Estimating the risk of a scuba diving fatality in Australia

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Abstract

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Introduction: There are few data available on which to estimate the risk of death for Australian divers. This report estimates the risk of a scuba diving fatality for Australian residents, international tourists diving in Queensland, and clients of a large Victorian dive operator.

Methodology: Numerators for the estimates were obtained from the Divers Alert Network Asia-Pacific dive fatality database. Denominators were derived from three sources: Participation in Exercise, Recreation and Sport Surveys, 2001–2010 (Australian resident diving activity data); Tourism Research Australia surveys of international visitors to Queensland 2006–2014 and a dive operator in Victoria 2007–2014. Annual fatality rates (AFR) and 95% confidence intervals (95% CI) were calculated using an exact binomial test.

Results: Estimated AFRs were: 0.48 (0.37–0.59) deaths per 100,000 dives, or 8.73 (6.85–10.96) deaths per 100,000 divers for Australian residents; 0.12 (0.05–0.25) deaths per 100,000 dives, or 0.46 (0.20–0.91) deaths per 100,000 divers for international visitors to Queensland; and 1.64 (0.20–5.93) deaths per 100,000 dives for the dive operator in Victoria . On a per diver basis, Australian residents are estimated to be almost twenty times more likely to die whilst scuba diving than are international visitors to Queensland, or to lower than fourfold on a per dive basis. On a per dive basis, divers in Victoria are fourteen times more likely to die than are Queensland international tourists.

Conclusions: Although some of the estimates are based on potentially unreliable denominator data extrapolated from surveys, the diving fatality rates in Australia appear to vary by State, being considerably lower in Queensland than in Victoria. These estimates are similar to or lower than comparable overseas estimates, although reliability of all such measurements varies with study size and accuracy of the data available.

Key words

Deaths; Diving incidents; Recreational diving; Survey; Statistics

Introduction

Scuba diving is an 'adventure sport' which many consider to be a dangerous activity.[1] Media publicity about shark attacks and divers being left at sea likely serve to increase this perception. It is important for both the diving industry and the general community to have a reasoned perspective of the level of risk, based on estimated activity and incidents, rather than media perceptions. There are few available data on which to estimate the risk of fatality for Australian divers and much of these data have considerable limitations. Earlier reports explored estimates for Australia (including overseas travellers) but these were based on limited data and were affected by methodological errors, predominantly the combination of activity data from two surveys which used different methods of data collection.[2,3] In this study, individual estimates are based on single data sources.

To estimate a fatality rate for divers, it is necessary to obtain both an accurate numerator (i.e., the number of deaths over a time period) and denominator (i.e., a measure of diving activity over that same period). In Australia, we can be reasonably confident in the accuracy of the number of dive-related fatalities reported each year because of our effective coronial reporting system and the active involvement of the Divers Alert Network Asia-Pacific (DAN AP) in collection of relevant data and its access to the National Coronial Information System (NCIS). As with most other countries, it is difficult to find a reliable estimate of Australian diving activity. Denominators, the measure of risk exposure, can be based on the number of divers, the number of dives or time at risk. Where reasonably sound activity data are available, the fatality rate per dive is a better measure of actual exposure risk than is a per person death rate, which provides no detail of actual diving exposures. The actual hours of exposure time provides the best denominator to establish an accurate measure of incident risk.[4] However, in the diving population this is rarely reported and, therefore, not available.

In this report, data on the diving activity of Australian-based divers and the associated fatalities are examined to provide 'best guess' estimates of the risk of death for Australian divers overall, as well as for subsets of divers in Queensland and Victoria.

Methodology

Numerators were obtained from the DAN AP dive fatality database.[5] DAN AP systematically collects data from all States and Territories through media and diver reports, the National Coronial Information System (NCIS) and coronial offices throughout Australia. Denominator data were sought by: (1) A literature search for suitable Australian activity data; (2) Diving records of a large diving charter operator in Victoria.

