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SNORKELLING AND SCUBA DIVING DEATHS IN NEW ZEALAND, 1980-2000

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Key Words
Deaths, drowning.

Abstract

Drowning is the third leading cause of unintentional injury death in New Zealand (NZ). Between 1980 and 2000 there were 184 unintentional diving related deaths in NZ, 61 snorkellers and 123 scuba divers. The mean age was 34.3 years, and 24% were Maori. Diving related deaths were 5.4% of the total 3449 unintentional drownings recorded over this period. The death rate in NZ scuba divers is estimated to be at least 5.8 per 100,000 divers per year. Many deaths were associated with inadequate training, poor water skills/fitness and poor equipment. Over 75% of scuba divers were either diving alone or became separated from their buddy. The bodies of 173 people were recovered. Blood alcohol was measured in 72 victims and this was positive in 21% of snorkellers and 8% of scuba divers tested. Pre-existing medical conditions may have contributed to death in 24% of snorkellers and 20% of scuba divers, many of whom were uncertified. If the coroner's autopsy was performed to recommended guidelines, arterial gas embolism was identified as a contributing factor in 55%. The reporting of diving accidents needs to be better standardised. The number of untrained divers and those with pre-existing medical conditions suggest tighter standards for medical assessment and some means of restricting scuba equipment use by untrained people may be required. Diving activities contribute importantly to water recreation fatalities in New Zealand although no increase in the annual diving death rate is evident over this 21-year period.

Introduction

Drowning is the third leading cause of unintentional injury death in New Zealand (NZ).[1] The Injury Prevention Research Unit (IPRU) recently analysed drowning related incidents in NZ for the period 1980-1994, using linked data files.[2] A brief section on diving fatalities in this report prompted one of the authors (MD) to review these data in greater detail and to update these with Water Safety New Zealand (WSNZ) records to year 2000. There were three purposes in mind. Firstly, to provide a comprehensive review of the epidemiology of diving related deaths over a 21-year period in NZ. Secondly, to report on diving practices and other factors that might contribute to these deaths and thirdly to document the way diving accidents were reported.

Methods

The study was performed in several stages. A database of scuba and snorkelling related deaths was built from several sources. Information in the database was verified and supplemented using WSNZ files and, where necessary, missing coronial files were obtained. First, cases for the period 1980-1994 were captured with the IPRU database developed by linking information from the NZ Health Information Service (NZHIS)[3,4] and from the WSNZ database called DrownBase™. For the period 1995-2000, DrownBase™ alone was used to capture cases. Since WSNZ and NZHIS now collaborate, this should be comparable to the IPRU database. The IPRU and WSNZ databases matched for all but five deaths, whilst five divers were incorrectly coded - two scuba divers and three snorkellers.

Next, the individual case files held by WSNZ for the whole period, 1980-2000, were examined by one author (MD). Finally, where the information in the case records was deficient, the coronial records were obtained from the Tribunals Division, Department of Courts. Data for the year 2000 were incomplete as several coroner's hearings had not been held at the time of analysis. The WSNZ and coronial

case records were searched for demographic details, specific aspects of diving practice, environmental factors, medical history and the autopsy reports. A total of 30 fields were included in the final MS Access® database (Table 1).

Autopsy reports were examined to identify pre-existing disease, especially respiratory or cardiovascular pathology, which might have been contributory. In scuba divers recovered early after their deaths particular attention was paid to whether the autopsy was carried out in compliance with the guidelines of the Royal College of Pathologists of Australasia (RCPA).[5]

TABLE 1

VARIABLES RECORDED FROM EXAMINATION OF THE IPRU AND WSNZ DATABASES AND CORONER'S REPORTS.

ID code	Solo diver	Buddy's action
Snorkel/Scuba	Separation	Body recovery
Age	BC inflation	Basic Life Support
Sex	Weights dropped	Asthma
Ethnicity	Out of Air	CVS disease
Qualification	Panic	Epilepsy
Experience	Sea state	Other medical
Region	Cave/wrecks	Autopsy (PM)
Depth	Entanglement	Gas embolism
Dive Time	Trauma	Other PM findings
	Free text	

Results

There were 186 diving deaths recorded. These cases were all corroborated by inspection of the individual files. Two deaths were excluded - one scuba death subject to a murder investigation and a boat occupant not snorkelling or diving - leaving 184 divers, 61 snorkellers and 123 scuba divers. The annual rate varied from a low of four (1999) to a high of 16 (1985) (average 8.8 per year, range 4 – 16), but there was no obvious trend over these two decades (Figure 1). Diving related deaths were 5.4% of the 3449 unintentional drownings recorded in NZ over this period (Table 2).

