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MEDICAL SUPERVISION OF SPORT DIVING IN SCOTLAND: REASSESSING THE NEED FOR ROUTINE MEDICAL EXAMINATIONS

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Key Words

Diving medicals, fitness to dive, recreational diving.

Abstract

Background

The value of diving medicals in preventing incidents is uncertain and there has been only limited evaluation of the fitness to dive guidelines in a sport diving population.

Objective

To examine the need for routine diving medical examinations in the Scottish Sub-Aqua Club (SSAC) between 1991 and 1998.

Methods

A medical examination of all SSAC divers is performed at entry and then every one to five years based on their age and medical condition. This information was analysed in terms of questionnaire findings and examination abnormalities.

Results

There were 2,962 medical forms available for analysis. Examination abnormalities were found in 174 subjects (5.9% of the population), with obesity affecting 75 subjects (2.5%). There was a linear increase in mean body mass index ($r^2 = 0.92$), and a significant difference between 1991 and 1998 (mean (\pm SD) of 24.1 (\pm 3.07) and 25.02 (\pm 3.4) respectively, $p = 0.002$) which was not related to age or sex distribution. There was also a significant increase in the prevalence of smokers ($\chi^2 = 4.02$, $p = 0.045$). The most common specialist referral was for evaluation of asthma, with hypertension and obesity as the next most common reasons. Most subjects were allowed to dive, with only 43 (25%) being failed outright. Overall, no examination abnormality alone caused a subject to be classified unfit to dive, and referrals were prompted by the answers in the questionnaire.

Conclusions

No significant unexpected abnormalities were found on clinical examination in this population of sport divers. Conditions that prevented subjects from diving were detected by the questionnaire, and this prompted referral for further assessment by the medical advisers. Routine medical examinations were of little value.

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Introduction

Sub-aqua diving is a popular sport in the United Kingdom involving almost 100,000 amateur divers in 1998.

As with any sport, specific risks are involved,¹ but serious injury is rare,^{2,3} reflecting the high standard of training provided by the diving organisations. They rely on medical support to identify preexisting conditions that may increase the risk of incidents. The main medical risks of diving in the United Kingdom are conditions causing increased susceptibility to decompression illness, or unexpected incapacity that is likely to be hazardous underwater. For example, epileptics requiring medication or diabetics with recent hypoglycaemia are advised not to dive because of the risk of unexpected loss of consciousness which could be fatal underwater.

Diving incidents are usually the result of a sequence of events and it is important to eliminate medical conditions as part of this chain. There are detailed guidelines on medical fitness to dive,⁴⁻⁶ although many of these are based more on physiological theory than convincing scientific evidence, as no randomised controlled trials have been performed. It would not be possible to perform such studies for ethical reasons, for example allowing uncontrolled epileptics to dive. The aim of the guidelines is to minimise the risk of an incident without excluding too many people who are keen to take up the sport.

Divers belonging to three of the main United Kingdom organisations, the British Sub-Aqua Club (BSAC), Scottish Sub-Aqua Club (SSAC), and Sub-Aqua Association (SAA), are currently screened using a questionnaire and a standardised medical examination by any qualified doctor. Most medical examinations are performed by general practitioners, and, if there is concern about a subject's fitness to dive, then an expert opinion is sought from a medical referee with diving medicine experience. The medical advice for these organisations is based on collaboration of the medical advisers forming the UK sport diving medical committee and conducted by over 60 approved medical referees across Britain. Other diving organisations use a self administered questionnaire for medical assessment of divers, with medical examinations performed only if necessary. This saves the expense of a routine medical examination, and there is pressure from divers to consider removing the need for this in the United Kingdom.

It is important to distinguish amateur sport divers from commercial divers who undergo a detailed medical examination at regular intervals as required by the Health and Safety Executive. Employers may be liable for the health of their divers whereas sport divers make an informed decision to participate in an activity with known risk. However, their ability to respond in an emergency, for example, to rescue a diving partner, is an essential requirement, and this is one of the most important criteria when assessing fitness to dive. If this ability is impaired, then either the subject should not dive or additional support

must be made available. For example, some disabled divers require two experienced diving partners to help cope with restricted mobility.

The value of diving medicals in preventing incidents is uncertain, and there has been only limited evaluation of the fitness to dive guidelines in a sport diving population. The aim of this study is to examine the need for routine diving medical examinations in the SSAC population.

Methods

All SSAC divers have a medical examination at entry and then every one to five years based on their age and medical condition. Medicals are required every five years below the age of 40, every three years between 40 and 50, and annually over the age of 50. This information has been stored centrally since 1991 and forms the basis of the analysis described below.