Table 1
Search terms

Search No.	Search items
#1	scuba OR snorkel* OR diving
#2	survey* OR rate* OR statistic* OR census OR participa* OR count
#3	Australia OR Queensland
#4	death* OR fatal*
#5	risk OR estimat*
#6	#1 AND #2 AND #3
#7	#1 AND #4 AND #5

LITERATURE SEARCH

Diving activity data for Australia from 1980 to 2015 inclusive were sought through searches of the *South Pacific Underwater Medical Society Journal* and *Diving and Hyperbaric Medicine*, other relevant sporting activity reports, liaison with industry bodies and internet searches. Search engines accessed were Google, Google Scholar, Medline, CINAHL, Heath Source (Nursing/Academic Edition), Sportsdiscus, Psychinfo, Global Health, Academic Search Complete, Informit and Embase. Details of the search terms are shown in Table 1. The inclusion criteria for relevant articles were: (1) There was a measure or estimate of diving activity either from survey, recorded dives, tank fills or membership/insurance counts; and (2) data were available for at least five consecutive years.

Three sources of denominator data met the inclusion criteria. These were: (1) The Australia-wide Participation in Exercise, Recreation and Sport (ERASS) Surveys;[6–15] (2) Tourism Research Australia Surveys of International visitors to Queensland (Tourism Research Australia, April 2015, with permission);[16,17] (3) Victorian dive operator records from 2007 through 2014 (confidential communication, 2015).

ERASS NATIONAL SPORTING PARTICIPATION SURVEYS 2001–2010

The ERASS data were collected via telephone-based surveys conducted on behalf of the Australian Sports Commission (ASC) from 2001 through 2010, inclusive (by AC Neilson Research 2001–2007 and Newspoll Market and Social Research 2008–2010).[6–15] The basic questionnaires changed little over the years. The surveys utilised random samples of at least 3,400 Australian residents over 15 years of age, per quarter. Participants were asked about their sporting activities, including scuba diving, during the previous year.

TOURISM RESEARCH AUSTRALIA SURVEYS OF INTERNATIONAL TOURIST ACTIVITY IN QUEENSLAND

Since 2006, Tourism Research Australia has consistently conducted annual surveys of international and national tourists who have visited various Australian States and Territories.[16,17] The International Visitor Survey (IVS) samples annually 40,000 departing, short-term international visitors over 15 years of age. It is conducted in the departure lounges of major international airports and utilises computer-assisted personal interviewing. Participants are shown a list of activities which includes scuba diving and snorkelling. The survey results are weighted to data on international visitor numbers over the period, provided by the Department of Immigration and Citizenship, with the assistance of the Australian Bureau of Statistics.

In earlier research, based on the IVS, interviewees who indicated that they had been diving in Queensland in a 12-month period from April 2006 were given a supplementary questionnaire on the number of times they had dived.[18] The resulting data were based on interviews with 1,685 scuba divers and indicated an average of 3.7 dives each. It was assumed that a similar number of dives per person could be applied for the years 2006–2014 and these figures were used to estimate the total number of dives conducted for these years and subsequently the per dive fatality rate.

As the IVS contains relatively few diving-related data for most parts of Australia, most were not investigated further due to the increased potential for measurement bias. However, on the advice of Tourism Australia (which oversees the surveys), the international visitor data for Queensland were assumed to be based on sufficiently large samples which ranged between 1,795 and 2,155 diver respondents annually from 2006 through 2014.

DIVE CHARTER OPERATOR

Data were collected from the largest dive charter operator in Victoria which has up to six boats of various sizes and conducts charters for divers, snorkellers and sightseers. It operates an average of four days per week and up to seven days in the summer months. Each dive is logged and scuba activity records from mid-2006 were available.