WSNZ divides drownings into various categories related to the activity, type of water and region of the country. One of these is "Sporting and Recreational", which includes angling, board-riding, diving (as in jumping), duck shooting, net & shell fishing, rafting & tubing, river crossing, snorkelling, scuba diving, swimming and windsurfing. During 1980-94 there were 425 deaths in this category, 275 of them in the sea of which 129 (47%) were divers. Diving drownings occurred throughout NZ but with 40% in the

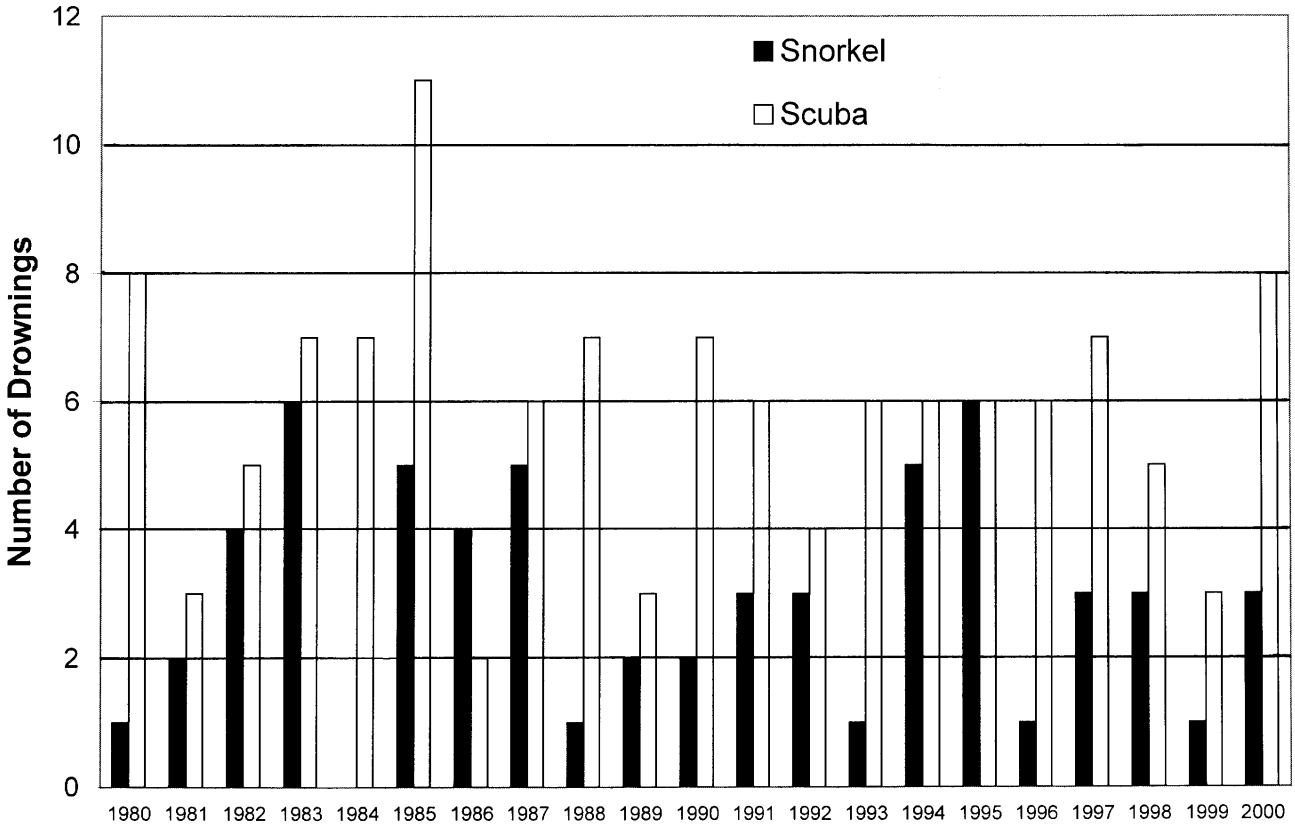

Figure 1. Annual snorkeling and scuba diving drownings in New Zealand, 1980-2000.

TABLE 2

NEW ZEALAND DROWNINGS, 1980-2000. DIVING DROWNINGS ARE 5.4% OF ALL DROWNINGS.

	All drownings	Snorkeling	Scuba
1980-1994	2606	44	88
1995-2000	843	17	35
Total	**3449**	**61**	**123**

two northern regions (Table 3) and were most common in the summer months as shown in Figure 2.

DEMOGRAPHICS

The sex, ethnicity and age of drowned divers are shown in Table 4. All but one snorkeller was male, whereas 14.6% of scuba deaths were in women. Of the 44 Maori drowned, only two were women. Thirty four percent of snorkelling deaths and 19% of scuba deaths occurred in Maori (overall, 24%). The youngest scuba drowning was aged 13, and snorkeller sixteen. Age distribution is slightly skewed (Figure 2), with 10% being over 50 years old.

TABLE 3

184 SNORKEL AND SCUBA DIVING DROWNINGS IN DIFFERENT REGIONS OF NEW ZEALAND

	Number	%
Northland	36	19.6
Auckland, Hauraki Gulf and Coromandel	38	20.6
Bay of Plenty	16	8.7
Hawkes Bay and Gisborne	14	7.6
Wellington	25	13.6
Marlborough and Tasman	19	10.3
Canterbury, Otago and Southland	21	11.4
Other and unknown	9	4.9
All sea drownings	**178**	**96.7**
Lakes and Rivers	**6**	**3.3**

DIVING EXPERIENCE

Diving experience was documented in 88 scuba divers, but their diving qualifications in only sixty-seven. Experience was defined loosely for this study as inexperienced – less than two years diving, moderate – two to four years or a qualification above open water/basic and experienced – more than four years or at least Dive Master.

