The usefulness of the RSTC medical questionnaire in pre-participation health risk assessment of recreational scuba divers in Hong Kong

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Key words
Fitness to dive; Medicals-diving; Recreational diving; Risk assessment

Abstract
(Cheung TK, Meintjes WAJ. The usefulness of the RSTC medical questionnaire in pre-participation health risk assessment of recreational scuba divers in Hong Kong. Diving and Hyperbaric Medicine. 2021 June 30;51(2):173–181. doi: 10.28920/dhm51.2.173-181. PMID: 34157733.)
Introduction: The current practice in Hong Kong is to have potential recreational divers complete a Recreational Scuba Training Council self-declared medical statement (RSTC form) prior to participation in diving. There are no reports in the literature on the usefulness of the Chinese version of the form.
Methods: The Professional Association of Diving Instructors (PADI) RSTC form (Chinese version) was completed by 117 research participants who were then individually interviewed (without examination) to establish whether relevant information was not captured by the form. Any discrepancies or problems identified were recorded for further analysis.
Results: Among participants, 15.4% expressed difficulty in completing the RSTC form. Less than one-third (28.2%) replied 'all negative' to the questions. Some health conditions that could impose diving risks were not elicited by the questionnaire alone. Nevertheless, there was good sensitivity, specificity, positive predictive value and negative predictive value with the exception of a few questions. However, significant discrepancies were identified when comparing the English and Chinese versions. There was also uncertainty with aspects of implementation, including attitudes of the user and provider, reliability of self-declaration answers and the handling of completed questionnaires.
Conclusions: Health screening with a questionnaire for recreational divers remains practical and acceptable. Full revision of the RSTC form in Chinese is recommended in view of problems with the construct validity and translation. People should be informed about the non-prescriptive approach of health assessment for recreational divers. Further research on the implementation of the form may help to improve the screening strategy in the future.

Introduction

Scuba diving has unique health risks. These are dynamic, multi-factorial and dependent on different modes of diving.[1,2] For simplicity and regulatory reasons, participants are grouped into recreational and non-recreational (for example commercial and military) divers. All scuba divers that decide to dive for enjoyment and not for financial gain are regarded as recreational scuba divers.

In order to manage diving-related health risks in recreational divers, the current practice in most parts of the world is to have potential participants sign a self-declaration medical statement prior to allowing participation. Many dive certification agencies adopted the Recreational Scuba Training Council medical statement (RSTC form).[3] The form consists of a self-declaration section, including a medical questionnaire that needs to be completed by the participant. The participant is assumed to have no need for medical consultation or examination if all questions are answered negatively. Positive responses will direct the person to medical consultation prior to possible engagement in dive activities.[4,5]

While the RSTC form has undergone update and review over time, there is no study on the usefulness of the Chinese version of the form. This study aimed to assess the usefulness of the most widely adopted Chinese version of the form among potential Hong Kong Chinese divers and to identify any potential pitfalls with the medical questionnaire component of the form. It will be a useful basis for assessment of the upcoming new diving medical screening questionnaire.

Methods

Ethical approval for the study was obtained from the Stellenbosch University Health Research Ethics Committee (ethic reference number U19/09/042).

Participants were recruited during the primary investigator's on-duty sessions at three private primary care clinics in

October and November 2019. All primary care clinic attendants were invited to join the research if they met the inclusion criteria for participation in the study. These included being 18 years or older, and being willing and able to complete the questionnaire and the informed consent document. Patients who were acutely ill or unable to read the Chinese questionnaire were excluded. The RSTC form [10063C(Rev 09/01)Ver. 2.0] was distributed to research participants.[6] They were asked to complete the form and the researcher would go through the same questionnaire with the research participant immediately afterwards. The researcher would ask the questions as though conducting a consultation in the sequence of the questionnaire. Clarifications were made by the researcher on the identified ambiguous wordings and translation. The participants would also be encouraged to discuss and express their ideas in filling the form. No clinical examination or screening tools apart from the history taking were performed for the research. All discrepancies or issues identified were recorded for analysis.

In order to have a 90% power to detect at least one occurrence of a problem with the questionnaire when the assumed prevalence of the condition is 2% in the population, a sample size of 114 individuals was required.[7]

In the analysis, the clinical consultation and interview was considered the gold standard to determine the sensitivity, specificity, positive and negative predictive values of the questions.

