A longitudinal cohort study of UK divers with asthma: diving habits and asthma health issues

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Key words
Asthma, scuba diving, health surveillance

Abstract

(Glanvill P, St Leger Dowse M, Bryson P. A longitudinal cohort study of UK divers with asthma: diving habits and asthma health issues. *SPUMS J.* 2005; 35: 18-22.)
Few epidemiological studies have evaluated the safety issues relating to diving and asthma. This study followed a group of divers for a period of up to five years, observing the effect of asthma on their normal diving habits. Certified divers were recruited. Data gathered included demographics, diving history, and asthma history. Divers returned data annually. Diving practices considered to expose a diver to an increased risk of arterial gas embolism were evaluated. One hundred divers participated (68 male, 32 female), 30 being new to the sport at the start of the study. There were 12,697 dives reported during the study, with 43 respondents improving their diving grade. Twenty-eight had performed a free ascent, 37 had shared air at some time in their diving career, and 15 had performed both exercises. It is unknown if these activities were routine diving practice or emergency procedures. Twenty reported problems during diving activities, with 12 reporting wheezing underwater. One respondent reported two episodes of decompression illness, and a patent foramen ovale was subsequently confirmed. All 20 respondents reporting problems would have been excluded from diving using the UK guidelines, together with a further 40 who reported specific trigger factors. This study suggests that current UK guidelines with regard to diving and asthma, in this study group, are sufficiently restrictive.

Introduction

The subject of asthma and diving is a perennial topic of interest to diving physicians. There have been few studies to evaluate the impact of asthma on divers. In a survey of self-selected divers with asthma published in 1990 there was no evidence of an increased incidence of decompression illness (DCI) and no respondents reported significant problems with their diving, despite their diving practices often being contrary to the advice current at that time.[1] It was concluded that the standards applied to divers with asthma, wishing to dive in the UK, were reasonable. The work was criticised,[2] and as recently as 2002 it was observed "*there is little or no consensus on which, if any, asthmatics are safe to dive*".[3]

The aims of this study, therefore, were to follow a group of divers with asthma over a period of time and to observe their normal diving habits and histories to determine whether the United Kingdom Sport Diving Medical Committee (UKSDMC) guidelines are adequate. This paper details the results of that study.

Methods

The study was a longitudinal cohort study of UK divers with asthma. Recruitment of certified divers was made by direct contact during medical examinations for fitness to dive, by referral from other diving physicians, and via UK sport-diving magazines. Divers were asked to complete a questionnaire (based on the 1990 study)[1] annually for up to five years from the commencement of the study. The questionnaires were mailed annually to all participating divers with an accompanying explanatory letter and a stamped addressed envelope. Divers were included in the study if they had returned at least one of the five questionnaires. Contact was maintained where appropriate by telephone. Data requested included diving history (training organisation, diving grade, number of years' diving, total dives in diving career, annual number of dives and maximum depth dived), emergency diving practices (sharing air, free or emergency ascents), diving-related illness (decompression sickness, gas embolism, pneumothorax), and asthma history (age of onset, wheezing triggers and frequency, medication regime, and pre-dive medication management). No incentive was offered to participate in the project and respondents were free to withdraw at any time.

Data were processed by trained operators and entered into a Microsoft Access™ database. All the records were independently scrutinized and quality-assessment procedures followed with hard copy checked against data entry.

No statistical analyses were used in this study; the data are presented as recorded by the divers from fixed option responses. Some data were evaluated from free-form solicited text that related to defining any problems divers reported with asthma and diving, and are treated separately in the section 'Problems and additional information reported by solicited free text'.

A total of 100 respondents answered at least one questionnaire and were included in the study. All numbers can therefore be considered as percentages except where indicated in the text.

Definitions

'Still diving' should be read not as 'currently diving' but as an expression of enthusiasm to dive should the opportunity arise. 'No longer diving' should be read as including divers where no positive information is available, as well as those who have described reasons for ceasing to dive. Declarations of frequency of wheezing may not take into account the effect of prophylactic medication.

