Leisure and SCUBA diving safety tips during and after COVID-19

Yalın Aygün¹* and Şakir Tüfekçi¹

Abstract: The novel coronavirus (COVID-19) has disrupted travel and scuba diving operations around the world in an unprecedented way. As the impact of the virus spreading and receding from each country evolves, local regulations adapt, creating a patchwork of situations that is hard to stay up to date with. The aim of this study was to bring together safety tips to be followed when pursuing leisure and Recreational SCUBA Diving during and after the COVID-19 pandemic, and strengthen divers' commitment to and interest in the underwater world. An interpretive qualitative methodology was deemed appropriate to achieve the study's research objectives. A focus group interview was held via a “Google Meet video meeting” with eight participants who were both specialist physicians and diving professionals. The analysis turned up four main themes: (1) High Standards in Diving Services and Diving Gear Hygiene, (2) Diving Trip Safety, (3) Diver Training Safety, (4) Social Change for Social Support. COVID-19 is experienced as a life-changing event that shows a kaleidoscopic view of leisure-adventure limitation. We stress that the conceptualization of limitation must be considered due to its service philosophy and sociopolitical aspirations. Thus, creating conceptual and holistic safety protocols for Recreational SCUBA Diving experience can inspire people to discover their passions, to self-realize, to form trust-based relationships with the outside world its actors.

Subjects: Leisure Studies; Leisure Management; Marine Recreation; Outdoor Recreation

Keywords: COVID-19; SCUBA diving; leisure-adventure; marine location

ABOUT THE AUTHOR

Yalın Aygün is an Assistant Professor in the Faculty of Sport Sciences at Inonu University. His research interests include tourism management, adventure leisure experiences and marine tourism. He has recently completed his Ph.D. studies examining human experiences in recreational SCUBA diving. Şakir Tüfekçi is a Lecturer in the Faculty of Sport Sciences at Inonu University. His research interests include recreation, youth camps activities and leisure management. He has recently been doing Ph.D. studies examining leisure activities in high schools.

PUBLIC INTEREST STATEMENT

In this paper, we seek answers to the following questions: “What are the main safety tips for those engaging in leisure-adventure activities, travel and Scuba Diving during and after the COVID-19 pandemic?” and “How can divers strengthen their commitment to and interest in the underwater world?” This is significant because this study concerns both the safety of divers, and the health of local diving, travel and hospitality businesses. The study focuses on what sort of an environment the COVID-19 disease and pandemic creates for Recreational Scuba Diving as a leisure-adventure activity, and the additional safety protocols recommended by diving professionals who are also specialist physicians.

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1. Introduction
The increase in popularity of adventure experiences among the public seems to indicate that the belief that adventure activities are only for daredevils and the reckless has finally been broken (Creyer et al., 2003; Ewert & Hollenhorst, 1997; Olivier, 2006). The term “soft adventure” has entered the language used to describe certain leisure activities, lending more weight to the view that it is not only thrill-seekers that search for adventure (Dimmock & Wilson, 2009). This social change (Centola et al., 2018) supports the idea that adventure activities appeal to the masses.

Leisure and adventure studies accept that various experience states are possible during a single encounter (Gymothy & Mykletun, 2004; Marion & Leung, 1998; Mortlock, 1984). In contemporary societies, leisure offers physical, psychological and environmental comfort to those seeking a balanced and healthy life (Bernardi & Kowaltowski, 2006; Dimmock, 2009; Woodward, 2003). Those taking part in such activities may face challenge and distress during their leisure activities, as they may encounter occasional risk (Barnett, 2005; Priest, 1992). Moreover, the optimal or peak experiences involve participants competing against leisure elements involving risk (Csíkszentmihályi, 1990, 1992; Nakamura & Csíkszentmihályi, 2009). What is not clear, based on our current knowledge of leisure-adventure activities, is what emerges during or after novel and unusual encounters. Accordingly, the aim of this study was to bring together safety tips to be followed when pursuing Leisure-adventure and Recreational SCUBA Diving during and after the COVID-19 outbreak, and strengthen divers’ commitment to and interest in the underwater world. The study focuses on what sort of an environment the COVID-19 disease and pandemic creates for Recreational SCUBA Diving as a leisure-adventure activity, and the additional safety protocols recommended by diving professionals who are also specialist physicians. The study aims to make important contributions to literature on leisure-adventure experiences, diver behaviors, diver training and public health. This study concerns both the safety of divers, and the health of local diving, travel and hospitality businesses.

