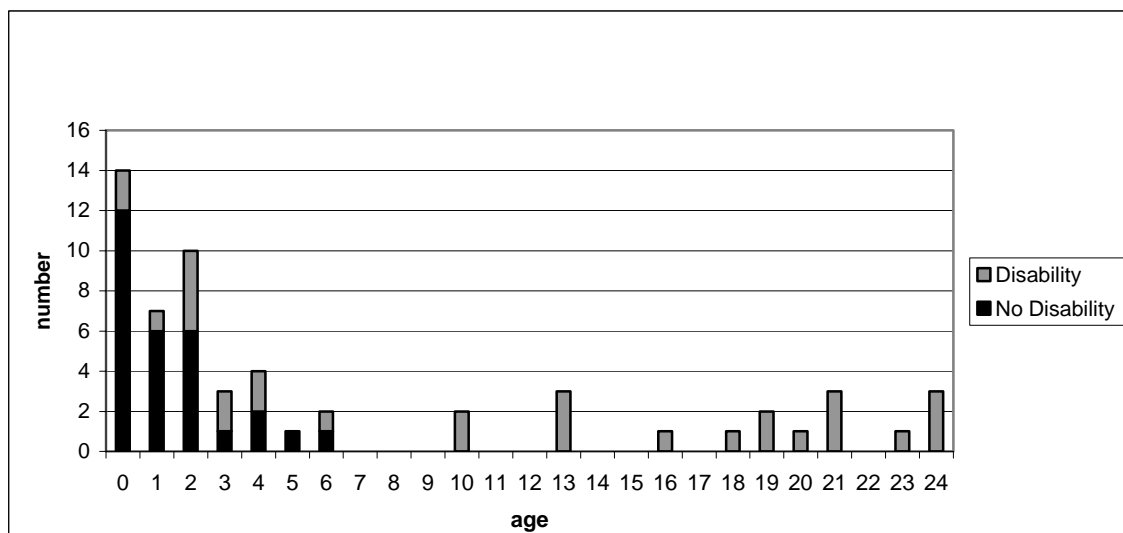


Figure 15. Age and distribution for bath drownings (with disability as a proportion of deaths)

Thirteen children between the ages of 24 months and six years drowned in the bath with no apparent disability. As these deaths were thought to be unusual given the developmental abilities of this age group, the coroners reports were examined for each case. In five children (ages two to three years), a medical condition which was likely to have contributed to drowning was found. These were hypoglycaemia (1), developmental delay (1), history of convulsions (2), and febrile illness (1). Of the remaining eight deaths, three occurred in situations highly suggestive of abuse. A further three deaths occurred in situations of likely neglect, although a lack of investigation at the time of death prevents any conclusions to be made. One three year old child climbed into the bath fully clothed, unbeknown to his mother and subsequently drowned. A two year old child died in apparently unsuspecting circumstances with no known significant medical history, although a post mortem was not performed.

Seven children drowned when they were left 'supervised' with siblings. When stated, the siblings ages ranged from 11 months to two years. One of these children was left in a 'bath safety ring' with a toddler in the bathtub also.

Children were usually left momentarily, for example while the caregiver answered the telephone or door, or to fetch clothes. Some cases related to finishing other household tasks, while others related to parental illness or tiredness. Rarely, young siblings attempted to bath an infant without parental knowledge.

Farm Sites

Twenty-six toddlers drowned on various farm sites: ponds, troughs, tanks, irrigation ditches, drains, water races, and creeks.

Grey Waters

There were 93 deaths in bodies of water commonly referred to as “Grey waters.” These deaths occurred in creeks (29), drains (14), estuaries (26) and streams (24). Ninety-eight deaths occurred in still bodies of natural water. These were lakes (55), ponds (26), and ‘other’ (17).

Private Swimming Pools

The age range for drownings in home swimming pools was 0-24 years. Once disability and involvement with alcohol were excluded, the age range was 0-6 years, with a peak incidence between 12-36 months of age.