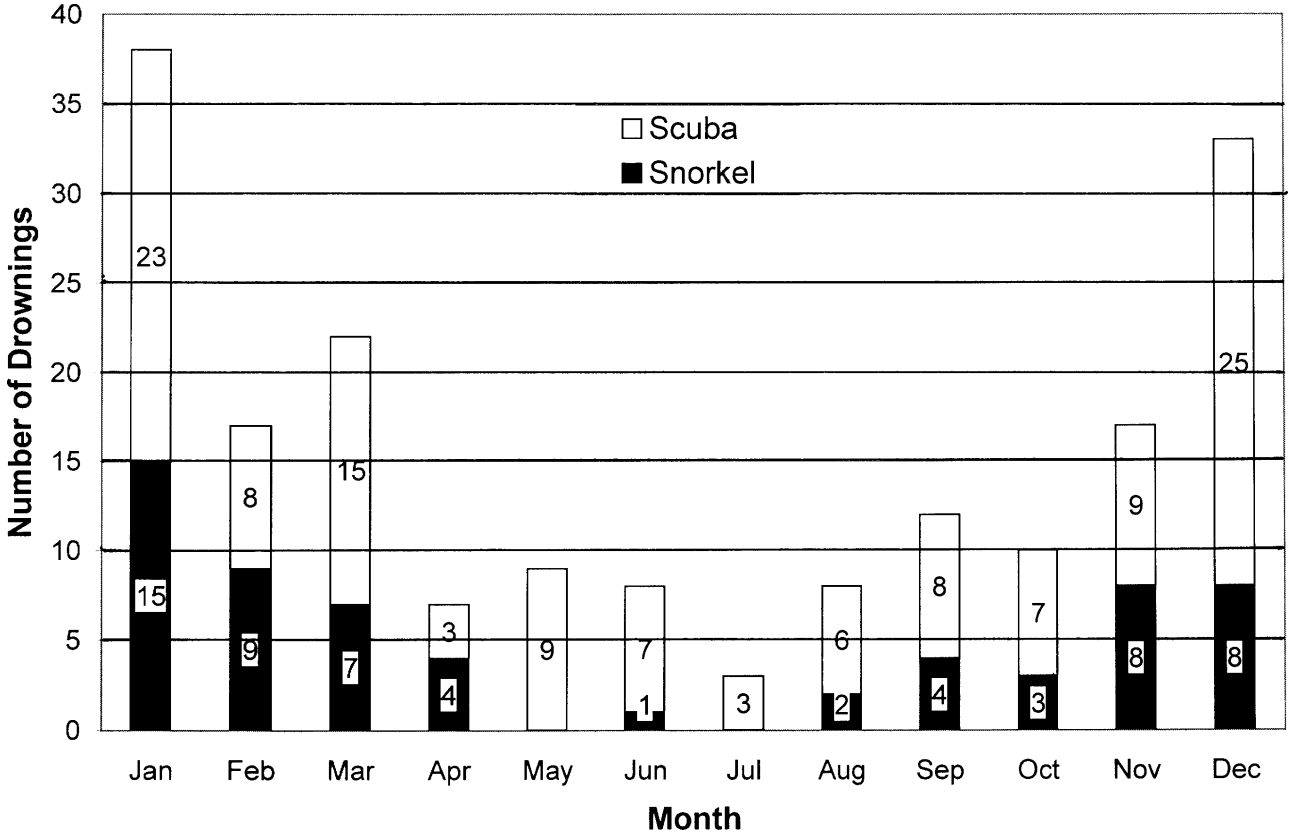

Figure 2. Snorkeling and scuba diving drownings in New Zealand, 1980-2000, by month.

TABLE 4

SEX, AGE AND ETHNICITY OF DROWNED SNORKELERS AND SCUBA DIVERS, 1980-2000.

		Snorkel (N=61)	Scuba (N=123)
Male		60	105
Female		1	18
Age:	Mean	34.3	34.3
	Median	31	33
	Mode	23	30
	Range:	16 to 66	13 to 73
Asian		3	4
European		31	89
Maori		21	23
Pacific Islander		3	1
Unknown		3	6

The majority of deaths occurred in inexperienced or unqualified divers (Table 5). Six divers drowned on their first or second dive, three on basic diving courses. Three divers died in a triple fatality on a Dive Master course. The level of experience of only 19 snorkellers was recorded, of whom nine were described as experienced. Whether any of the snorkellers had a scuba qualification was rarely recorded.

DIVING CONDITIONS

Information on the depth was recorded for 93 scuba divers. This might be the depth where a diver disappeared, or from which the body was recovered or the diver is known to have got into difficulties and was therefore of little value. The surface, tidal or underwater conditions were recorded in 109 scuba accidents, and were believed to be contributory to 29 (27%) of these deaths. Examples included seven divers who suffered head injuries from being swept off or against rocky shores in breaking or rough seas. In total, 10 divers died on the surface. Surges and rips, both surface and underwater, contributed to at least 11 scuba deaths, the most notable of which was a triple fatality in a party of seven divers who were swept to a depth of over 90 m by strong currents during a dive. Two inexperienced divers became