Analysis

The database was anonymised and transferred to a spreadsheet for statistical analysis. This is mainly descriptive, including distribution graphs and frequency tables. Free text responses were categorised, for example into classes of drugs or disease types. Obesity was defined as a body mass index greater than 30 (defined as weight in kg divided by height in m²) and hypertension as a systolic blood pressure greater than 160 mm Hg or a diastolic pressure greater than 90 mm Hg. Percentages are of the total population analysed. Statistical analysis was performed using SPSS for Windows (version 9.0) using t tests for comparison of means between groups with normal distributions, and χ^2 for non-parametric comparisons.

Results

There were 2,962 medical forms available for analysis, of which 868 were repeat examinations. Figures 1 and 2 show basic demographic information.

The response to the self administered questionnaire is shown in Table 1 (page 177) which lists positive answers to each of the questions. Table 2 gives the reasons for previous hospital admission for 627 divers (21.2%). Medication was taken regularly by 112 (3.8%) divers (Table 3 page 177). Although only 59 subjects reported taking medication, some were using multiple preparations and therefore 127 drug types were recorded.

Table 4 (page 177) shows the examination findings. Blood pressure information was available for 1,148 examinations because this only became a requirement of the medical examination in 1995. Examination

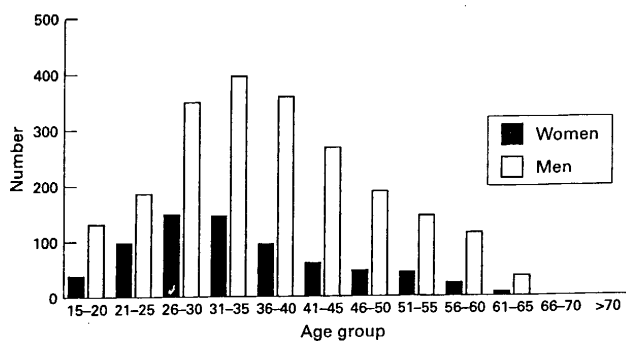


Figure 1. Age/sex distribution for the Scottish Sub-Aqua Club (SSAC) population (total 2,962 divers).

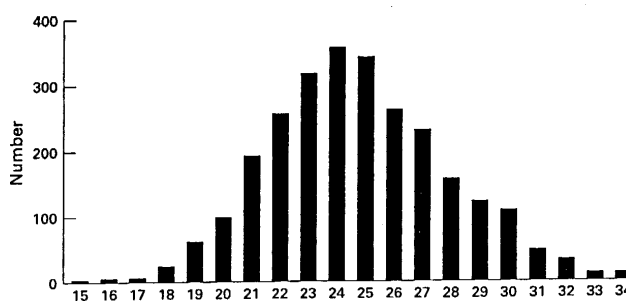


Figure 2. Body mass index (BMI) distribution for the Scottish Sub-Aqua Club (SSAC) population (total 2,962 divers). Obesity is defined as an index greater than 30.

TABLE 2

REASONS FOR HOSPITAL ADMISSION IN 2,962 DIVERS

Reason for admission	n	%
Ear, nose or throat	112	3.8
Trauma	112	3.8
Appendix or hernia surgery	86	2.9
Orthopaedic surgery	66	2.2
Gynaecology or urology	62	2.1
Gastrointestinal	39	1.3
Respiratory	38	1.3
Skin	19	0.6
Dental surgery	16	0.5
Childbirth	13	0.4
Ophthalmic surgery	12	0.4
Endocrine (including diabetes)	12	0.4
Unspecified surgery	11	0.4
Varicose veins	10	0.3
Psychiatric illness	7	0.2
Neurology	6	0.2
Other	6	0.2
Total	627	21.2

TABLE 1**POSITIVE RESPONSES TO THE SELF ADMINISTERED QUESTIONNAIRE (THE UK SPORT DIVING MEDICAL FORM BASED ON THE ORIGINAL WORK OF THE BSAC MEDICAL COMMITTEE AND JOINTLY PUBLISHED BY SSAC, SAA AND BSAC) IN 2,962 SSAC DIVERS**