STATISTICAL ANALYSIS

Estimates were considered to be significantly different if their respective 95% confidence intervals did not overlap. Annual fatality rates (AFR) and 95% confidence intervals (CI) were calculated based on an exact binomial method as implemented in the Binomial Test in the R statistical package.[19]

Results

Over the 10-year period, the mean annual number of Australian residents who went scuba diving was 84,767 (95% CI 61,767–107,748). Between them, these participants conducted an average of 1,552,728 dives per year (95% CI 1,125,985–1,979,472). In total, there were 129 scuba diving-related fatalities in Australia from 2001–2014. These were both Australian residents and international tourists.

Table 2
ERASS-derived estimates of the number of divers and dives conducted, recorded deaths, and estimated AFRs 2001-10 (95% CI)

Year	Sample size	Divers (residents)	Dives/person (Australians)	Dives	Deaths in Australia	Deaths overseas	Deaths total	Deaths/100K divers		Deaths/100 K dives	
2001	13,640	79,379	18.7	1,484,387	11	0	11	13.86	(6.92–24.79)	0.74	(0.37–1.32)
2002	13,632	73,331	16.3	1,195,295	8	0	8	10.91	(4.71–21.49)	0.67	(0.28–1.32)
2003	13,644	90,592	21.2	1,920,550	6	0	6	6.62	(2.43–14.42)	0.31	(0.11–0.68)
2004	13,662	103,337	17.7	1,829,065	7	2	9	8.71	(3.98–16.53)	0.38	(0.15–0.79)
2005	13726	86,791	20.7	1,796,574	5	0	5	5.76	(1.87–13.44)	0.28	(0.09–0.65)
2006	13,710	76,035	12.1	920,024	5	0	5	6.58	(2.14–15.35)	0.54	(0.18–1.27)
2007	16,400	69,912	24.0	1,677,888	8	1	9	12.87	(5.89–24.43)	0.54	(0.25–1.02)
2008	17,293	90,200	17.2	1,551,440	6	1	7	7.76	(3.12–15.98)	0.45	(0.18–0.93)
2009	23,031	83,313	20.3	1,682,923	5	0	5	6.00	(1.95–14.00)	0.30	(0.09–0.69)
2010	21,603	94,783	15.5	1,469,137	7	2	9	9.50	(4.34–18.02)	0.61	(0.28–1.20)
Mean	16,034	84,767	18.4	1,552,728	6.8	0.6	7.4	8.73	(6.85–10.96)	0.48	(0.37–0.59)

Table 3
Estimated AFRs by gender and age group based on ERASS data and recoded deaths (95% CI)

	Divers	Dives	Deaths	AFR/100K divers		AFR/100Kdives	
Male	645,927	11,838,137	59	9.13	(6.95–11.78)	0.50	(0.38–0.64)
Female	201,746	3,697,476	15	7.44	(4.16–12.26)	0.41	(0.23–0.67)
<45 years	605,239	11,092,428	33	5.45	(3.75–7.66)	0.30	(0.20–0.42)
≥45 years	242,434	4,443,185	41	16.91	(12.14–22.94)	0.92	(0.66–1.2)

Table 4
Annual activity and fatality rates for international visitors in Queensland, 2006-13; * data for 2014 not included as fatality numbers for that year are not finalised

	Year							
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Divers (*n*)	236,327	228,166	220,836	226,596	222,704	185,543	197,867	213,506
Dives (*n*)	874,410	844,214	817,093	838,405	824,005	686,509	732,108	789,972
Fatalities (*n*)	2	2	0	2	0	0	0	2
Fatalities /100,000 divers (95% CI)	0.85 (0.10–3.06)	0.88 (0.11–3.17)	0.00 (0.00–1.67)	0.88 (0.11–3.12)	0.00 (0.00–1.66)	0.00 (0.00–1.99)	0.00 (0.00–1.86)	0.94 (0.11–3.38)
Fatalities /100,000 dives (95% CI)	0.23 (0.03–0.83)	0.23 (0.03–0.86)	0.00 (0.00–0.45)	0.24 (0.03–0.86)	0.00 (0.00–0.45)	0.00 (0.00–0.54)	0.00 (0.00–0.50)	0.25 (0.03–0.91)