The IBM SPSS statistics package version 26 (IBM, Armonk (NY), USA) was used for data analysis.

Results

A total of 496 clinic visitors were encountered, of whom approximately 25% met the inclusion criteria of the study. Most excluded cases were due to age being under 18 years. The overall response rate among eligible visitors was 94.4%. A total of 117 questionnaires and successful interviews were completed. The demographics of the study participants are shown in Table 1, while their question responses and comparison with the medical interview are displayed in Table 2. Problems identified during the interviews are shown in Table 3.

Table 1
Demographics of study participants ((*n* = 117)

Characteristic	*n* (%)
Diving experience	
No experience	83 (70.9)
Discovery dive	25 (21.4)
Open water	3 (2.6)
Advanced open water	1 (0.9)
Rescue diver	0 (0)
Divemaster	5 (4.3)
Diving Instructor	0 (0)
Education level	
Primary	6 (5.1)
Secondary	58 (49.6)
Tertiary	53 (45.3)
Age Group	
18–29	44 (37.6)
30–39	40 (34.2)
40–49	14 (12)
50–59	12 (10.3)
60 or above	7 (6)
Gender	
Male	69 (59)
Female	48 (41)

Discussion

GENERAL OVERVIEW OF DATA ANALYSIS

Most questions had high positive and negative predictive values (at least 80% and 98% respectively) (Table 2). Question 5 ("*Frequent or severe attacks of hay fever or allergy?*"), question 7 ("*Any form of lung disease?*") and question 18 ("*Inability to perform moderate exercise....*") were the only exceptions. All questions were high in specificity (> 95%), but the sensitivity had a wide range. Questions 5, 7, 11 ("*Epilepsy, seizures...*"), 22 ("*Back, arm or leg problems following surgery, injury or fracture?*"), 32 ("*Hernia?*") and 33 ("*Ulcers or ulcer surgery*?") were questions that had lower sensitivity (< 70%), indicating that these questions were not good at identifying respondents who actually had these conditions.

The relatively low negative predictive values of questions on hay fever, allergy and lung diseases (questions 5 and 7) may relate to the wording of the questions. Both questions also had low sensitivity in this study cohort. Some replied "*no*" to question 5, despite the presence of intermittent allergic rhinitis. For question 7, those with asthma or hyperactive airway problems did not reply "*yes*". Some said that they were not aware that the airway problem was also a form of lung disease.

For question 32 ("*Hernia*"), the low sensitivity may relate to use of a medical term in the Chinese translation, instead of a more commonly used term in society for the condition. The same occurred with the inquiry regarding skin ulcer or ulcer surgery (question 33), where the Chinese version adopted a rather technical term.

The study reported a low positive predictive value to the inquiry regarding physical fitness (question 18). People expressed difficulty in understanding the given example (walk 1.6 km/one mile within 12 minutes).

Some health conditions that could impose diving risks on individuals were not directly elicited by the questionnaire alone (Table 3).

Table 2

Participant responses to the questionnaire and the sensitivity, specificity, positive and negative predictive values of each question. FP – false positive; FN – false negative; NPV – negative predictive value; PPV – positive predictive value; TN – true negative; TP – true positive; Sens – sensitivity; Spec – specificity. ** – denotes values that could not be calculated. For discussion purposes, questions were assigned numbers from top to bottom, left to right of the Chinese RSTC form [10063C(Rev 09/01)Ver2.0]