1.1. The COVID-19
Coronaviruses (CoV) are a large family of viruses that cause several diseases, ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV) (Turkish Ministry of Health, 2020). The Novel Coronavirus (COVID-19) was first defined on 13 January 2020 following studies conducted with a group of patients who developed respiratory tract symptoms (fever, cough, shortness of breath) in late December in Wuhan, the capital city of the Hubei province of China. The virus was first detected in people who had visited a seafood and livestock market in the area. Through human-to-human transmission, it then spread within Wuhan, and to other cities in the Hubei province, and from there to other provinces China and to the rest of the world (Turkish Ministry of Health, 2020).

Known also as SARS-CoV-2, the novel coronavirus, which is the cause of the COVID-19 disease, has infected 2,164,111 people in 213 countries and regions to date, and has killed 146,198 people (WHO, 2019). SARS-CoV-2 is a member of the viral group known as “corona” (“crown” or “halo of light” in Latin), named after the appearance of their surface proteins (ECDC, 2020). This group of viruses is estimated to be responsible for 15–30% of acute respiratory tract infections every year, however, these figures are subject to rapid change owing to the current pandemic (Lauer et al., 2020).

COVID-19 is transmitted in a variety of ways from the respiratory system, including through airborne droplets generated by coughing or sneezing, through touching virus-contaminated surfaces, or through close contact with someone infected with the virus. The incubation period of the virus varies between 2 and 14 days (ECDC, 2020). In one study, the mean incubation period was found to be 5.1 days, and 97.5% of the patients were found to develop symptoms within 11.5 days (Lauer et al., 2020).
States, global experts and stakeholders are working closely to monitor the spread and virulence of this novel virus, and are making recommendations to countries and the global community on measures to protect health and prevent the spread of the disease. In this vein, the present study seeks answers to the following questions: “What are the main safety tips for those engaging in leisure activities, travel and SCUBA Diving during and after the COVID-19 pandemic?” and “How can divers strengthen their commitment to and interest in the underwater world?”

1.2. COVID-19 and recreational SCUBA diving

SCUBA is an acronym for “Self-Contained Underwater Breathing Apparatus”, and is in common use as a generic word (Dimmock, 2009; Johansen, 2013; Lew, 2013). SCUBA diving involves the use of a portable air source (independent of a surface source) that allows the diver to stay underwater for an extended period of time (Dimmock, 2007; Garrod, 2008). Prior to the nineteenth century, the ocean figured in Western minds only as a waterway between land masses. The sea was viewed as a large space thought to be empty and devoid of any features (Rozadowski, 2005). By the twentieth century, diving suits were being designed that provided protection against the cold, and attempts were being made to deal with the other negative effects of diving (Diole, 1954; Miller & Koblick, 1984).