Table 5
Annual fatality rates (AFR) for SCUBA divers from the three data sources (95% CI); Qld – Queensland

Group	Period (y)	Method	Dives	Divers	AFR per 100,000 dives		AFR per 100,000 divers	
Australian residents (ERASS)	2001–10	Survey	1,552,728	84,787	0.48	(0.37–0.59)	8.73	(6.85–10.96)
Qld International tourists (Tourism Australia)	2006–13	Survey	800,840	216,443	0.12	(0.05–0.25)	0.46	(0.20–0.91)
Victorian operator	2007–14	Measured	15,235	–	1.64	(0.20–5.93)	–	

Table 2 includes the ERASS-derived estimates of the number of active divers and the dives conducted from 2001–2010. In addition, it shows the number of Australian residents who died while scuba diving both in Australia and while overseas as recorded on the DAN AP database. The overseas fatalities are included as the ERASS survey did not ask where the diving was conducted and many Australian residents divers do some diving overseas.

According to the ERASS data, 76% of the divers were male, and approximately 30% were aged 45 years or older. By comparison, 59 (80%) of the 74 Australians who died while diving in Australia or overseas from 2001 through 2010 were male and 41 (70%) were aged 45 years or older. These data, along with the associated AFRs are shown in Table 3.

Table 4 shows the annual activity data, annual deaths of international visitors (based on DAN AP fatality data[5]), and

per diver and per dive fatality rates based on the Tourism Research Australian activity data for all of Queensland from 2006 to 2013 inclusive. (Tourism Research Australia, April 2015, with permission). The mean annual scuba fatality rate among international visitors over the period was 0.46 deaths per 100,000 divers (95% CI 0.2–0.91); or 0.12 deaths per 100,000 dives (95% CI 0.05–0.25).

DIVE CHARTER OPERATOR, VICTORIA 2007–2014

From 2007 through 2014, an average of 15,235 scuba dives were conducted annually from this operator's vessels, during which time there were two deaths, one in 2010 and one in 2014. This gives a mean annual death rate of 1.64 deaths per 100,000 dives (95% CI 0.20–5.93).

Table 5 provides a summary of the annual fatality rate estimates derived from the three sources.

Discussion

The AFRs from these three sources vary more than tenfold. This is likely due to differences in diving conditions and practices, data reliability, and possibly to some differences in diver characteristics. The denominators used as baselines for the AFR estimate calculations vary in reliability. The most accurate denominator was that from the dive operator in Victoria as it was measured rather than extrapolated from surveys. The AFR from this dive operator (1.64 per 100,000 dives) is lower than one based on a one-year Victorian tank fill survey[20] and averaging fatalities over a five-year period (2.5 per 100,000 dives).[2] The difference may indicate that diving with this operator is safer than general diving in Victoria or may reflect the divers who choose to dive with this operator. However, these two estimates lie within each other's 95% confidence intervals so there may be no significant difference in the underlying risk.

The estimated scuba AFR for Victorian divers is significantly higher than that for international visitors diving in Queensland. These differences could be the result of inaccuracy of denominator data. However, other local factors may have been contributory. Waters in Victoria are colder, visibility is generally much poorer and much of the diving occurs in sites with strong currents or prone to surges. The more challenging conditions and the associated requirement for thicker suits and greater weighting can increase problems with buoyancy, breathing gas consumption, exertion and stress, thus increasing the risk of an accident.[21,22] In addition to the generally easier diving conditions in Queensland, diving there is highly regulated due to the existence and enforcement of a regulated Code of Practice (COP) and this may help to mitigate the risk. Although COPs exist in two other States (including Victoria), these are voluntary, not enforced by either industry or government and are likely to have little effect.