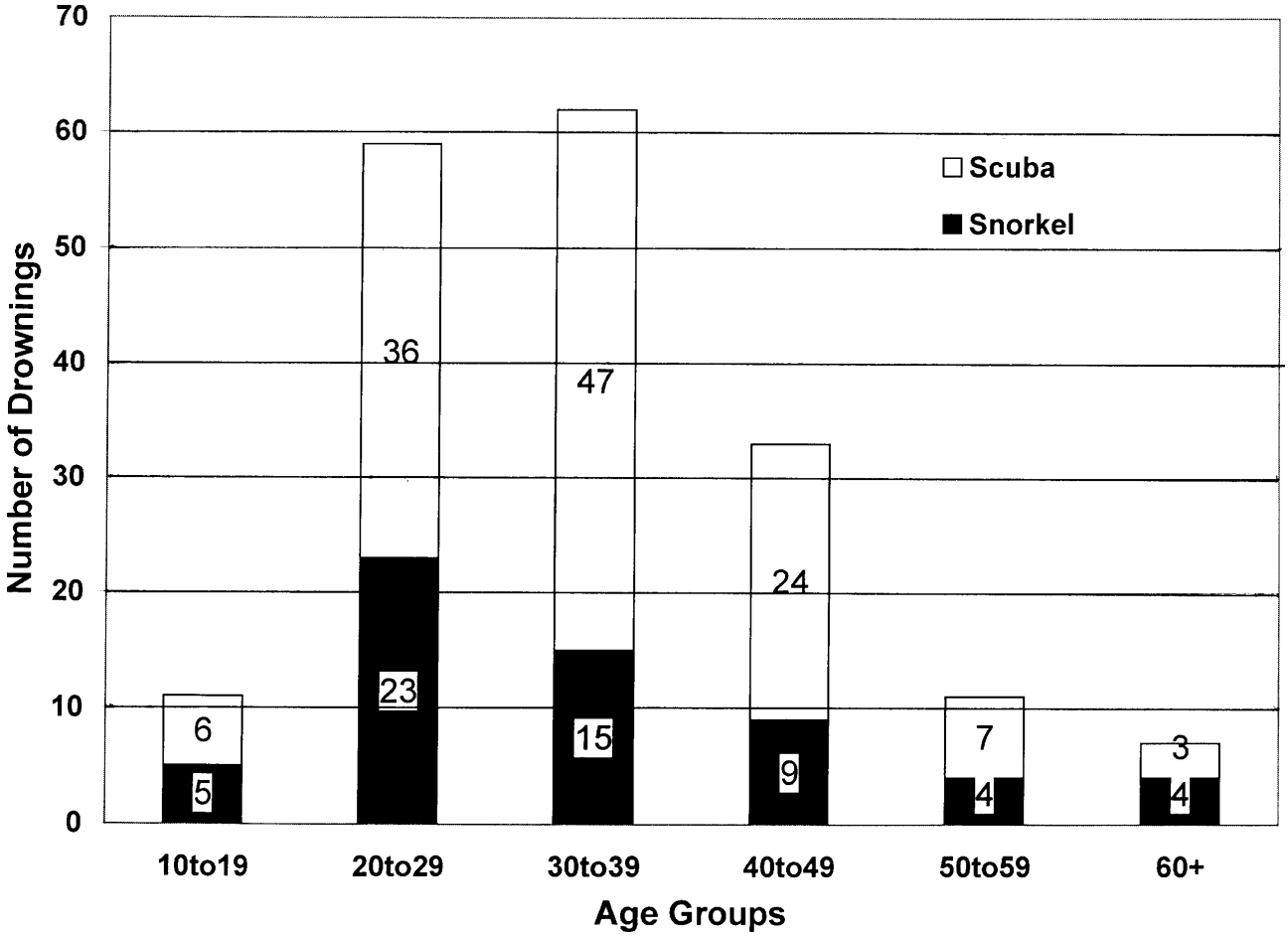

Figure 3. Snorkeling and scuba diving drownings in New Zealand, 1980-2000, by 10-year age groups.

TABLE 5

DIVING EXPERIENCE AND QUALIFICATIONS IN DROWNED SCUBA DIVERS.

Experience (N= 88)	Number
Inexperienced	44
Moderately experienced	21
Experienced	23
Qualifications (N=67):	
None	22
Basic	40
Advanced	5

TABLE 6

SOLO AND BUDDY DIVING PRACTICES IN DIVING DROWNING INCIDENTS.

	Solo	Buddy diving	
		Separated	Not separated
Snorkeling (N=59)	26	10	23
Scuba (N=120)	36	58	26

TABLE 7

ACTIONS OF DIVING BUDDIES FOLLOWING AN IMMERSION INCIDENT IN SNORKELLERS AND SCUBA DIVERS

	Scuba (N=55)	Snorkelling (N=32)
Buddy breathe	5	Not applicable
Deep water rescue	2	Not applicable
Surface rescue	26	23
Attempted rescue		2
Search	10	4
Alert nearby boats/people	10	3
Self-care	2	

separated underwater from an instructor-led group in poor visibility and never surfaced.

The average depth recorded for 27 snorkellers was 5 m, range – surface to 24 m. The surface or tidal conditions were recorded in 43 snorkel accidents, with eight snorkellers getting into difficulty in currents or choppy and rough seas.

SCUBA DIVING PRACTICES

All the scuba fatalities occurred whilst diving on air. The presence or otherwise of other scuba divers was recorded in 120 scuba deaths. Solo diving and buddy separation were common, occurring in 78% of scuba drownings (Table 6). Whether panic was a factor was either unknown (and therefore only surmisable) or only recorded in a minority of cases. Panic was thought to have contributed in 30 of 44 scuba deaths (68%) in which the diver's state was noted.

In four divers the weights could not have been released because of incorrect assembly of the equipment, whilst four divers were considerably over-weighted. The buoyancy compensator was not connected to an air supply in three divers whilst the inlet/exhaust hose was tangled in a catch bag in one case. Two divers were thought to have removed their breathing equipment to get into narrow cracks or holes for crayfish. Two divers suffered convulsive-like loss of consciousness (possibly due to acute CNS oxygen toxicity) on deep air dives at 55 and 80 m in separate incidents.