Results

AGE AND GENDER DISTRIBUTION

Between 1991 and 1995, 100 divers completed questionnaires suitable for analysis (68 male, 32 female). The median age of divers at the start of the study was 29.5 and the mean 30; ages ranged from 11 to 57.

DIVING HISTORY, GRADES AND PRACTICES

The number of dives reported by respondents over the study period was 12,697. At the start of the study they reported a previous history of 14,814 dives (Table 1:a). Thirty respondents were new to the sport at the start of the study and a further 19 had completed 20 dives or fewer. Experienced respondents, during the period of the study, averaged 34 dives per year, whilst newly qualified divers averaged nine dives per year over the same period. Fourteen reported having dived to 50 metres or more, with two respondents having dived to 62 metres. Number of years' diving ranged from 31 years to novice divers with one year's experience. Twenty reported 10 years or more of experience.

Diving grade was improved in 43 of the respondents (Table 1:b) with 14 of the respondents having attained the highest grades, e.g., instructor or advanced diver, prior to the start of the study.

Table 1
Diving history

a. Number of dives (n = 100)

Start of study	End of study	During study
14,814	27,511	12,697

b. Changes in diving grade (n = 100)

No change	Change	No data
55	43	2

c. Diving practices (n = 80)

Free ascent	Air share	Free ascent + air share
28	37	15

Diving practices that might be considered to expose a diver to an increased risk of arterial gas embolism (AGE) were evaluated. A free ascent was reported by 28, and 37 had shared air at some time during their diving career. Although it was not clear if these activities were part of routine diving practice or emergency procedures, it is most likely that they were elements of diver training. Fifteen reported that they had performed both exercises (Table 1:c).

ATTRITION

At the end of the study 60 respondents reported that they were still diving. Of those individuals who had stopped diving and reported a reason for doing so, nine reported unrelated medical problems, 15 reported social reasons including three who had had children, three specifically reported losing interest, and the remainder gave financial or social reasons. 'Drop out' rates of divers with asthma in this study after the first year were compared with the drop-out rates of the British Sub-Aqua Club (BSAC) data for the UK recreational diving population as a whole (personal communication, Mary Tetley, BSAC, 2001), and found to be similar; and were also comparable to those obtained in a study by Edge et al.[4]

ASTHMA PROFILES, PROPHYLAXIS, PREVENTION, PRE-DIVE MANAGEMENT

Seventy-six respondents had developed asthma in childhood and adolescence. The mean age of onset of asthma was 12.5 years, range 1–44 years. Most respondents reported more than one trigger factor causing them to wheeze and these are shown in Table 2 in descending order of frequency. At the end of the study, trigger factors in those still diving showed similar trends (Table 2). Fifty-five respondents described themselves as wheezing 'rarely', but 29 reported that they wheezed weekly or daily.

Asthma prophylaxis/prevention using inhaled steroids alone was practised by five respondents, but 37 relied on relief alone, another 50 used both a reliever and prophylaxis, and eight did not provide data. Of those individuals reporting pre-dive asthma management, none on prophylaxis/prevention alone used an inhaler before diving, whilst 16 of those using relief only used a pre-dive reliever, and 18 on dual therapy used a pre-dive reliever (Table 2).

PROBLEMS AND ADDITIONAL INFORMATION REPORTED BY SOLICITED FREE TEXT

One diver had reported dysbaric illness, experiencing two episodes of neurological decompression illness (DCI), both occurring during the course of the study. Interrogation of medical records revealed that in the opinion of the treating physicians paradoxical gas emboli secondary to right-to-left shunting through a large patent foramen ovale (PFO) was likely. A large PFO was later confirmed by contrast echocardiography. It should be noted that this diver rarely

Table 2
Trigger factors, pre-dive management and underwater wheezers (n = 100)

Trigger factors	Start of study	End of study
Exercise	60	35
Pollen	48	31
Cold air	47	29
Cold infections	45	24
Cold air and exercise	33	20
Emotion	29	15
Animals	26	17
Dust mites	26	19

Pre-dive management

Reliever with preventer only	0
Reliever with reliever only	16
Reliever with preventer and reliever	18

Trigger factors	'Underwater wheezers'	Divers with 'problems'
Exercise	6	5
Pollen	6	1
Cold air	4	3
Cold air and exercise	4	3
Emotion	1	3
Dust mites	0	3
Animals	0	3

wheezed and that he reported his triggers as cold air and exercise; there were no signs and symptoms of asthma during the episodes of DCI.