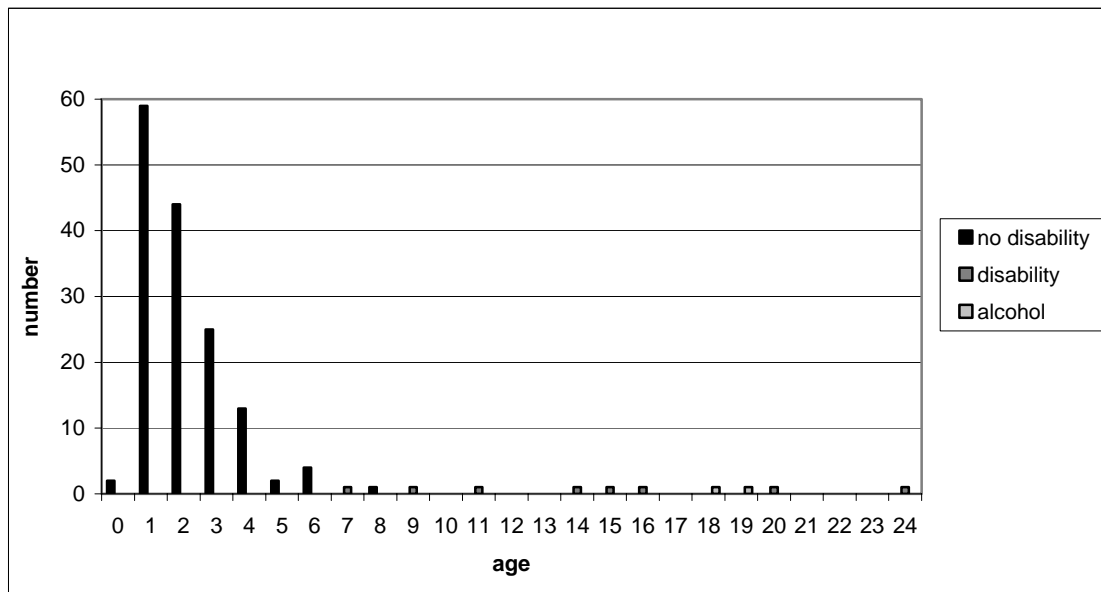


Figure 16. Home pool fatalities with disability and alcohol involvement

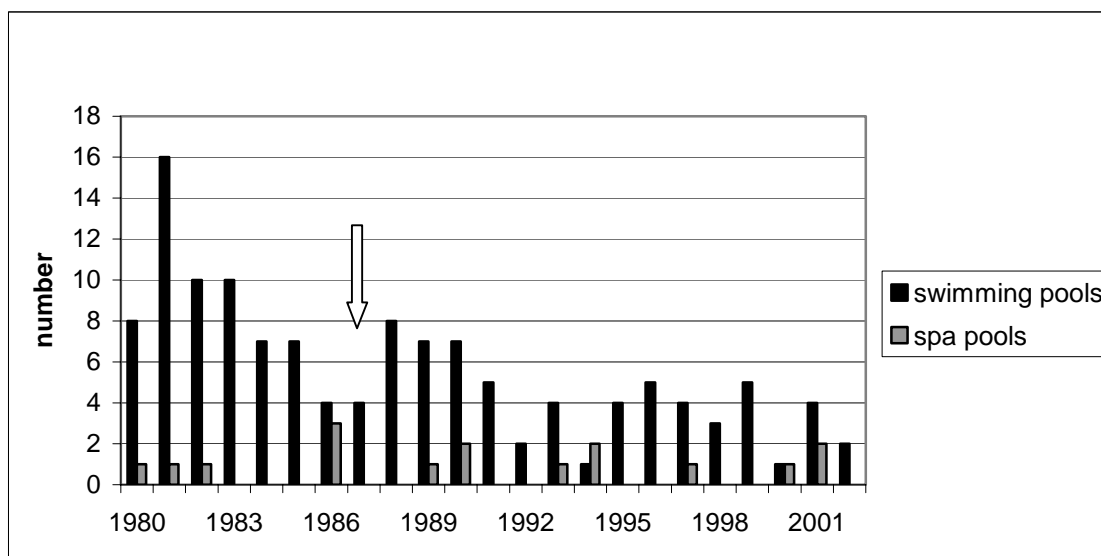


Figure 17. Home pool drownings for 0-4 year olds
Note: Arrow indicates 1987 when FSPA was made legislation

Private Spa Pools

Eighteen people drowned in private spa pools. All but two were in the 1-4 age bracket. One eight year old girl got her hair caught in the outlet opening. By the time she was freed, CPR was unsuccessful. A 20 year old had an epileptic seizure and drowned.

Fencing

Of all home pool (swimming and spa pool) deaths (n=159), 144 were in the 0-5 year age group. Of these, 39 (27%) occurred in unfenced pools. In unfenced pools, 31 (79%) deaths occurred between 1980 and 1987, with the remaining eight deaths over the following 15 years. A further 32 deaths were due to the pool enclosure gate being inadequate or propped open. Twenty victims obtained access through the house, and 14 pool sites had incomplete or inadequate fences. Three children drowned after they climbed over the pool fence either with objects left by the fence (e.g. blocks) or by using the pool ladder that had been left in place. Three deaths occurred in pools that were fenced, a further five were attributed to lack of supervision when the child was known to be in the pool area. For 28 drownings, no information was available regarding pool fencing.