Questions	n	%
1 Have you ever attended or been admitted to hospital?	627	21.2
2 Are you diabetic?	11	0.3
3 Do you wear dentures?	261	8.8
4 Do you regularly or frequently take any medication or other treatment with or without prescription?	59	2.0
5 Have you ever had any form of decompression sickness?	2	0.1
6 Are you currently receiving medical care, or have you consulted the doctor in the past year?	908	31.0
7 Have you ever been refused a diving medical certificate or life insurance or been offered special terms?	13	0.4
8 Has there been any change in your physical or mental health since your last medical?	23	0.8
9 Do you smoke?	351	11.9
10 Have you ever suffered at any time from any of the following:		
(a) Ear trouble, earache, discharge or deafness?	355	12.0
(b) Sinus trouble?	197	6.7
(c) Chest disease, including asthma, bronchitis or TB, pneumothorax, collapsed lung or exposure to dust?	220	7.4
(d) Attacks of giddiness, blackouts and fainting?	35	1.2
(e) Fits or any nervous disorders, including persistent headaches or concussion?	34	1.1
(f) Anxiety, "nerves", nervous breakdown?	27	0.9
(g) Diseases of the heart and circulation, including high blood pressure, chest pains and palpitation?	36	1.2
Totals	3,159	107.0

TABLE 3**REGULAR MEDICATION TAKEN BY THE DIVERS**

Medication	n	%
Oral contraceptive pill	31	1.1
Antihistamines	15	0.5
Antibiotics	15	0.5
Asthma inhalers	14	0.5
Analgesia	7	0.2
Antacid therapy	7	0.2
Skin preparation	5	0.2
Thyroxine	5	0.2
Insulin	4	0.1
Miscellaneous	24	0.8
Total	127	4.3

TABLE 4**EXAMINATION ABNORMALITIES**

Condition	n	%
Obesity	75	2.5
Ear, nose or throat	26	0.9
Cardiovascular	20	0.7
Musculoskeletal	12	0.4
Teeth	9	0.3
Eyes	7	0.2
Skin	6	0.2
Hypertension	5	0.2
Neurological	5	0.2
Respiratory	3	0.1
Abdominal mass	3	0.1
Other	3	0.1
Total	174	5.9

abnormalities were found in 174 subjects (5.9% of the population); the most common was obesity, affecting 75 subjects (2.5%). Although 20 subjects had detectable

TABLE 5
REFERRALS FOR SPECIALIST OPINION

Condition	Number	% of referrals
Respiratory	52	30.2
Cardiovascular	22	12.8
Obesity	15	8.7
Diabetes, requiring insulin	14	8.1
Medication	12	7.0
Ear, nose or throat	10	5.8
Neurological	8	4.7
Epilepsy	7	4.1
Various	7	4.1
Previous decompression sickness	6	3.5
Musculoskeletal	5	2.9
General query	4	2.3
Leukaemia or lymphoma	4	2.3
Head injury	4	2.3
Psychiatric	2	1.1
Failed outright	43	25.0
Total	172	100.0

murmurs, none was found to be clinically significant after clinical assessment or investigation by echocardiography. Only two subjects were known to have murmurs before the medical. The neurological abnormalities listed were the result of previous illness and were therefore identified by the questionnaire.

Table 5 lists the cases formally referred in writing to the SSAC medical advisers during the study period. The most common referral was for evaluation of asthma, with hypertension and obesity as the next most common reasons. Most subjects were allowed to dive, with only 43 (25%) being failed outright. Referrals were also received by telephone, and in many cases the problems could be resolved immediately without requiring formal assessment. Most of these cases have not been included in table 5.

Figure 3 shows the gradual increase in body mass index in the SSAC population; it is not related to any other change in the population, including age or sex distribution. There was a linear increase with time ($r^2 = 0.92$, $r = 0.96$) and a highly significant difference between 1991 and 1998 (mean $24.1 (\pm 3.07)$ and $25.02 (\pm 3.4)$ respectively, $p = 0.002$).

Figure 4 shows the prevalence of smokers; there was a significant increase between 1991 and 1998 ($\chi^2 = 4.02$, $p = 0.045$). This increase is not restricted to any particular subgroup, for example young women, and reflects a general trend.

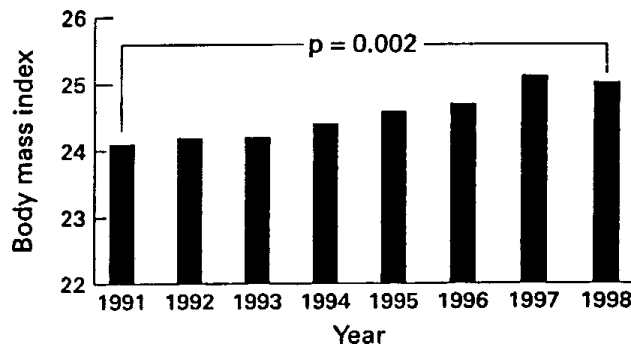


Figure 3. Gradual rise in body mass index over time, with a highly significant difference between 1991 and 1998.