The apparent three-fold increased risk of death in divers aged 45 years or more is consistent with other reports and is often reflective of cardiac-related incidents among divers with known or occult cardiac disease.[23,24]

The Australian estimates generally compare favourably with those reported from other countries. For example, the AFR for DAN America members has been calculated to be 16.4 (95% CI 14.2–19.0) per 100,000 divers (based on measured data).[23] Similarly, British Sub-Aqua Club (BSAC) membership and fatality data indicate an AFR of 14.4 (95% CI 10.5–19.7) per 100,000 members.[25–31] These higher rates may be partly explained by population differences (e.g., DAN members are generally older, with an increased association of co-existing medical conditions) and diving conditions (e.g., UK conditions are often more challenging). At the lower end, measured data from an inland lake in Leicester (UK) yielded an AFR of 2.9 (95% CI 1.2–6.0) per 100,000 divers.[32] Despite this site being cold and potentially deep, diving there is generally well-controlled and more predictable and this may explain the relatively low death rate. Measured data from British Columbia in Canada indicated an AFR of 2.04 (95% CI 0.0–6.0) per 100,000 dives.[33] This is comparable to Victoria, although the water temperature is substantially colder.

LIMITATIONS

Comparisons between estimates from different data sources would usually be age/sex-adjusted to reduce possible confounding effects of different age/sex distributions. However, age/sex–specific data were not available from the IVS and the dive operator in Victoria so no age/sex standardisation was possible. Hence comparison of results may be influenced by different age/sex distributions in the populations.

Although commonly utilised by researchers to provide a denominator for a variety of sporting activities in Australia,[34,35] the ERASS, as with most surveys, has several limitations.[36,37] These include:

- Based on a relatively small sample, it is subject to sampling error. However, with the national diving data, the mean relative standard error was 14% (range 12–15%) indicating that the annual sample should be sufficiently reliable.
- It is retrospective and subject to recall bias. However, the participants were surveyed about activities in the previous year so the elapsed time was not substantial.
- The response rate in 2010 was 17.6% which may have introduced selection bias.
- Until 2010, the survey only included 'landlines' and not mobile phones. This raises the concern of selection bias resulting from mobile-only households being excluded from the previous years' samples, mainly associated with the likely younger age of the residents.

The proportion of Australian residents living in mobile-only households increased from 5% in 2005 to 13% in 2010.[38] This may have led to under-reporting of the dives conducted by younger divers who tend to only have mobile phones.

- The ERASS surveys did not include divers who were younger than 15 years old. However, these divers likely represented a small proportion of divers (< 1%)[39] and their exclusion should have little effect on the overall results. In addition, there were no deaths of divers younger than 15 years in Australia during that period.

Despite these limitations, the annual ERASS surveys appear to provide the best available national estimates of the scuba diving activity of Australian residents during the period of study.

As with most surveys, the results of the IVS are based on samples, rather than a census of visitors and are therefore subject to sampling error. However, the relative standard error for the number of participants was approximately 3.5%, indicating that sampling error was not a major barrier to their use. Given that most visitors would have stayed in Australia for a relatively short period, recall bias should have been small. Recall bias would have been further reduced given that many of the scuba divers had come specifically to dive. Like the ERASS survey, the Tourism Australia surveys did not include persons younger than 15 years.

Despite accurate denominator data from the operator in Victoria, over the eight-year period there were very few fatalities. This would have reduced the reliability of the estimate, as indicated by the wide confidence intervals. In addition, the results of a single operator may not be representative of the diving fatality rate throughout Victoria.

Conclusions

It is difficult to obtain substantial and reliable data on the diving activity and, therefore, AFRs in Australia. The only measured denominator data currently available comes from a 1994 Victorian tank fill survey and the activity logs of a single dive operator in Victoria from 2007 through 2014. Other denominator data are based on surveys, with their inherent limitations. On the basis of the information currently available, the diving fatality rate in Australia appears to vary by State, with the estimated rate in Queensland being considerably lower than the estimated rate in Victoria or for Australia overall, which may be partly explained by generally more favourable conditions and/or local diving regulations. These rates are similar to or lower than comparable data from overseas, although reliability of all such estimates varies with the size and accuracy of numerator and denominator data. More research is required to further improve diving activity data collection so that risk estimates can be more accurately determined.