	Statement in the questionnaire	TP	FP	FN	TN	Sens	Spec	PPV	NPV
1	Could you be pregnant, or are you attempting to become pregnant?	3			114	100%	100%	100%	100%
2	Are you presently taking prescription medications? (with the exception of birth control or anti-malarial)	11		1	105	92%	100%	100%	99%
3	Are you over 45 years of age and can answer YES to one or more of the following? - currently smoke a pipe, cigars or cigarettes - have a high cholesterol level - have a family history of heart attack or stroke - are currently receiving medical care - high blood pressure - diabetes mellitus, even if controlled by diet alone	17	4	1	95	94%	96%	81%	99%
4	Asthma, or wheezing with breathing, or wheezing with exercise?	27		1	89	96%	100%	100%	99%
5	Frequent or severe attacks of hay fever or allergy?	9		16	92	36%	100%	100%	85%
6	Frequent colds, sinusitis or bronchitis?	25	3		89	100%	97%	89%	100%
7	Any form of lung disease?	5		18	94	5%	100%	100%	84%
8	Pneumothorax (collapsed lung)?	1			116	100%	100%	100%	100%
9	Other chest disease or chest surgery?	1			116	100%	100%	100%	100%
10	Behavioural health, mental or psychological problems (panic attack, fear of closed or open spaces)?	3		1	113	75%	100%	100%	99%
11	Epilepsy, seizures, convulsions or take medications to prevent them?	1		1	115	50%	100%	100%	99%
12	Recurring complicated migraine headaches or take medications to prevent them?	4	1		112	100%	99%	80%	100%
13	Blackouts or fainting (full/partial loss of consciousness)?	7		2	108	78%	100%	100%	98%
14	Frequent or severe suffering from motion sickness (seasick, carsick, etc.)?	22		1	94	96%	100%	100%	99%
15	Dysentery or dehydration requiring medical intervention?	5			112	100%	100%	100%	100%
16	Any dive accidents or decompression sickness		1		116	**	99%	0%	100%
17	History of recurrent back/spine disease?	5		2	110	71%	100%	100%	98%
18	Inability to perform moderate exercise (example: walk 1.6 km/one mile within 12 minutes)?	2	1		114	100%	99%	67%	100%
19	Head injury with loss of consciousness in the past five years?				117	**	100%	**	100%
20	Recurrent back problems?	5		1	111	83%	100%	100%	99%
21	Diabetes?	2			115	100%	100%	100%	100%
22	Back, arm or leg problems following surgery, injury or fracture?	2		1	114	67%	100%	100%	99%

Table 2 continued.

	Statement in the questionnaire	TP	FP	FN	TN	Sens	Spec	PPV	NPV
23	High blood pressure or take medicine to control blood pressure?	9			108	100%	100%	100%	100%
24	Heart disease?	2			115	100%	100%	100%	100%
25	Heart attack?	2			115	100%	100%	100%	100%
26	Angina, heart surgery or blood vessel surgery?	2			115	100%	100%	100%	100%
27	Sinus surgery?				117	**	100%	**	100%
28	Ear disease or surgery, hearing loss or problems with balance?	1			116	100%	100%	100%	100%
29	Ear equalisation problem during air travel?	13		2	102	87%	100%	100%	98%
30	Recurrent ear problems?	1			116	100%	100%	100%	100%
31	Bleeding or other blood disorders?				117	**	100%	**	100%
32	Hernia?	2		2	113	50%	100%	100%	98%
33	Ulcers or ulcer surgery?			1	116	0%	100%	**	99%
34	A colostomy or ileostomy?				117	**	100%	**	100%
35	Recreational drug use or treatment for, or alcoholism in the past five years?	3			114	100%	100%	100%	100%

Table 3
Problems identified during the interviews with 117 participants

Find difficulty in filling the questionnaire	
Yes *n* (%)	18 (15.4%)
No *n* (%)	99 (84.6%)
Problematic question (number of respondents); details of the problem encountered	
Question 6 (2); uncertainty about the definition of "*frequent attack*"	
Question 7 (1); is allergic airway a kind of lung disease?	
Question 8 (1); do not know the meaning of collapsed lung/pneumothorax	
Question 9 (1); should breast surgery be declared as chest surgery?	
Question 15 (5); should the use of medication be classified as medical intervention?	
Question 18 (1); cannot appreciate the example (walk one mile within 12 minutes)	
Question 32 (3); do not know the translated medical term "*hernia*"	
Question 33(1); do not know the translated term "*ulcers*"	
Conditions of respondents that were not detected by the questionnaire (number of respondents)	
Hyperlipidaemia in respondent < 45 years old (1)	
Hepatitis B carrier that needed regular follow-up (1)	
History of appendicectomy done (1)	
History of breast lump with lumpectomy done (1)	
History of hypothyroidism that previously needed thyroxine replacement (1)	
History of hyperthyroidism (? Grave's disease) (1)	
History of lymphoma with full remission > 10 years (1)	
Eye condition (Retinitis pigmentosa) with deterioration of visual acuity (1)	
Chronic renal failure on continuous ambulatory peritoneal dialysis (1)	