Table 3. Fencing state of home pools for 0-5 year olds

Pool Characteristics	Number of fatalities
Fenced	3
Unfenced	39
Inadequate/incomplete fencing	14
Gate open/inadequate	32
Access through house	20
Ladder left in place (above ground pools)	2
Climbed over fence with aid (blocks etc.)	1
In pool area – lack of supervision	5
No information regarding fencing state	28

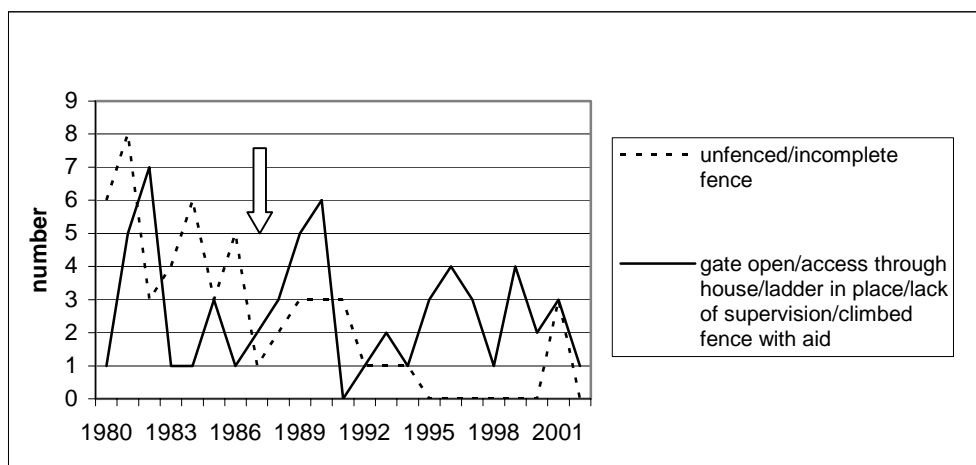


Figure 18. Pool fencing trends 0-5 years

Rates were calculated for incidence of pre-school drownings in home pools. See figure 19.

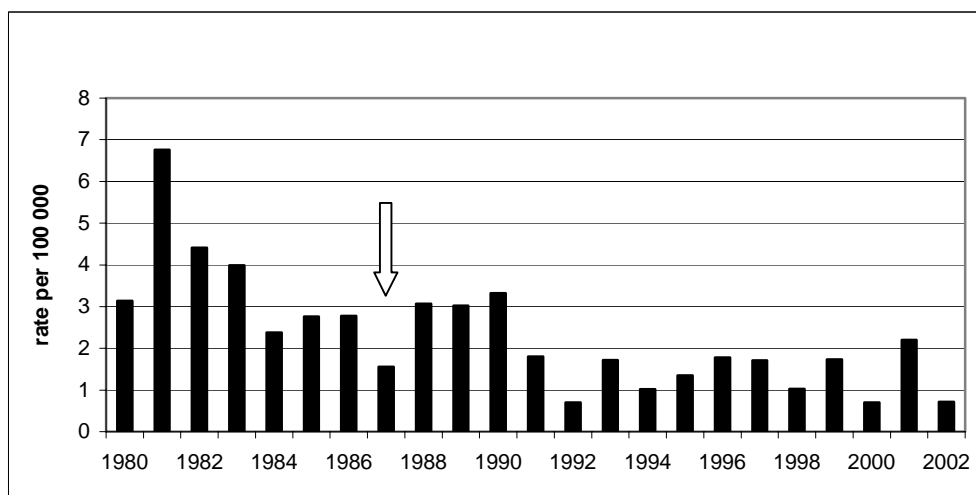


Figure 19. Deaths in home pools 0-4 years

For a five year period prior to the enactment of the FSPA (1980-84) there was an average of 4.12 deaths per 100,000 per year. Five years were allowed for the FSPA to have an effect, and the drowning rates for the following years were calculated. The average rate over 1993-1997 was 1.51 per 100,000 and over 1998-2002 was 1.27 per 100,000. Recent rates of pre-school drowning in home pools were 2.2 per 100,000 for 2001, and 0.71 per 100,000 for 2002.

Other Pools

Sixteen drownings occurred in public pools over 23 years and a further 18 in thermal pools. Seven children aged 1-4 drowned in paddling pools. Twenty-two people drowned in school, institution and hotel/motel pools.

Swimming

Two hundred and forty-two people drowned while swimming. One hundred and sixty-two (67%) of these were in the 15-24 year age group. Thirty-five of these deaths involved alcohol.

Motor Vehicle Accidents

One hundred and ninety-two drownings over the studied period resulted from MVAs. One hundred and sixty-three (85%) of the deaths were in the 15-24 year age group. Ninety-eight (51%) deaths involved alcohol.