References

1 Pedersen DM. Perceptions of high risk sports. *Percept Mot Skills*. 1997;85:756-8.

2 Lippmann J. Review of scuba diving fatalities and decompression illness in Australia. *Diving Hyperb Med*. 2008;38:71-8.

3 Lippmann J. Australian scuba diving fatalities and decompression sickness: erratum and further analysis. *Diving Hyperb Med*. 2009;39:48.

4 Knowles SB, Marshall SW, Guskiewicz KM. Issues in estimating risks and rates in sports injury research. *J Athl Train*. 2006;41:207-15.

5 Divers Alert Network Asia-Pacific. *Diving-related fatality database and cumulative register. http://www.danap.org* (data available only to authorized internal investigators).

6 Standing Committee on Recreation and Sport. Dale T, Ford I. *Participation in exercise, recreation and sport 2001*. Canberra: Australian Sports Commission; 2002. [cited 2016 March 15]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

7 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport 2002*. Canberra: Australian Sports Commission; 2003. [cited 2016 March 15]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

8 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport. Annual report 2003*. Canberra: Australian Sports Commission; 2004. [cited 2016 March 15]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

9 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport. Annual report 2004*. Canberra: Australian Sports Commission; 2005. [cited 2016 March 15]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

10 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport. Annual report 2005*. Canberra: Australian Sports Commission; 2006. [cited 2016 March 18]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

11 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport. Annual report 2006*. Canberra: Australian Sports Commission; 2007. [cited 2016 March 18]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

12 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport. Annual report 2007*. Canberra: Australian Sports Commission; 2008. [cited 2016 March 18]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

13 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport. Annual report 2008*. Canberra: Australian Sports Commission; 2009. [cited 2016 March 18]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

14 Standing Committee on Recreation and Sport. *Participation in exercise, recreation and sport. Annual report 2009*. Canberra: Australian Sports Commission; 2010. [cited 2016 March 24]. Available from: http://www.ausport.gov.au/information/casro/ERASS.