Five scuba divers died in wrecks, including a double fatality. One diver surfaced in a shipping lane and was hit by a powerboatsuicide soon after related to the accident. Two surface tethered divers became entangled in their lifelines in strong current conditions and could not be retrieved. One of these drownings highlights the often multi-factorial nature of diving accidents, in that the diver was inexperienced in the working environment, was reported to be cold, was diving in a strong current, became entangled and almost certainly panicked. At autopsy he was also found to have previously unrecognised severe coronary artery disease.

The actions of the buddy were recorded in 88 accidents and are summarised in Table 7. Excluding the two double fatality dives where no details are known, no buddies died attempting to rescue or search for the victim, though it is known that five suffered decompression illness requiring recompression, one was near-drowned and one committed suicide soon afterwards. A non-diving rescuer drowned when his dinghy capsized whilst he was trying to assist a snorkeller.

There is a complex, often unknown inter-relationship between the air supply, ditching of weights and use of buoyancy devices (BC) in any scuba diving incident. Because of this complexity all recorded combinations of these three factors as known from the coroner's reports are listed in Table 8. The weight belt was ditched by only seven divers and only ten inflated their BC. Seven divers were recorded as not wearing a BC. The contents of 94 cylinders were checked. Forty-six divers still had a useable air supply in their cylinder whilst 48 were probably out of air.

TABLE 8

THE RELATIONSHIP BETWEEN INFLATION OF A BUOYANCY DEVICE, DITCHING OF WEIGHTS AND LOSS OF AIR SUPPLY IN 106 SCUBA DIVING DROWNINGS

BC inflated	Weight belt dropped	Out of Air	Number
Unknown	Unknown	No	5
Unknown	No	Unknown	2
Unknown	Yes	No	1
Unknown	No	No	4
Unknown	Yes	Yes	1
Unknown	Unknown	Yes	9
No	Unknown	Unknown	1
No	Yes	Unknown	1
No	No	Unknown	5
No	Unknown	No	2
No	No	No	23
No	No	Yes	32
No	Yes	No	1
No	Yes	Yes	1
Yes	No	Yes	2
Yes	Yes	Yes	1
Yes	No	No	3
Yes	No	Unknown	1
Yes	Unknown	No	3
No BC	No	No	3
No BC	No	Yes	1
No BC	No	Unknown	1
No BC	Yes	No	1
No BC	Unknown	Yes	1

Inflated	**10**	**Yes**	**7**	**Yes**	**48**
Not inflated	**66**	**No**	**76**	**No**	**46**
No BC	**7**				

TABLE 9

EQUIPMENT FAULTS IDENTIFIED FROM EXPERT EXAMINATION OF 75 SCUBA DIVERS' EQUIPMENT FOLLOWING DROWNING

No Faults	61
Equipment Faults	
Buoyancy device	8
Regulator	5
Contents gauge	2
Pillar valve	1
Air contamination	1
Mask	1
Unknown	1
Total	**19 faults in 14 divers**

EQUIPMENT

All the diving equipment functioned correctly in 61 of 75 cases for which an equipment report was available. The faults identified in the other 14 divers' equipment are listed in Table 9.

SNORKEL DIVING PRACTICES

Snorkellers' experience or training, aspects of diving practice, the equipment being worn or problems with equipment were often poorly documented. However, solo diving or buddy separation were noted in nearly two-thirds (Table 6). At least 21 were not wearing fins and several were grossly over-weighted. Five snorkels became entangled in nets or ropes, one suffered a severe mask squeeze while diving to clear an anchor and one was hit by a powerboat whilst swimming on the surface. Eight snorkellers were believed to have lost consciousness from breath-hold hypoxia. Five people with epilepsy probably had fits in the water.

RESCUE AND RESUSCITATION

Twenty eight scuba divers surfaced in distress and either disappeared again (18) or lost consciousness and were recovered on the surface (10).

The bodies of 173 divers were recovered. The time to recovery varied from immediate rescue, including two deep-water rescues from over 50 m, to months later. Basic Life Support (BLS) was provided in 78 cases (Table 10).

AUTOPSY FINDINGS

Coroner's autopsies were carried out on 169 bodies. Two snorkellers who were recovered promptly from the surface and received bystander BLS and two scuba divers whose bodies were not recovered for some time after the event did not undergo autopsy.

In scuba divers who were recovered within 24 hours of their deaths, 49 of the 94 autopsies were performed in accordance with or close to the RCPA guidelines. In 27 of these cases (55%) cerebral arterial gas embolism (CAGE) was a contributory cause of death. In the remaining 45 autopsies, whilst possible CAGE was mentioned in a few cases, it was not listed as a contributory cause of death at all (Table 11). Of the 28 divers who surfaced in distress, only nine had a correctly conducted autopsy, of whom six had CAGE, one had severe coronary artery disease and two were out of air with no other cause of drowning.

Blood alcohol levels were measured in 72 divers whose bodies were recovered within 24 hours and were positive in five of 24 snorkellers (21%) and four of 48 scuba divers (8.3%). In three drownings alcohol was a possible

TABLE 10

RECOVERY OF DIVERS' BODIES AND THE PROVISION OF ON-SITE RESUSCITATION.