Social trends in travel and tourism resulted in the development of Recreational SCUBA Diving as a niche market, and it came to be recommended as a form of mass ecotourism, reflecting the increasing popularity of the activity (Arin & Kramer, 2002; Davis & Tisdell, 1995). Recreational SCUBA Diving is a type of SCUBA Diving that covers a wide range of adventure, leisure and pleasure activities and related skills, and is differentiated from commercial, military, public safety or scientific diving. The increasing demand for Recreational SCUBA Diving as a leisure-adventure activity has led to a growing interest in fauna and flora habitats, artificial and natural reef formations, various geological formations and symbiosis, as well as in leisure activities taking place in natural underwater environments that are close to the local ecosystem, or possibly at an unpredictable distance (Lew, 2013; Musa & Dimmock, 2012). Moreover, the activity has now turned into an industry, meeting the worldwide demand among those seeking an element of unpredictability with potentially unique, exciting and interesting experiences (Carter, 2009; Carter & Carter, 2007). In addition, popular culture has fueled interest in Recreational SCUBA Diving, and television documentaries, movies and books by pioneers such as Hans and Lotte Haas, Jacques-Yves Cousteau, and others have generated significant interest among diving enthusiasts (Johansen, 2013; Lindgren et al., 2008). The US-based journal “Skin Diver”, first published in the 1950s, was the first diving-oriented journal, and played an important role in the growth of the Recreational SCUBA Diving industry. This journal had a large following in the past, and maintains a wide audience still today. Journals continue to play an important role in the promotion of diving sites, and there are currently more than 60 such journals estimated to be published worldwide (Dimmock & Cummins, 2013).

Previous literature on Recreational SCUBA Diving contains many studies on diver behavior and underwater environments (Anderson and Loomis, 2011; Barker & Roberts, 2004; Chung et al., 2013; Hammerton, 2017; Hammerton & Bucher, 2015; Luna et al., 2009; Ong & Musa, 2011; Poonian et al., 2010; Roche et al., 2016; Salim et al., 2013; Toyoshima & Nadaoka, 2015; Uyarra & Côté, 2007), however there have been no studies to date examining diver behaviors regarding safer Recreational SCUBA Diving during and after the COVID-19 pandemic. The present study can thus be considered unique in terms of its methodology, research questions and expected results and findings.

Even though there are countries and regions that have been recommended for diving during the novel coronavirus (COVID-19) outbreak, the recreational SCUBA diving community is subject to many limitations, restrictions and barriers. One participant, however, paints a positive picture for the future:

The underwater will be waiting for divers when this is all over, and there are things that can be done to retain a connection to diving. However, it is known that SCUBA diving for leisure has not stopped completely in regions of the world that were affected or less affected at different times. (Kiraz)
2. Methodology

2.1. Methodological approach
The lack of relevant empirical studies opens up opportunities for examinations of diver behaviors for safer SCUBA Diving as a leisure-adventure activity during and after the COVID-19 pandemic, and for strengthening divers’ commitment to and interest in the underwater world. An interpretive and qualitative method was considered appropriate for the purposes of the study. Changes and trends away from the positivist approach in terms of research traditions have resulted in the gradual acceptance of the need for qualitative research methods (Denzin & Lincoln, 2018; Hollinshead, 2006). Leisure researchers agree that qualitative approaches are most appropriate for constructive and innovative attempts to reveal meaning through a search for alternative methods, using a different set of research questions (Aitchison, 2005; Stewart, 1998). Qualitative research supports different assumptions, such as the presence of different sets of values, a multiplicity of meanings that can explain human action, and the value-laden character of language used to describe and interpret social behavior (Lincoln et al., 2011; Silverman, 2013). Qualitative research methods provide researchers with the necessary richness of data to allow meaning to be uncovered and a wider range of phenomena to be perceived (Marshall & Rossman, 2014).

2.2. Participants
To locate potential participants, phone calls were made with, and e-mails sent to volunteers who were both specialist physicians and diving professionals to inform them about the study content. The participants illustrated in Table 1 were secured on the basis of pre-determined criteria to ensure the richness and diversity of the data (Patton, 2002). A total of eight diving professionals with different fields of medical specialization and levels of experience (five dive instructors and three dive leaders) were included in the study after they provided informed consent. The use of different criteria helped ensure the analyses included diverse and alternative views, rather than focusing on findings that represented the mainstream view and overlooked variation (Miles et al., 2014). The sample size was small, but is not considered a priority in qualitative research, as the level of interest validates the significance of the data (Saldaña, 2009). Pseudonyms were when reporting the findings, and all personally identifiable information was kept confidential.