Alcohol

Two hundred and nineteen drownings were alcohol related. Of alcohol related drownings, 98 were due to MVAs, ten were suicides, and there was one homicide. For the purposes of further description deaths due to MVA, suicide and homicide were excluded. Of the remaining 110 drownings, 108 involved males, and the remaining two involved females. The most common activity prior to death when alcohol was involved was 'immersion accident' (55). The next most frequent activity was swimming (35). The remaining 20 deaths occurred whilst snorkelling, boating, rowing, scuba diving, fishing, rescuing others, or while engaged in non-water related activities. Of note, there were a total of 181 boating related deaths (includes powered and non powered craft, as well as rowing and kayaking), of which only nine were known to be alcohol related.

Buoyancy Aids

Of the total 1,334 deaths, the use of buoyancy aids was considered 'not applicable' in 1,115 cases, reflecting the high incidence of accidental immersions, and drowning while swimming. Of the remaining 219 deaths, buoyancy aids were not available in 79 cases. In 46 drownings buoyancy aids were available but not worn. In 68 cases buoyancy aids were worn, and in seven other cases were worn but fell off. The use of buoyancy aids was unknown in 19 of the drownings. Only 35% of those aged 15-24 years who drowned wore buoyancy aids when appropriate. There was no decrease in incidence of using a flotation aid when alcohol was involved, but there was only a small number of alcohol related deaths where buoyancy aid use would have been appropriate.

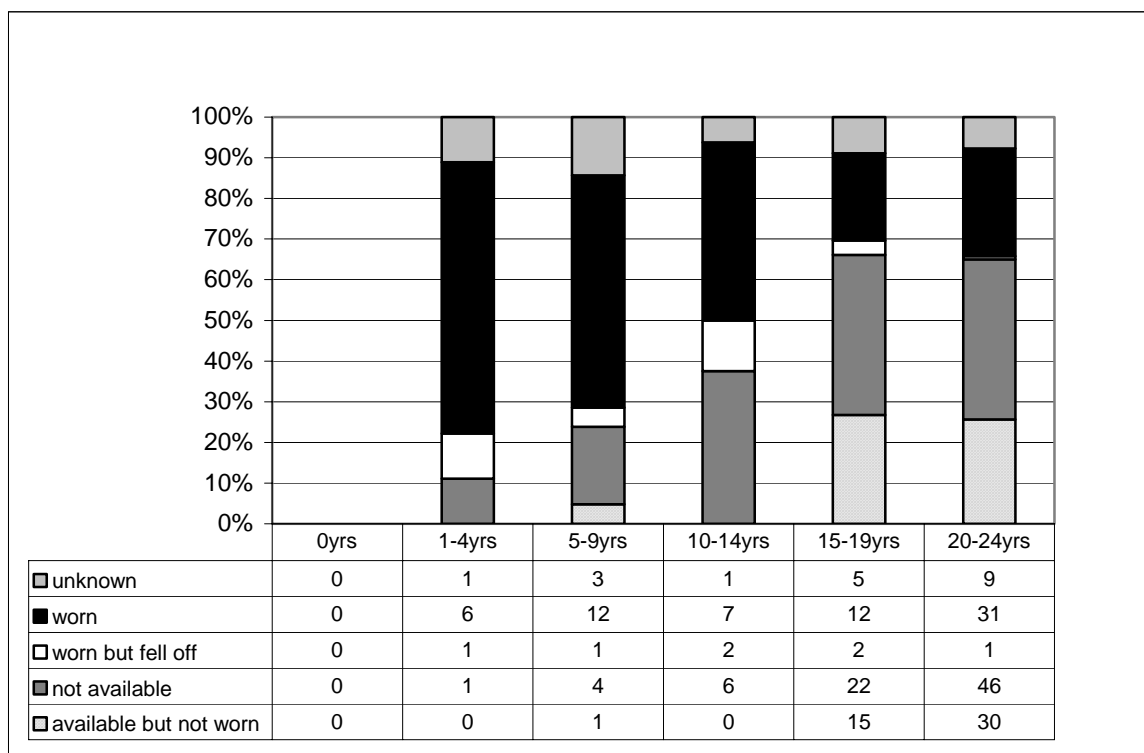


Figure 20. Use of buoyancy aids ('not applicable' excluded)

Resuscitation

In 477 drownings (36%) an attempt was made at resuscitation. For 830 drownings (62%) resuscitation was considered not applicable. For eight (0.6%) people resuscitation was 'not used but could have been', and in 19 cases (1.4%) it is unknown as to whether an attempt was made or not. Of course, from this study it is unknown how many successful resuscitations there were.