Divers wheezing underwater numbered 12, with seven of this group reporting no problems when this happened. Of the remaining five, one diver reported wheezing to be a problem when commencing an ascent from 22 metres after a 17-minute dive, and on a latter dive in warm water to 12 metres. Two had aborted their dives when wheezing commenced. Two rested after they became wheezy then continued their dives. One related this to hard finning, which was also found to be a problem on the surface. One reported feeling anxious when this happened. The most common reported trigger in this group was exercise, followed by pollen, colds, cold air, emotion, and dust mites. Some respondents in this group reported multiple triggers.

Eight divers provided comments concerning difficulties when diving that they perceived to be related to their asthma. They did not report having wheezed underwater. Of this group, two divers reported difficulties snorkelling long distances in heavy seas, experiencing sensations of breathlessness if not wheezing. One did not dive in winter owing to cold air, and one expressed a preference for diving in warm water. One reported that asthma "affected his diving", though did not define this statement. One reported using air more quickly, and another had aborted dives after experiencing wheezing prior to diving, and had subsequently become wheezy after the aborted dive. Only one reported a problem if consuming alcohol the night before (pollen allergy was reported as the only trigger). This group, excluding the last respondent, reported a similar distribution of trigger factors to the group reporting having wheezed underwater (Table 2).

Five respondents, although reporting no specific problems with their asthma, had given up diving citing asthma in combination with other factors as the underlying reason.

Six respondents had each accumulated over a thousand dives, when taking into account dives logged at the start of the study and reported during the time of the project. Of these, three reported cold air as a trigger, three reported exercise as a trigger, and one respondent reported both as triggers. Four of this group used prophylactic and bronchodilator inhalers, and two used only bronchodilators. One respondent used a pre-dive bronchodilator. One respondent in this group had stopped diving due to an entirely unassociated illness. None of this group reported that they had wheezed underwater.

Seven respondents also provided comments to the effect that diving had had a beneficial effect on their asthma by reducing their need to use bronchodilators.

Discussion

This simple field study highlights the problems inherent in studying a group of recreational divers over a period of time. It was not possible to statistically analyse these data; divers on the study did not dive every year therefore did not always return consecutive year data. Social history (marital status, house moves and employment) further contributed to the difficulties in maintaining contact with respondents and accounted for attrition during the period of the study. In future studies, alternative methods of follow up, e.g., e-mail and text messaging through mobile phones, should be considered as well as increasing the number of participants to allow statistical analysis.

Diving practices vary and this has relevance to the period of time over which a diver gains experience. Diver training comes from a number of providers and this has made recreational diving more accessible to a wider population who have diverse health problems. Some individuals may dive rarely after their training, but any health risks relevant to diving will remain constant. The average number of dives per year for each diver was 25, although some performed far fewer dives and some many more.

Asthma appears to be on the increase in the general population. In the 1994–8 NHS UK study on asthma prevalence, rates of 5–6% in the 16–44 age group were reported.[5] In 2001 an audit by the National Asthma Campaign (in the UK) reported 1 in 13 adults (7.7%) were being treated for asthma.[6] This amounts to 5.1 million individuals as

opposed to the 3.4 million reported in a previous audit. It is reported from New Zealand that 15% of adults aged 15–44 have a history of wheeze,[7] underlining the fact that this is an increasing issue of concern for diving medical practitioners worldwide.