NEEDS OF MEDICAL SCREENING FOR RECREATIONAL DIVERS

Only 33 out of 117 (28.2%) of the research participants replied negatively to all questions, and 25 (75.8%) of these were truly "*all negative*" upon interview. While the research cohort might be different from actual potential scuba diving participants, it supported the need for pre-dive medical assessment. Standardised diving medical evaluation can also help different stakeholders to gauge the potential risks and draw a line of acceptance. In modern times, this is relevant to the liability of individuals and the involved parties. Until further research deems otherwise, use of a self-declaration questionnaire for screening is still the most widely accepted strategy.[8–10]

A highly prescriptive set of rules in the determination of medical clearance is usually adopted for commercial or military divers.[11–14] For recreational divers, the medical evaluation is more intended for health risk identification. Thereafter, the risks should be mitigated and/ or accepted or evaluated as being unacceptable ('high risk'). High risk individuals are subsequently advised against participation.[11,15,16]

One major drawback in using only a self-declaration questionnaire for screening is the definition of threshold of risk acceptance that is presumably defined by the diving medical expert panel involved in the design of the questionnaire. Use of screening questionnaires will unavoidably lead to excessive medical referral in the current logistics if every detail and extent of conditions are included. On the other hand, overly selective questions could be challenged for the risk of missing other important conditions.

LOCAL USE OF RSTC FORM

As in most parts of the world, in Hong Kong there is no legal restriction in relation to individuals participating in recreational scuba diving.[17] A self-regulatory system is adopted among diving organisations. With the Professional Association of Diving Instructors (PADI) being the dominant diving training agency in the territory, the PADI RSTC form is hence the most commonly used medical statement in the local diving community.[18] Unless specifically indicated otherwise, traditional Chinese/Cantonese is the language used for written documents, instruction and teaching among the local Chinese population.

The PADI RSTC form has had regular updating and revision with time. The 2001 Chinese translation version [10063C(Rev.09/01)Ver. 2.0] was derived from the 1998 English version.[6] The updated Chinese version [10038TC(Rev. 6/12)Ver. 1.0] was not launched until 2012.[3,19] For many years, the 2001 Chinese version has been the most commonly available form.

In brief, the 2012 Chinese version adopted the changes in the 2001 English version, where the question on ear equalisation problems during air travel (question 29 in the 2001 Chinese version) was removed. The question on past history of recurrent back and spine disease (question 17 in the 2001 Chinese version) was replaced by the inquiry of any back/ spine surgery (question 20 in the 2007 English version). Other questions in the 2012 Chinese version were the same as the 2001 Chinese version (grossly the same sequence and exactly the same wordings), except for the new question on back/spine surgery as mentioned above.

ASSUMPTIONS WHEN USING QUESTIONNAIRE FOR SCREENING

The meaningful implementation of the questionnaire relies on a number of assumptions, including: 1) the validity of the questionnaire (original design); 2) the validity of the applied form (for example: Translation version); 3) appropriate implementation of the screening (time, place, person); 4) users' understanding and co-operation; 5) people completing the questionnaire correctly and honestly; and 6) appropriate handling of the completed questionnaire (referral, inquiry, feedback system). These assumptions are further discussed below.

Validity of the original questionnaire design

Some health conditions of the respondents were not detected by the questionnaire (Table 3). While not all conditions would result in unacceptable diving-related health risk, it is unreasonable for participants and diving agencies to assume liability without prior warning. For example, a participant with retinitis pigmentosa was not detected by the questionnaire alone. Another respondent with a lipid disorder was younger than 45 years old. According to the questionnaire, he was not expected to indicate this cardiovascular risk factor.

In an analysis of recreational diving fatalities, cardiac events were considered the disabling injury in 26% of cases.[20] In other studies trauma resulted in 5% of disabling injuries.[20–25] According to a report that reviewed the coroner's records of reported diving-related fatalities (2006–2009) in Hong Kong, two out of eight cases were trauma-related (impact with boat or boat propeller). One case was definitely related to a cardiac incident and another case was suspected to be cardiac related.[25] It seems reasonable to assume the mortality and morbidity pattern among Hong Kong divers is similar to other nationalities, although it would be preferable to have more evidence to support this observation. Moreover, diving incidents among Hong Kong residents during their diving trips outside Hong Kong were not explored. Re-examining the scope and design of the questionnaire will improve its validity since evidence has grown in recent years.[26]

Table 4
Discrepancies in translation. Q – question (with numbers corresponding to those in Table 2)