Commercial Fishing

Thirty-three drownings occurred whilst engaging in commercial fishing. These were all in the 15-24 year age group. Notably, in only three of these drownings were buoyancy aids considered not applicable, and in five cases it was unknown if an aid was worn. For the remaining deaths, there were 20 in which buoyancy aids were available but not worn, and a further five when aids were not available.

DISCUSSION

New Zealand has a high incidence of drowning, yet with similar sites of drowning and age and gender distribution when compared to other OECD countries.¹⁸⁻²⁰

The number of deaths by drowning is higher for males than for females for all ages. The overall male to female ratio of 3.2:1 is similar to a UK figure of 3:1²¹ with the gender differences becoming more apparent with increasing age. This is consistent with overseas findings²² and thought to be due to behavioural sex differences, even at an early age.²³

Males aged 15-19 years have a high risk of drowning. Overseas, this has been attributed to the three “Ds” – drinking, drugs and dares, factors which are more likely to influence adolescent males than females.²⁴ Recent research in the US found that males were more likely to engage in aquatic activity than females, and were more likely to engage in activities with a higher likelihood of submersion.²⁵ Men were more likely to overestimate their swimming ability. Males also drank more while engaged in aquatic activities, and were more likely to drink while swimming alone, at night, or at unpatrolled beaches.²⁵ This combination of risky behaviours helps to explain the sex discrepancy in drowning rates.

Bath Deaths

For children less than five years old, the home is the most hazardous environment^{26, 27} and in New Zealand the bathtub is the most risky place for drowning in infancy. Most of the infants that drowned were unsupervised by an adult, even if only momentarily. This trend is seen internationally in the United Kingdom and United States where 80%²¹ to >90%²⁸ of children that drowned in bathtubs were left unsupervised by an adult. Health professionals need to explain the developmental limitations of infants and toddlers who, although able to sit, have great difficulties righting themselves quickly or successfully once they have slipped over in the bath.²⁹ All children less than three years of age should be continuously supervised in the bath by an adult.³⁰ In addition, we recommend that children with developmental delay or medical conditions should be supervised past three years of age, depending on the condition and abilities of the child.

In this study seven children drowned when left in the bath with an older sibling. Other studies report high incidence of drowning while older siblings are present. A Utah study found an older sibling (age range 2-7 years) was present in the bath for all of the bathtub drownings.³¹ Toddlers are not suitable caregivers for siblings. If left to supervise younger children they may not realise the implications for their brother or sister who has submerged in the bath.²⁹ They might even be ‘playing’ with the child and not realise the need to rescue. There are reports of the older sibling having left the bath and the younger child being found drowned some minutes later.³² This likely reflects an overestimation on the parents part, of the sibling’s ability to supervise a younger child.³¹ Quan et al recommend that younger children should not be left alone in the bath with a child less than five years of age.²³

One child in this study was a victim of homicide in the bath, with a further three deaths highly suspicious of abuse. Non-accidental bath drowning is a recognised form of child abuse.^{33, 34} This should be considered in the differential diagnosis of bathtub submersions without a typical accident description and in children outside the age range of eight to 24 months in the absence of epilepsy or developmental delay.²⁹ Specific points about the history should be noted, such as the age of the victim, any history suggestive of child abuse, inconsistencies in the history, delayed presentation, maternal mental illness,²⁹ and be combined with relevant physical and autopsy findings. A thorough history should be taken for all drowning victims as underlying medical conditions can contribute to drowning.³⁵

Neglect is a form of child abuse. The border dividing appropriate supervision of children and allowance of age appropriate independence from neglect is poorly defined and should vary with the child's developmental abilities.³⁶ Many parents may not be aware of hazards and the ability of the child to avoid them. Leaving a young child unattended in a bathtub or in wandering distance of a pool may be a single neglectful event. It may also result from a pattern of neglect.³⁶

Bucket Deaths

Seven children drowned in buckets, aged 10 months to less than two years. All drownings were in the home. Infants and young toddlers are at risk of drowning in large buckets because of the large capacity and stability of this type of bucket. The rim is just below the toddlers upright centre of gravity.³⁷ Toddlers may be attracted to objects in the water such as toys, clothes etc. All buckets used in households with children should have childproof lids, and be placed in a separate room with the door kept closed, well out of reach of children.

Other Domestic Sites

Our data confirms that domestic sites such as the garden and surrounding area can be dangerous. In the UK most drowning deaths in children under five years of age occur in garden ponds.³⁸ Farms are also recognised as a risky place for the wandering toddler, with drowning being the most common mechanism of injury death for children less than five years of age who lived on farms in Australia.³⁹ In this study 26 toddlers drowned in farm sites.