15 Committee of Australian Sport and Recreation Officials (formerly Standing Committee on Recreation and Sport).

Participation in exercise, recreation and sport annual report 2010. Canberra: CASRO; 2011. [cited 2016 March 24]. Available from: http://www.ausport.gov.au/information/casro/ERASS.
16 Tourism Research Australia. *International tourist statistics*. [cited 2016 February 21]. Available from: http://tra.gov.au/research/International-tourism-statistics.html.
17 Tourism Research Australia. *Domestic tourism statistics*. [cited 2016 February 21]. Available from: https://www.tra.gov.au/research/domestic-travel-by-australians.html.
18 Tourism Research Australia. *Queensland scuba diving and snorkelling report – visitor activities and characteristics*. Queensland Government; 2007 (internal report only).
19 Ihaka R, Gentleman R. R: A language for data analysis and graphics. *J Comp Graph Stat*. 1996;5:299-314.
20 McDonald W. Victorian air fill survey 1993-1994. *SPUMS Journal*. 1994;24:194-6.
21 Denoble PJ, Caruso JL, de L Dear G, Vann RD. Common causes of open-circuit recreational diving fatalities. *Undersea Hyperb Med.* 2008;35:393-406.
22 Lippmann J, Baddeley A, Vann R, Walker D. An analysis of the causes of compressed gas diving fatalities in Australia from 1972–2005. *Undersea Hyperb Med.* 2013;40:49-61.
23 Denoble PJ, Pollock NW, Vaithiyanathan P, Caruso JL, Dovenbarger JA, Vann RD. Scuba injury death rate among insured DAN members. *Diving Hyperb Med.* 2008;38:182-8.
24 Lippmann J, Lawrence C, Fock A, Jamieson S, Harris R. Provisional report on diving-related fatalities in Australian waters in 2011. *Diving Hyperb Med*. 2016;46:207-40.
25 Cumming B. *NDC Diving incidents report*. South Wirral, Cheshire: British Sub-Aqua Club; 2006. [cited 2015 June 18]. Available from: http://www.bsac.com/core/core_picker/download.asp?id=9803&filetitle=Diving+Incident+Report+2006.
26 Cumming B. *NDC Diving incidents report*. South Wirral, Cheshire: British Sub-Aqua Club; 2005. [cited 2015 June 18]. Available from: http://www.bsac.com/core/core_picker/download.asp?id=9804&filetitle=Diving+Incident+Report+2005
27 Cumming B. NDC *Diving incidents report*. South Wirral, Cheshire: British Sub-Aqua Club; 2004. [cited 2015 June 18]. Available from: http://www.bsac.com/core/core_picker/download.asp?id=15167&filetitle=Diving+Incident+Report+2004.
28 Cumming B. NDC *Diving incidents report*. South Wirral, Cheshire: British Sub-Aqua Club; 2003. [cited 2015 June 18]. Available from: http://www.bsac.com/core/core_picker/download.asp?id=15168&filetitle=Diving+Incident+Report+2003.
29 Cumming B. NDC *Diving incidents report*. South Wirral, Cheshire: British Sub-Aqua Club; 2002. [cited 2015 June 18]. Available from: http://www.bsac.com/core/core_picker/download.asp?id=15169&filetitle=Diving+Incident+Report+2002
30 Cumming B. NDC *Diving incidents report*. South Wirral, Cheshire: British Sub-Aqua Club; 2001. [cited 2015 June 18]. Available from: http://www.bsac.com/core/core_picker/download.asp?id=15170&filetitle=Diving+Incident+Report+2001.
31 Cumming B. NDC *Diving incidents report*. South Wirral, Cheshire: British Sub-Aqua Club; 2000. [cited 2015 June 18]. Available from http://www.bsac.com/core/core_picker/download.asp?id=15171&filetitle=Diving+Incident+Report+2000.
32 Hart A J, White, SA, Conboy P J, Bodiwala G, Quinton D. Open water scuba diving accidents at Leicester: five years' experience. *J Accid Emerg Med.* 1999;16:198-200.
33 Ladd G, StepanV, Stevens L. The Abacus Project: establishing the risk of recreational scuba death and decompression illness. *SPUMS Journal.* 2002;32:124-8.
34 Boufous S, Dennis R, Finch C. *A profile of hospitalisations and deaths due to sport and leisure injuries in New South Wales, 2000–2004*. Sydney, Australia: NSW Injury Risk Management Research Centre; 2006. [cited 2015 July 10]. Available from: www.irmrc.unsw.edu.au.
35 Gabbe BJ, Finch CF, Cameron PA, Williamson OD. Incidence of serious injury and death during sport and recreation activities in Victoria, Australia. *BJSM*. 2005;39:573-7.
36 Kelley K, Clark B, Brown V, Sitzia, J. Good practice in the conduct and reporting of survey research. *Int J Qual Health Care*. 2003;15:261-6.
37 Kasunic M. *Designing an effective survey*. Handbook CMU/SEI-2005-HB-004. Pittsburgh: Carnegie Mellon; 2005.
38 Australian Communications and Media Authority. *Australians cut the cord*. Research snapsots – blog. 5 July 2013. [cited 2015 February 15]. Available from: http://www.acma.gov.au/theACMA/engage-blogs/engage-blogs/Research-snapshots/Mobile-only-Australians-top-over-3-million.
39 Divers Alert Network Asia-Pacific. *DAN Asia-Pacific Membership records.* http://www.danap.org (data available only to authorized internal investigators).

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John Lippmann is the Founder and Chairman of DAN AP. DAN is involved in the collection and reporting of dive accident data and provides evacuation cover and dive injury insurance to recreational divers. This study was funded by DAN AP.

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