Question number in Chinese version (2001/2012)	Original question / words in the 2007 English version	Identified problem(s) in the Chinese version of the corresponding question
Q2 / Q2	Are you presently taking prescription medications? (with the exception of birth control or anti-malarial)	The exception of anti-malarial is not mentioned
Q3 / Q3	...diabetes mellitus, even if controlled by diet alone	Incorrect translation. Meaning becomes "*diabetes mellitus, even with diet control*" instead of the original idea of identifying diabetics with or without use of medications
Q4 / Q4	Asthma, or wheezing with breathing...	Incorrect translation. Not exact translation of "*asthma*" in Chinese. Uses a term with the meaning of "*shortness of breath*"
Q6 / Q6	Frequent colds, sinusitis or bronchitis?	Use of an ambiguous Chinese term that means "*flu*" instead of "*colds*"
Q10 / Q10	...psychological problems (Panic attack, fear of closed...)	Misleading translation of "*panic attack*" into words that imply physical attack ("*assault*")
Q14 / Q14	Frequent or severe suffering from motion sickness...	Mistranslation of "*or severely suffering from*". Only asks whether or not the respondent has "*frequent suffering*"
Q18 / Q17	Inability to perform moderate exercise (example: walk 1.6 km/ one mile within 12 mins)?	Misleading translation of "moderate exercise" as "*gentle exercise*" There is no mention that the example is just a reference.
Q19 / Q18	Head injury with loss of consciousness in the past five years?	Incorrect translation. Meaning becomes "*Any head injury after loss of consciousness, in the past five years?*"
Q27 / Q27	Sinus surgery?	Incorrect translation. The term becomes "*venous sinus surgery*" instead of original enquiry of "*nasal sinus surgery*"
Q28 / Q28	Ear disease or surgery, hearing loss....	Failure to include "*ear surgery*" in the translation

Concerning the same organ system, there are questions of a general nature, and also enquiries on specific conditions. For example, comparing the answers to question 4 ("*Asthma, or wheezing...*") and question 7 ("*Any form of lung disease*"), a significant number of respondents who replied positively to question 4 did not think they had lung disease. The isolated specific disease entities inquiry seemed useful.

Validity of the translation version

Comparison of the 2007 RSTC English version with the 2001 and 2012 RSTC Chinese version shows that some questions in the Chinese and English version are significantly different in terms of the meaning and question details. Discrepancies identified are presented in Table 4.

It would be preferable to have a translated version with the same meaning yet in simple, understandable and legally acceptable expressions and presentation. The use of illustrations in addition to a 'word for word' translation may be useful. This is done for one question (question 34) in the Chinese version. The term colostomy is followed by the explanatory note: "*artificial anus*". The inconsistencies with the original intended questionnaire design will impact negatively on the construct validity of the translated version of the questionnaire. The sub-optimal and incorrect translations could result in potentially high-risk divers being missed.

Implementation of the questionnaire screening

Details of the local implementation of the RSTC form need future research.

All trainee divers are required to submit a medical screening questionnaire. According to the recreational diving safety manual (page 73) promulgated by the Hong Kong Underwater Association, all entry level scuba divers are recommended to pass a pre-dive diving medical examination by a licensed physician.[17] This is not a mandatory step and is therefore unlikely to be implemented in practice.

It is assumed that participants receive questionnaires with adequate time to grasp questions and respond appropriately before the practical sessions. Individuals are expected to complete the documents on their own without input from medical professionals. In this study, 15.4% of respondents found difficulties in understanding some expressions in the questionnaire (Table 3).

Participants are supposed to answer "*yes*" if they are not sure about a question. However, we cannot assume this

occurs. For example, with question 27 ("*Sinus surgery*"), 100% of respondents gave a negative answer to the unknown condition (incorrect Chinese translation). People reacted simply by ignoring the unfamiliar conditions being asked and giving "*no*" as the answer.

There is currently no requirement for recreational divers to undergo regular medical screening in order to keep diving certification validated. The diver will be required to complete the health screening questionnaire again only upon enrollment in another new certification course. Medical clearance is mandatory, according to PADI, if the participant has any significant medical problem during the dive course. The lack of longitudinal surveillance of the divers' health status is alarming. Cardiovascular risk of individuals increases with age. People may not be aware of these potential problems when they are allowed to dive with the diving certification card they obtained when they were younger.[26]

User attitude

New scuba divers may have problems in completing the questionnaire on their own as discussed above. People are told to review any questions regarding the medical statement or the medical questionnaire section with their instructor before signing. Yet, it is stressed that the scuba instructor is not a medical expert.[4,5] It may be useful to explore the attitude of the questionnaire providers (for example dive shops and diving instructors) in future studies. This may help to improve the way the RSTC form is used.