The UKSDMC guidelines specifically exclude from diving those individuals with asthma that is precipitated by cold air, exercise, and emotion. Individuals with allergic asthma and normal pulmonary function who are well controlled by inhaled steroids are permitted to dive provided they do not need to regularly use a bronchodilator. The British Thoracic Society (BTS) guidelines published in 2003[8] are almost identical to the UKSDMC guidelines. The strict application of these criteria would have excluded at least 60 of the divers in our study, which may be considered by some to be excessively restrictive. However, there are insufficient data at present to identify clearly those most at risk. Most, if not all, respondents would have had medical examinations prior to diving, although not necessarily performed by diving medical physicians, and it is therefore unlikely that their self-reported diagnoses of asthma are inaccurate.

It is impossible to determine the accuracy of a diver's self-assessment of his or her precipitating factors. Anecdotal data suggest many asthmatics may believe themselves to be free of significant disease and will not declare their condition. Prospective divers may suspect that declaration of their asthma will result in automatic failure to pass a medical examination or cause them to require one. One respondent (a health professional) was concerned that data supplied should remain confidential in the event of the study pointing to a more proscriptive approach in the UK to divers with asthma.

Decompression illness (DCI) in this group was no more common than might be expected in the general diving population.[9–11] It could be argued there may have been too much emphasis on pulmonary barotrauma as a cause of morbidity in divers with asthma. A diver with asthma is likely to be as much at risk on the surface as underwater due to the potentially strenuous nature of the sport. It may be that varying forms of diving practice around the globe contribute to the variation in morbidity that appears to be represented in accident statistics. In support of this argument it is worth noting that although 12 divers reported wheezing underwater some of these specifically reported finning or snorkelling in heavy seas as a precipitant factor. A search of the literature suggests other diving physicians share this view.[12–14]

If medical referees submitted data from examination of prospective divers to a central database the establishment of a national database of divers with asthma would be feasible, and could allow follow up of both health and diving history. Divers would need to give consent at their first medical examination for data to be retained on such a database. A template for reporting divers with a history of asthma, who have been assessed by a diving medical physician, is now available.[8] Amendments to the British Hyperbaric Association database with regard to recording pre-existing morbidity would then allow cross reference, should any individuals present for treatment at a hyperbaric unit. In the proceedings of the SPUMS Annual Scientific Meeting 2001, Francis refers to the desirability of such a database.[15] Unfortunately, at the present time, not all hyperbaric units in the UK submit details of diver treatments to the BHA database. It is acknowledged that divers with asthma presenting at a chamber may not give detail of their medical history.

The authors hypothesise that variations in the reported morbidity of those diving with asthma in various parts of the world may also be related to the conditions under which training is undertaken. In Britain open water dives may be conducted at times of the year when ambient air and water temperatures are low, and it could be that some trainees either exclude themselves from diving under these conditions, or exercise considerable caution until they gain sufficient experience. Data obtained from the Swedish study may support this view, as asthma was not perceived to be a morbidity factor in this cohort.[16]

Medical referees in the UK are, for the most part, general practitioners who have undertaken diving medical courses; they are also required to be divers. Assessment of divers (trainee or qualified) with a possible history of asthma induced by exercise is practical in most GPs' surgeries, but bronchial challenges are less feasibly undertaken.[17,18] It is worth noting that some individuals in our study population reported that they found diving beneficial for their respiratory disease certainly with regard to breath control, and they submitted anecdotal evidence to support their observations.

This prospective study suggests that, despite diving often contrary to current medical advice, divers with asthma in this study did not report more episodes of physician-diagnosed DCI than would be expected.[9–11] However, data in our study should be treated with caution, as it was too small for definitive conclusions to be drawn. The findings also suggest that there is a risk of wheezing for divers with a history of asthma precipitated by cold air, exercise or emotion, and that this risk is present on the surface as well as underwater. With the incidence of asthma increasing, diving physicians are likely to receive an increasing number of inquiries from individuals who have a history of asthma and wish to learn to dive.