Home Pools

The group at risk is 1-4 year old children, who are mobile but lack understanding of the sinister nature of water, and lack the physical ability to get themselves out of a pool should an accidental submersion occur. In this study most of the toddler deaths were in those aged 1-2 years, as has been shown by other case series.^{40, 41} A young child is by nature inquisitive and water offers exciting possibilities⁴² especially if tempted by toys floating on the surface of the water.⁴³ Toddlers may struggle minimally when compromised, and are not able to vocalise loudly to attract attention when help is required.⁴⁴ They are most likely to drown in pools at their own home, or at the home of a place they are visiting; very few toddlers drown as a result of trespassing.^{40, 45}

In recognition of the number of toddlers that die each year in home pools, New Zealand has had mandatory pool fencing for all domestic pools since 1987, requiring the immediate area surrounding the swimming and/or spa pool be fenced. Building walls with house doors are allowed to form part of the fence. Local government are responsible for ensuring compliance and developing their own procedures to do so. This is in contrast to Western Australia where the inspection of pool fencing has been mandatory since the introduction of legislation in 1992, and has been shown to increase compliance.⁴⁶ The drowning rate in under fives in Western Australia (1988 to 2000) was 4.4 per 100,000 per year. In New Zealand the comparable figure (1980-2002) was 3.95 per 100,000 per year. This would suggest that the drowning rate in New Zealand is lower than in Australia, however this is likely to be at least partly due to the fact that there are more home pools in Western Australia than in New Zealand.

Research in 1997 found that compliance with the FSPA was low,⁴⁷ reflected in the estimate of 25,000 unfenced home pools.⁴⁸ Factors identified as limiting the Act's effectiveness were ambiguities in the legislation, and little attempt being made to locate pools or monitor compliance.⁴⁷ However, in 1998 there was a high profile case when a toddler drowned in a home pool that was non-compliant with the FSPA. This resulted in both the prosecution of the pool owners and an out of court settlement between the parents and the council responsible for ensuring compliance with pool fencing. Subsequently the council involved and many others have changed their policies for locating and inspecting home pools. There has not been any formal research investigating the effectiveness of this yet.

Perhaps most tragic is the large number of children who died in pools that were fenced to comply with the FSPA, but were made accessible to the wandering toddler by having the gates propped open (non-compliant with the FSPA). This has also been noted in Australian statistics⁵¹.

Statistics from Queensland showed that when pool owners were required to comply with uniform pool fence requirements in 1992 the number of toddler drownings markedly decreased, but increased once again in 1994 to numbers similar to pre-1992⁵¹. This suggests that the decrease in toddler drownings in 1992 and 1993 may have been more to do with "increased publicity and community awareness of the risk"⁵¹ than the fencing requirement itself. Nevertheless, pool fencing has been proven to be effective where fencing policies are rigidly policed.⁵⁰ Suggestions to increase compliance include public education campaigns emphasising the risk to family and friends.⁵¹ In a recent publication by the Committee on Injury, Violence and Poison Prevention it was recommended that paediatricians be encouraged to identify families who have residential swimming pools and schedule several appointments in the first few years of the child's life to ensure that parents remain aware of the risk of drowning⁸⁰.

Although the numbers are small, there is a significant contribution to the toddler death toll by spa pools. Notably, the incidence of drowning in a spa pool has not decreased as drownings in swimming pools have. We hypothesise a multifactorial explanation for this. Spa pools are more likely to be situated inside a house than a swimming pool, and therefore access is gained through the house. House doors allowing access to a pool do not have to be self closing if left open (unlike gates on pool fences), therefore require active processes on the part of the pool owner to maintain a safe pool area. This is in comparison to pool fence gates that if properly maintained to automatically swing shut, require no conscious thought to keep the pool area safe when not in use. Additionally, Morrison et al found that spa pools were more likely to be granted an exemption from the FSPA, usually because of the presence of a pool cover.⁴⁵ The major focus of the FSPA was to take away the requirement for human intervention, however in contrast to home pools which once fenced require little intervention, the use and maintenance of a spa pool cover requires human involvement, therefore compromising the intent of the Act. Another recognised hazard of spa pools, although rare, is that of entrapment by suction pumps.^{52, 53}

The incidence of drowning in an unfenced home pool has been declining over this study period, and since the FSPA was enacted, the number of drownings has further reduced. Of note is the number of deaths in fenced pools with non-compliant gates or doors, which has remained reasonably static. There has been a reduction in the number of drownings in home pools coinciding with FSPA, but it is evident that passing an Act in Parliament is not enough to prevent drowning. Legislation must be enforced. In terms of primary prevention, education must also play a key role. Parents and swimming pool owners need to be informed of the importance of keeping pool fences and gates maintained and compliant with the Act, of keeping gates and doors to pools shut, and of appropriate supervision of children while they are in the pool area. An effective pool barrier should supplement, not replace, adult supervision.⁵⁵