Recovery (N=184)	Snorkel	Scuba
Surface	24	33
Surface-delayed	12	13
Underwater	6	16
Underwater-delayed	12	47
Unreported	6	4
No body	1	10
Basic Life Support given	36	52

TABLE 11

PERFORMANCE OF AUTOPSIES ACCORDING TO RCPA GUIDELINES AND THE DIAGNOSIS OF CEREBRAL ARTERIAL GAS EMBOLISM(CAGE)

Procedure	Snorkel	Scuba
Correct	52	49
		CAGE 27
Incorrect	Not applicable	45
		CAGE unknown
Late	6	17
No autopsy	2	2
No body	1	10

contributing cause of death. One scuba diver, a known user, tested positive for pethidine (Demerol).

A number of medical conditions were either identified at autopsy or were known pre-existing conditions. Medical conditions were considered to be contributory to death in 14 of 58 (24%) snorkellers and 23 of 113 (20%) scuba divers. The deaths of three divers with a known history of paroxysmal supraventricular tachycardia were attributed to sudden onset arrhythmias. Seven scuba divers with previously known medical conditions contributing to death had diving qualifications and therefore must have undergone a diving medical at some time. Their conditions included rheumatic valvular heart disease, paroxysmal tachyarrhythmia, coronary artery disease, alcoholism (positive for alcohol at time of death), severe schizophrenia and gross obesity. The medical conditions identified are listed in Table 12.

TABLE 12

MEDICAL CONDITIONS KNOWN OR IDENTIFIED AT AUTOPSY IN DROWNED SNORKELLERS AND SCUBA DIVERS. THOSE BELIEVED TO HAVE CONTRIBUTED TO THE DEATH ARE SHOWN IN BRACKETS.

Medical Conditions	Snorkel		Scuba	
Asthma	5	(2)	5	(4)
Other pulmonary (eg. adhesions)	1	(0)	5	(3)
Coronary artery disease	3	(3)	8	(7)
Other cardiac (eg. myocarditis, arrhythmias)	6	(2)	4	(3)
Epilepsy	5	(5)	4	(4)
Gross obesity	3	(1+?2)	4	(1+?1)
Diabetes	0		1	(0)
Severe psychosis	0		2	(?1)
Alcohol	5	(1)	4	(1+?1)

Discussion

Epidemiological studies of sports injury may be of three broad types. Descriptive studies, such as case-series or cross-sectional reports, are concerned with quantifying the occurrence of injury. These do not provide incidence rates, but do give information on the nature and circumstances of injury and may identify risk factors for injury. Both Project Stickybeak[6,7] and the present report are case-series studies.

Analytic studies are used to evaluate the role of potential risk factors in the causation of injury, and may provide some information on incidence. Examples are CAGE in free ascent training and a study on mortality and morbidity at Stoney Cove in England.[8,9] The third type are interventional studies, such as randomised controlled trials, that might evaluate the efficacy of preventative measures in sports injury. We know of no case-controlled or interventional studies in the diving literature.

The methodology used for the IPRU database, linking NZHIS and WSNZ data, has been described in detail elsewhere [2,3]. Classification of death according to a single cause such as drowning has the potential to miss some water related fatalities coded to other causes of death such as blunt trauma and heart disease. As a result, total diving related deaths are likely to be underestimated, since deaths in divers that do not include a reference to drowning in the NZHIS data and not identified by WSNZ as drowning would not have been included in the IPRU database. One of the authors (MD), for instance, is aware of two scuba fatalities in the

1980's documented as due to acute myocardial infarction not in the database. These difficulties have been discussed previously in relation to the Project Stickybeak database.[6]

The overall drowning rate in NZ over 1980-1994 was 4.4 per 100,000 at risk compared to 2.0 per 100,000 (recalculated from the original data) in Australia for 1992-97.[2,10] Australia and the USA have similar rates.[13] Thus there is clear evidence that New Zealand compares poorly internationally in its overall unintentional drowning statistics. Is the same true of diving activities? Unlike overall population statistics, we have only a poor understanding of the size of the population at risk.

All diving accidents requiring hospitalisation from Stoney Cove, the largest inland diving centre in England where all divers must register before diving, are taken to Leicester Royal Infirmary. Over a 5 year period, 1992-1996, there were 25 accidents & seven fatalities in 238,501 divers giving a fatality rate of 2.9 per 100,000 scuba divers per year.[9] The Professional Association of Diving Instructors (PADI) reported that over the five years 1989-1993 the fatality rate in PADI scuba instructors internationally averaged 1.8 per 100,000 scuba divers per year.[1] Other PADI data from Australia and Japan quoted by Monaghan suggested a much higher fatality rate of 20-30 per 100,000 "active divers".[12]

Throughout most of the 1970s and 1980s, the National Underwater Accident Data Center (NUADC), University of Rhode Island, reported data from the USA, which by 1987 amounted to more than 2600 diving fatalities.[13] Based on research on the "active diver" population funded by the Diving Equipment Manufacturers Association (DEMA) and NUADC's own figures, the estimate for the 1987 USA diving fatality rate was 3.22 to 4.14 per 100,000 divers per year. This estimate has been questioned by Monaghan who argued, based on his own analysis of the same DEMA research, that the numbers of divers in the USA used to calculate these rates were overestimated by three to five times.[14]

Turning to NZ, there are no nationwide data on the number of active scuba divers or snorkellers. However, PADI and Scuba Schools International who between them have about 95% of the diver training market in NZ issued 18,387 scuba certificates at all levels (of which there are many) in 1999 and 22,772 in 2000 (Nimb and Scappens, unpublished data). Of these, 6,789 and 8,629 were entry level certifications. DEMA estimated there is a drop-out rate of 80% for new divers in any one year and 10% per year for experienced divers (quoted by Monaghan),[14] while there is an unknown minority of active but unqualified divers. Given these figures, industry estimates of 100,000 active divers per year in NZ may be too high and using Monaghan's model would approximately halve this figure. Assuming, however, 100,000 is a close estimate then it suggests a fatality rate in NZ of at least 5.8 per 100,000 scuba divers per year during 1996-2000.