Reliability of self-declaration answers

The false positive and false negative answers were minimal except for questions 5 and 7. Most admitted to carelessness, or uncertainty about the wording of the questions. Yet the study also suggested that respondents were willing to reply honestly to the questions. Further research may help to elicit whether or not pre-participation divers are inclined to conceal their medical history in order to pass the screening. The questionnaire should not be perceived as a barrier to participating in recreational diving. Honesty may be promoted if people understand that the questionnaire screening is not used to disqualify people from participation. It is used to identify someone that may benefit from having a formal medical assessment. People with significantly high risk will be advised against scuba diving for the safety of themselves and others.

Handling of completed questionnaires

This study did not examine the follow-up proceedings with the completed questionnaires. Diving instructors are expected to check the medical screening form and suggest physician consultation for potential medical clearance when it is indicated.[4,5]

The uniqueness of diving medicine and the lack of training opportunities in Hong Kong means that the number of well-trained medical professionals will remain inadequate for the foreseeable future. This barrier in having an appropriate fitness-to-dive assessment should not be underestimated. The RSTC form provides guidance to physicians (Guidelines for recreational scuba diver's physical examination).[3,6] The majority of doctors in Hong Kong are trained with English as the language in their professional career. It is uncertain whether someone who completes the Chinese version of the questionnaire will go to a doctor with the English version guideline as reference for the doctor.

It is also known that opinions of diving doctors (with postgraduate training on diving medicine) and general practitioners may not be consistent regarding fitness-to-dive.[27]

LOCAL CIRCUMSTANCES WITH THE USE OF RSTC FORM

The diving mortality of Hong Kong divers was not reported to be higher compared to other places despite the use of the Chinese RSTC form with its intrinsic problems.[25] This may be explained by the high standard of the local recreational diving operations. Most local scuba diving operations are non-decompression stop seawater dives with maximum depth of 10 meters or less in environments with no overhead hazards. This mode of recreational diving might change with time, subsequently leading to an alteration in health risks of participants.

Nonetheless, some individuals are happy to take high risks and some people continue to participate in scuba diving despite medical contraindications.[28] Risk appreciation by these individuals should only be assumed if adequate understanding and guidance is secured beforehand. The screening questionnaire by default should be one cornerstone to help all stakeholders to gauge and communicate about the acceptance of risk.

BIAS OF THE STUDY

There is selection bias by involving only clinic attendants. The age criteria excluded all youngsters who could be potential scuba divers. Further research that focuses on junior divers is needed. The collected data relied heavily on the recall of the study participants and history taking skill of the researcher. Although the researcher tried to explore relevant medical history, observational bias was unavoidably introduced without objective investigations or tools used.

IMPLICATIONS FOR THE 2020 NEW FORM

The recreational diving medical screening questionnaire has been substantially revised and a new version has been published since June 2020.[29] The new version retains most

of the enquires of the previous versions but the presentation and the questionnaire format are markedly modified. It is expected that the local diving community will move to use the new form in coming time especially after the COVID-19 pandemic. Based on the identified problems in this study, the authors plan to have ongoing reassessment of the updated version in a similar manner. Investigations of different non-English versions may help to clarify the situation.

Conclusions

Pre-participation health screening of recreational scuba divers is considered a useful risk management tool. Screening with questionnaires is still a practical and acceptable method. However, it should be noted that the assumptions leading to meaningful screening by self-declaration questionnaire may not be met. There are problems with the construction validity and translation of the RSTC form's Chinese version. Further updating of the RSTC form will likely improve its credibility. However, problems related to language translation of the form need special attention. The new 2020 version will likely face similar challenges. At the same time, the recreational diving community should be informed about the non-prescriptive approach of health assessment for recreational divers. Further research on the attitude of related parties towards the medical questionnaire can help to improve the implementation of the screening strategy in the future.

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Conflicts of interest and funding: nil

Submitted: 07 April 2020
Accepted after revision: 26 February 2021