Water Safety Training

Currently there is insufficient data to prove or disprove the effectiveness of water safety training for pre-schoolers.⁵⁶ Toddlers may be able to learn water confidence and improve swimming skills, but it is difficult to assess the impact of this on more realistic drowning scenarios and the ability to avoid or survive a real submersion episode.⁵⁷ However, swimming programmes in NZ address this issue, and expose infants and children to water in a disciplined environment, emphasising to the child and parents the importance of basic water safety. Children are not allowed to enter the water unless invited in, must be wearing correct swimwear and are always supervised. Although aquatic programmes should not be used in the place of adequate pool fencing and adult supervision, they are important for promotion of water confidence and swimming skills. Regardless of swimming ability, whenever infants and toddlers are in or around water, an adult should be within sight and able to provide immediate assistance if required.⁵⁶ Likewise, flotation devices are not safe for unsupervised use by infants and toddlers.⁴⁴

Resuscitation

Immediate resuscitation prior to the arrival of paramedical personnel is associated with better neurological outcome in patients hospitalised with submersion injury.⁵⁸ Wintemute et al found in 42% of drownings resulting from a child's immersion in his own home pool for 30 minutes or less, the child was retrieved from the water by a lay person – often a family member – with resuscitation delayed until the arrival of emergency services personnel.²² Previous research in New Zealand found 27% of children having an immersion incident at home did not receive any form of resuscitation prior to the arrival of ambulance crew.²⁶ Only 30% of those who did receive resuscitation had full CPR, the remainder had some form of rescue breathing. Although immediate CPR or mouth-to-mouth resuscitation is most beneficial in the event of an immersion accident, any immediate attempt at resuscitation can be beneficial; simple positioning and tactile stimulation have at times been effective.⁵⁸ Some suggest that first aid training should be mandatory for all pool owners, given the high incidence of immersion incidents in pools.⁵⁹⁻⁶¹

Public Pools

Public pool immersion incidents are associated with low mortality, as most victims are effectively resuscitated at the pool. Public pool immersion incidents are however, associated with disability,²¹ as are all pool deaths in children over five years.

Thermal Pools

There were 18 deaths in thermal pools, similar to the number in other public pools. Although actual use of thermal versus public pools is unknown, the number of drownings in thermal pools appears disproportionately high. Possible explanations for this are the cardiovascular effects of immersion in a hot body of water and differences in legislation regarding supervision at thermal versus other public pools. Since 2002 there has been a requirement for thermal pools to develop and implement safety standards and policy for pool supervision and training of staff, and CPR training was not mandatory. With a change in policy, the number of drownings should reduce.

Alcohol

Alcohol intoxication results in poor judgement, gives a false impression of warmth and may affect the body's protective mechanisms against drowning, such as the diving reflex and laryngospasm.⁶² Reported incidence of alcohol involvement in drowning in the US is about 37% in the 15-19 year age group.^{22, 63} New Zealand estimates vary, as there is a lack of standardised testing. Our figure of alcohol involvement in 51% of MVA related drownings is comparable to a previous NZ estimate of up to 50%.⁶⁴ In the US, of those tested up to 74% of deaths from motor vehicle immersions involved alcohol.⁶⁵

Alcohol is associated with boating deaths overseas.⁶⁶ In this study there were 181 boating related deaths; only nine were thought to involve alcohol. The low percentage (5%) may reflect different boating practices by New Zealand boaties, or be related to the younger age studied. Lack of routine testing of the Blood Alcohol Concentration (BAC) is probably a contributing factor.

These figures do not take into consideration the indirect effect of alcohol. Alcohol may impair adults supervising children who drown.⁶⁶ The high proportion of positive BACs in other NZ studies suggests a need to routinely sample all drowning victims over the age of 10 years.⁶⁴

Buoyancy Aids

New Zealand law introduced in 2003 now requires every vessel to carry a personal flotation device (PFD) of appropriate size for every person on board.⁶⁷ In the past there have been by-laws at certain local authorities that required carriage of PFDs, but this was not widespread [personal correspondence]. Of the 200 drownings where use of a buoyancy aid was appropriate and known, 68 people drowned while wearing a buoyancy aid. The remaining 132 deaths were potentially, but probably not all, preventable. Quan et al examined buoyancy aid use in the US and found overall use was low (25%), and was only 13% in 14 year olds and older. Buoyancy aid use was less in boaters and highest in kayakers, even when adjusted for age and sex. Adults wearing flotation aids in a vessel was positively associated with the children on board wearing a flotation aid also.⁶⁸