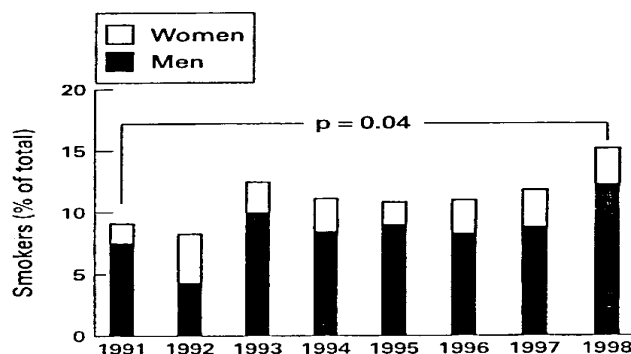


Figure 4. Prevalence of smokers over time, with the proportion of women remaining constant despite a significant overall increase from 1991 to 1998.

Overall, no examination abnormality alone caused a subject to be classified unfit to dive and referrals were prompted by the answers in the questionnaire.

Discussion

It is reassuring that no significant unexpected abnormalities were found on clinical examination in this population of sport divers. Conditions that prevented subjects from diving were detected by the questionnaire, and this prompted referral for further assessment by the medical advisers. The current system therefore has been very effective in the SSAC but relatively inefficient and expensive for the divers.

It is disappointing to see the gradual increase in body mass index and also the resurgence of smoking, particularly in the last year. Health promotion is an important part of any sport, particularly in sub-aqua diving where the risks can be substantial. The increase in weight is not a secondary finding related to age or sex characteristics of the divers and probably reflects a lifestyle problem for the Scottish population in general. A high body mass index is no longer a contraindication to diving, and obese divers are assessed in terms of their ability to complete physical tasks during training.

The questionnaire is usually completed in isolation by the diver, although in a small number of cases the examining doctor completes the form. This raises an important point about whether some divers conceal information that is relevant to their fitness to dive and any new system must take account of this. The form is a legal declaration, and if a diver is found to have been fraudulent in its completion, then his/her insurance is not valid. Divers are encouraged during training to take responsibility for their own safety and that of their diving partner. It is also appropriate that they monitor the development of symptoms or signs relevant to their fitness to dive. With guidance from a well designed questionnaire, this is feasible and much more economic than routine medical examinations of the whole diving population. It will then be possible to direct the medical supervision of divers more efficiently to those who require specialist support. This will have important commercial implications for the three organisations, and the United Kingdom sport diving medical committee is developing a new form to eliminate routine medical examination except for subjects estimated to be at high risk. The new questionnaire and the definitions of high risk subject groups will be based partly on this database, although regular surveillance of diving incidents and feedback from the organisations involved will be required to ensure safety.

Conflict of interest

SG is the Medical Adviser of the SSAC and Secretary of the UK Sport Diving Medical Committee (UKSDMC). JD is the previous Medical Adviser of the SSAC. The views represented are those of the authors and do not necessarily reflect SSAC policy or UKSDMC consensus.

Take home message

Diving is a safe sport requiring medical supervision, but routine clinical examination of all divers is unlikely to detect significant abnormalities relevant to their fitness to dive. A carefully designed questionnaire will allow most relevant conditions to be identified and save unnecessary expense for both divers and doctors.

References

- 1 Moon RE. Treatment of diving emergencies. *Crit Care Clin* 1999;15:429-456
- 2 Glen SK, Seath I. Annual incident report 1998, Scottish Sub-Aqua Club. Glasgow: The Cockburn Centre, 40 Bogmoor Place, 1998.
- 3 Anon. DAN 1998 report on diving accidents and fatalities. Durham, NC: Diver Alert Network, 1998.
- 4 Mebane GY, Mclver NKI. Fitness to dive. In: Bennett PB and Elliott DH. Eds. *The Physiology and Medicine of Diving*. 4th Edition. London: WB Saunders, 1993; 53-76
- 5 Vorosmarti J. Ed. Fitness to dive. 34th Undersea and Hyperbaric Medical Society Workshop, 1986.

Bethesda, MD: Undersea and Hyperbaric Medical Society, 1986.

- 6 Elliott DH. Ed. *Medical assessment of fitness to dive*. Ewell, Surrey: Biomedical Seminars, 1995.

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