New Zealand diving fatalities have been reported in the past. Lewis reviewed 28 deaths over the period 1961-1973 using similar methodology to our own.[15] There were 40 deaths between 1974 and 1979 recorded by the New Zealand Underwater Association Accident Reporter (Fraundorfer, unpublished data). All but two of the cases for the period 1981-1984 published by Walker match with the present database,[16,17] and these and other cases to 1987 formed part of the analysis of 100 consecutive scuba diving fatalities in Australia and New Zealand analysed by Edmonds and Walker.[6,8]

The age and sex distributions are similar to other surveys, particularly from the US.[13,19] So far, there has been no shift upwards in the age pattern of NZ divers drownings as has been suggested elsewhere.[6,19] Far fewer women snorkellers die in NZ and the USA[13] compared with Australia where 25% of drowned snorkellers were women.[20] The number and pattern of accidents in Australia is influenced by the large numbers of more elderly tourists snorkelling on the Great Barrier Reef, who account for half the fatalities.[20]

Several factors appear to contribute to the relatively higher overall drowning rates of men over women, including elevated risk for exposure, risk taking and alcohol use.[21] Over the past twenty years the proportion of women entering scuba diving in NZ has risen from less than 10% to 20-25% (various sources, unpublished data). Therefore, deaths in women divers (14.6% of the total) may be in keeping with this participation level.

Ethnicity coding in NZ is complex and inconsistent. Population statistics such as census reports, for instance, may not be based on the same criteria as used in NZHIS and this makes rate calculations problematic. In the 1996 census Maori represented 13 % of the total population aged 16-65. It would therefore seem that Maori are over-represented in diving drowning statistics as they are in the overall drowning statistics. However, adult Maori may be more likely to participate in seafood gathering activities. Coastal Maori communities need to focus, amongst other things, on snorkelling skills in their water safety education programs.

The lack of proper equipment and training in snorkellers was very evident even from the sketchy reports available. A particular feature of snorkelling fatalities in both NZ and Australia is the high proportion of victims not wearing fins.[7,20]

Solo diving, buddy separation, running out of air, lack of proper training and failure to carry out fundamental emergency procedures all figure highly in this report as in all others in the literature.[5,7,13] Reading eye witness reports of drowning accidents leaves one in agreement with Edmonds and Walker, "the real tragedy of this survey was that it shows that the lessons and teachings of yesterday are still not sufficiently appreciated today".[6]

Experienced, trained divers constituted a small proportion of scuba fatalities in NZ. PADI's NZ certification data (Nimb, personal communication) shows that the proportion of divers undertaking training beyond that of the basic course is steadily increasing. Whilst entry-level certifications rose 12% from 1996 to 2000, those for further training rose by 124%. The training agencies have mounted enthusiastic marketing campaigns in recent years to attract divers to undertake further scuba training beyond the basic level. Combined with improved standards of teaching this may help to explain why the annual fatality rates of today are no greater than 20 years ago despite more divers reportedly participating in the sport. Monaghan has questioned these conclusions.[14] Using the industry's own data he claimed there are "fewer divers, fewer dives and greater risk of fatalities" than used by the industry.

The safety of sport diving should not be over-emphasised. This is an adventure sport that requires a strong focus on risk avoidance and emergency procedures training from the very start. It is unclear from international studies of drowning statistics whether training in water safety skills reduces the risk of drowning overall, but it is probably important for diving, both snorkelling and scuba, activities. Diver training agencies may also need to provide more training in snorkelling skills in their entry-level programs.

The large number of untrained divers featuring in all surveys of diving fatalities indicate a possible need for legislation to be considered as has been enacted in Queensland. Somewhat like the drinking age laws, it would seem logical to make it an offence to sell diving equipment to or to fill scuba tanks for individuals without diving certification or on a validated training course. The retail diving industry has always been opposed to such legislation but has never adopted voluntary regulation of this type on a consistent basis.

Blood alcohol levels were recorded in only about a third of cases in a study of 320 NZ drownings in 1992-94 and were positive for 50% of the incidnets.[22] In NZ divers in the present series, 41% had a blood alcohol level measured and this was positive in only 15%, in few of whom was it thought contributory to the accident. Therefore, although some divers still drink whilst diving it does not appear to be as extensive a problem as in other drowning situations. However, blood alcohol levels should always be taken in all drowning victims at autopsy.

The quality of autopsy procedures in NZ divers was as variable as has been reported for other countries.[6,13] Guidelines have been promulgated in many countries but continue not to be followed by many coroner's pathologists. Improved quality assurance in this area is essential for the accurate diagnosis of CAGE.