Sixty-eight people drowned while wearing a buoyancy aid of some sort. This reinforces the need to be mindful of all aspects of water safety, such as checking weather conditions, adequate safety equipment, appropriate supervision and skill level before embarking on water based recreation, as well as the correct use of buoyancy aids.⁶⁹

Epilepsy

People with epilepsy are at increased risk of drowning, with a risk of 4-10 times that of the normal population.⁷⁰⁻⁷² Ryan et al found that one half of drownings attributed to epilepsy occurred in a bathtub at home – none of these people were being directly supervised although there was someone in the house at the time for over 90% of cases.⁷³ Epileptics need to be advised about this risk of unsupervised bathing, and should be encouraged instead to have showers.

Drownings due to epilepsy are not only limited to the epileptic themselves. Incidents of epileptic parents having a seizure while bathing a child and the child drowning are documented.⁷¹

Commercial Fishing

New Zealand has a high rate of work related drownings compared to the United States and Australia. It is our third leading cause of work related fatality.⁷⁴ In addition to risks intrinsic to boating, variables such as experience, fitness, fatigue, use of safety equipment, and the contribution of alcohol and drugs although not documented in NZ, have been implicated in the high fatality rate.⁷⁵ It can be seen here that use of buoyancy aids could have prevented up to 25 of the 33 deaths.

Motor Vehicle Accidents

The number of drownings caused by MVAs is small compared to the number of people who die on our roads each year. However, strategies to reduce road death could include barriers to prevent motor vehicles going off unprotected roads into the ocean and inland waterways.⁷⁶

Social Cost

Drowning or near drowning, especially in children, has a significant impact on families⁷⁷ exacerbated by the very suddenness of the accident which gives no time to anticipate the tragedy.⁷⁸ Many incidents are interpreted by one or both parents as having been potentially preventable, leading to later guilt and recrimination, either self- or spouse-directed, or both. Children are particularly vulnerable to abnormal forms of grief following the drowning of a sibling. This may be seen when a sibling is left to supervise a younger child who consequently drowns; it is also common for siblings to be involved in raising the alarm and in the rescue and extraction of the body from the water.⁷⁸ Li et al found that the death of a child less than 18 years old was associated with an increase in mortality in the parents.⁷⁹ Fathers had an early increase in unnatural death, and mothers had an increase in mortality from natural and unnatural causes. This risk in mothers was increased further if the child's death was unexpected or from unnatural causes. Further distress may be caused in situations where the body of the victim cannot be found. This can lead to the often false hope that the victim may not have drowned, and does not allow the family to grieve as they might otherwise. Additionally, the ability to appropriately farewell the physical body is of great significance to most cultures, particularly Maori. Following drownings in a family, attention needs to be given to the parents and remaining siblings involved in the tragedy.

Limitations

There were limitations to this study mostly relating to lack of detail provided. For alcohol related deaths, it was only recorded if alcohol was 'involved', 'not involved' or 'unknown'. Unless otherwise stated in the synopsis, no details were known about who was drinking. For example, in MVA related drownings it is unknown if the 'involvement' of alcohol meant the driver of the car, or the passenger, had been drinking, either of which scenarios could contribute to death. In those where alcohol was a factor, it is not documented if that was based on witnessed reports, on a Blood Alcohol Concentration or by other means. Unless otherwise stated in the synopsis, ages were provided in whole years only, hence the age range for bath and bucket deaths was unable to be accurately assessed. No attempt was made at description or analysis of ethnicity data because details were unknown in 550 cases. The collection of ethnicity data has improved over the study period in particular since 1993, and details are now known for most new cases. MVAs, suicide and homicide were not examined in detail as these figures represent a small subset of the total number of deaths by those causes.

Conclusions and Recommendations

Drowning, although reducing in incidence, is still a leading cause of death amongst NZ children and youth. Given the enormous social and economic cost of drowning and the preventable nature of these deaths, it is a problem worthy of our attention. Policy is in place to reduce toddler death in home pools, but attention needs to be given to enforcing compliance with legislation and further research would be useful to evaluate the effectiveness of this. Parents need to be educated by doctors, allied health professionals and media about the importance of supervision of infants and young children while they are near any body of water, especially the bathtub or swimming pools. Adolescents, particularly males, should be educated about the dangers of alcohol use when engaged in water-based recreation. Continued emphasis needs to be placed on the importance of wearing buoyancy aids, together with other aspects of water safety while participating in any water-based recreation.

A standardised leaflet for paediatricians to give their patients with epilepsy regarding water safety could be of value. Additionally, advice regarding bathing young children and advice about supervision of toddlers in and around water could be incorporated into the Well Child books which are given to all new babies.

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