Conclusions

After consideration of the data available from this study it would seem reasonable to conclude that the risk to divers with well-controlled asthma and without the triggers of cold air, exercise or emotion is low. UKSDMC and BTS guidelines would have excluded all of the divers in the study who reported either wheezing underwater or problems on the surface.

The way forward to ensure that applicants with asthma who wish to dive are properly assessed currently exists in the UK. Self-assessment forms similar to the Recreational Scuba Diving Council self-declaration used by PADI now channel prospective divers for referral to diving physicians. There will, however, always be individuals who complete self-assessment forms omitting or misrepresenting relevant medical information, either deliberately or out of genuine ignorance as to the nature of their illness.

The authors acknowledge that a response bias may exist in the findings of this study. More physiologically based research may be required to provide definitive answers. However, the project provides useful information relating to asthma and diving, and gives a valuable insight into the impact of mild asthma, trigger factors, and the use of asthma medication in a reasonable population of fit asthmatics.

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References

1 Farrell PJ, Glanvill P. Diving practices of scuba divers with asthma. *BMJ*. 1990; 300: 166.
2 Martindale JJ. Scuba divers with asthma [letter]. *BMJ*. 1990; 300: 609-10.
3 Edmunds C. Asthma. In: Edmonds C, Lowry C, Pennefather J, Walker R, eds. *Diving and subaquatic medicine*, 4th ed. London: Arnold; 2002. p. 559-74.
4 Edge CJ, St Leger Dowse M, Bryson P. Scuba diving with diabetes mellitus – the UK experience 1991–2001. *Undersea Hyperb Med*. In press, 2005.
5 Prevalence of treated asthma: by NHS Regional Office area, sex and age, 1994–1998: Regional Trends 37. Available at: http://www.statistics.gov.uk/STATBASE/ssdataset.asp?vlnk=5958&More=Y Accessed 22 August 2004.
6 Asthma news in the UK and Ireland. Available at: http://www.asthma-uk.co.uk/asthma4.htm Accessed 22 August 2004.
7 New Zealand Consumer Health information. Asthma in New Zealand, latest facts and statistics: March 1999. Available at: http://www.everybody.co.nz/docsa_c/asthmastats.html Accessed 22 August 2004.
8 British Thoracic Society Fitness to Dive Group, Subgroup of the British Thoracic Society Standards of Care Committee. British Thoracic Society guidelines on respiratory aspects of fitness for diving. *Thorax*. 2003; 58: 3-13.
9 Ladd G, Stepan V, Stevens L. The Abacus project: establishing the risk of recreational scuba death and decompression illness. *SPUMS J*. 2002; 32: 124-8.
10 Vann RD, Denoble PJ, Uguccioni DM, et al. Incidence of decompression sickness (DCS) in four recreational diving population samples. Proceedings of Undersea and Hyperbaric Medical Society Annual Scientific Meeting; 2004 May 27-29; Sydney, Australia. In press, 2005.
11 St Leger Dowse M, Bryson P, Gunby A, Fife W. Comparative data from 2250 male and female sports divers: diving patterns and decompression sickness. *Aviat Space Environ Med*. 2002; 73: 743-9.
12 Discussion following Meehan and Thomas papers. In: Conference Proceedings of the SPUMS Annual Scientific Meeting. *SPUMS J*. 2001; 31: 232-6.
13 Haller V, Williams G. Diving candidates as they present for fitness to dive assessment: diving medicine case studies. *SPUMS J*. 2001; 31: 157-60.
14 Acott C. Ten years of treating divers. *SPUMS J*. 2000; 30: 29.
15 Francis J. Pulmonary fitness to dive. *SPUMS J*. 2001; 31: 221–6.
16 Hagberg M, Ornhagen H. Incidence and risk factors for symptoms of decompression sickness among male and female dive masters and instructors – a retrospective cohort study. *Undersea Hyperb Med*. 2003; 30: 2.
17 Meehan C. Asthma and diving screening protocols. *SPUMS J*. 2001; 31: 226-8.
18 Thomas P. Lung function testing to detect asthma in recreational divers. *SPUMS J*. 2001; 31: 229-31.

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