In addition, the police records were often deficient in essential information. The diving equipment is supposed to be secured and professionally examined in all cases but this did not occur in one third of deaths. Diving accidents are relatively uncommon compared to other causes of death so coroners, police and pathologists may benefit from improved education in the handling of diving deaths. The diving industry and SPUMS could contribute to this by promulgating diving accident report forms to be used in all unintentional diving related deaths. Existing formats (eg. DAN forms) may suffice in a modified form.

Fitness for diving remains a controversial issue. Lack of water fitness and lack of skills cannot easily be assessed by the examining physician, but were clearly a contributing factor to many drownings. That a fifth to a quarter of the divers in this series had a contributing medical condition is of considerable concern. Many were unqualified and therefore had not undergone medical assessment but others must have had examinations, with conditions present that should have excluded the candidate from diving. These issues were discussed at length by Edmonds and Walker.[6] They concluded a decade ago that medical standards for diving were not being appropriately applied, and this study indicates this is still the case.

Asthma is a specific example. There is a current view that it may be safe to relax standards for people with stable asthma despite no good data to support this stance. Six divers with asthma in this series probably died from their disease. These preventable deaths would seem to support the views of Edmonds and others that take a prescriptive attitude to this disease.[23] Clearly a prescriptive approach is also correct for epilepsy, and better protocols are needed for screening in older divers with coronary artery disease. DAN reported that in 1998, the last year for which they have reasonably complete figures, 11% of USA scuba fatalities were insulin dependent diabetics.[19] Thorough medical assessment of entry-level divers by trained physicians applying current knowledge in an informed manner is clearly indicated.

Summary

Scuba diving and snorkelling contributed significantly to water sports drownings in NZ.

1 The scuba diving drowning rate in NZ was at least 5.8 per 100,000 divers per year
2 All but one of the snorkelling deaths were in men
3 Maori are over-represented on a population basis, especially in the snorkelling deaths, for reasons that are not apparent from these data
4 The majority of scuba divers who have drowned lacked experience and/or diving training
5 Poor water skills and poor dive planning (especially running out of air) were common risk factors
6 Emergency drills were frequently omitted
7 Autopsy procedures in many divers were not performed correctly and a blood alcohol level was taken in less than half the cases

8 Where the autopsy was conducted correctly, CAGE was a contributory cause of death in at least half the scuba divers

9 A fifth of scuba divers and a quarter of snorkellers drowning had an underlying contributory medical condition such as asthma, epilepsy or ischaemic heart or other cardiovascular disease.

Summary

The authors believe that this examination of two decades of diving drownings should lead to action on some or all of the following:

1 Promotion of competent medical assessment of all entry level divers

2 Establishment of snorkel training programs for the Maori community

3 Improvement in the teaching of snorkelling techniques and enhance training in emergency procedures in entry-level scuba diving courses

4 Standardisation of the reporting of diving related deaths and autopsy procedures in scuba divers

5 Conduct a study in New Zealand to establish the number of active divers so that incidence rates may be more accurately known

6 Consideration of legislation to restrict the purchase of diving equipment or compressed gases for scuba by unqualified divers

7 Public endorsement by SPUMS of the diving training agencies' current approach to a continuum of training in scuba diving and of water safety programs such as WSNZ/NZ Underwater's "Dive Safe" and "Mini-Dippers".

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Conflicts of interest

None

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THE WORLD AS IT IS

THE DIVERS ALERT NETWORK TODAY

John Lippmann

Key Words
Oxygen, rescue, research, training, transport, treatment.

The Divers Alert Network (DAN) is a not-for-profit organisation which was formed in 1980 in the United States to assist in the treatment of underwater diving accidents by providing a 24-hour emergency hotline. When government funding for this service evaporated, DAN established a membership program. For a small payment, subscribers received a diving accident manual and a regular newsletter, *Alert Diver*, dealing with various issues of diving safety.

As the popularity of diving and dive travel increased, numerous situations arose when divers with symptoms of DCI were stranded in remote locations without the funds required to pay for an expensive evacuation to a recompression facility. In the early 1980s, dive insurance was very difficult to obtain and DAN lobbied hard to enable divers to get access to appropriate insurance coverage. As DAN grew, it was able to provide its members with a worldwide evacuation service and diving injury treatment insurance.

DAN organisations have been established in several regions. These include DAN Europe, DAN Japan, DAN S.E. Asia-Pacific (SEAP) and DAN Southern Africa. DAN SEAP was established in 1994, and provides services to most countries in the Asia-Pacific Region. Together, the DAN organisations form the International Divers Alert Network (IDAN). These autonomous organisations work co-operatively towards a common goal of improving diving safety and treatment services worldwide. At the end of 2001, there were more than 205,000 DAN members worldwide.

The aims of DAN SEAP include improving diver safety through education, providing evacuation and insurance services for injured divers, improving the management of diving and other accidents by the provision of appropriate first aid training, oxygen provider training and equipment, support for regional diving emergency hotlines, diving accident data collection and research.

Improvement of dive safety through education

All DAN members receive a copy of Alert Diver, a regular journal dealing with various aspects of dive safety and health. The various DAN entities also conduct workshops and seminars relating to safety issues, and have large websites with a variety of useful health and safety information on them.

Provision of evacuation and insurance services

All DAN SEAP members automatically become eligible for emergency medical evacuation cover, for up to US$100,000, for diving and non-diving emergencies that occur more than 80 km from home. Members also have access to a variety of economical dive injury treatment insurance plans, and in some cases, personal accident plans.