2.3. Data collection
An application was made to the Ethics Board prior to the study, which confirmed that there were no ethical obstacles to the conducting of the proposed study, and thus granted approval [T14-02-16]. The participants were informed, both in writing and verbally, about the Declaration of Helsinki and the voluntary nature of participation, explaining also that they had the right to withdraw from the study at any time without consequence or effects on their future lives whatsoever. A virtual focus group involving open-ended questions addressed to the participants, to be held via a “Google Meet video

| Table 1. Participant profiles |
|------------------------------|
| **Diver** | **Medical specialty** | **Level of certificate** | **First diving experience** | **Number of dives** |
| Yaşar | Ear, nose, and throat | Dive instructor | 1991 | Thousands |
| Mustafa | Family physician | Dive instructor | 1998 | Thousands |
| Polat | Pulmonology | Dive instructor | 2000 | Thousands |
| Nazif | Cardiology | Dive instructor | 2008 | Thousands |
| Cemil | Microbiology | Dive instructor | 2010 | 900 |
| Yaşin | Infectious diseases | Dive leader | 2011 | 750 |
| Kiraz | Infectious diseases | Dive leader | 1982 | Thousands |
| Şamil | Psychiatry | Dive leader | 1999 | Thousands |
meeting”, was considered to be the best approach to allowing the participants to express their views (Lincoln & Guba, 1985; Sandelowski, 2000; Seidman, 2006). The meeting, which was held on an agreed date and took about 90 minutes, was recorded. To create a relaxed atmosphere, the meeting started with a short warm-up talk. Even though it is not a standard approach (Patel & Davidson, 2003), the main part of the meeting started with the following trigger question: “We have all been affected, if in small ways, by the epidemic, but what safety measures do you think, as physicians and diving professionals, that people should take to keep their diving dreams alive during and after the COVID-19 epidemic?” The participants were then asked follow-up questions based on their responses to encourage them to elaborate further on specific issues or ideas (Seidman, 2006). These included, for example, “Can you elaborate on that?” or “How would that work?” After the formal interview was finished, the record was turned off. None of the participants expressed a need for “debriefing” or further elaboration on anything due to the interview and to recalling memories from their experiences with COVID-19 and Recreational SCUBA Diving. Data reliability requires good meeting quality, in this case, referring to good sound quality, verbatim transcription, variations and examples in the data to reflect variations in cases, etc. (Lincoln & Guba, 1985; Patton, 2002).

2.4. Data analysis
A thematic analysis was conducted following the six steps explained by Braun and Clarke (2006). A thematic analysis was carried out to identify patterns in the data, and comprised the following phases: Phase one (data familiarization): The transcribed data were read repeatedly, and initial ideas were noted. Phase two (generating initial codes): Notable data characteristics within all the data were coded systematically, and the relevant data were organized under corresponding codes. Phase three (searching for themes): All data and codes were organized under relevant potential themes. Phase four (reviewing themes): Themes were checked for consistency with the data contents (Level 1) and the entire data set (Level 2) (Miles et al., 2014; Saldaña, 2009), and a thematic “map” of the analysis was prepared. Phase five (defining and naming themes): The analysis continued to refine the details of each theme and the overall narrative of the analysis was clarified, after which all themes were clearly defined and named. Phase six (producing the report): At this stage, as the final opportunity for analysis, concrete, striking and persuasive examples, along with direct quotes, were selected. The coded data snippets were analyzed one last time. The results of the analysis were associated with the research question and literature, and the findings were reported following academic conventions.

Thematic analyses do not attempt to quantify data, but instead aim to discover the experiences in participants’ narratives (Boyatzis, 1998). The participant narratives were thus represented with direct quotes from the data, which is considered important in improving the reliability of qualitative studies (Patton, 2002). The Cohen’s kappa (k) coefficient, used to measure inter-coder (and intra-coder) reliability, was calculated at .94.

3. Results
The findings of this study offer suggestions of how to lessen the risk of exposure to the COVID-19 disease and pandemic among divers and the promotion of dive safety, and how to strengthen their commitment to and interest in the underwater world. The analysis turned up four main themes: (1) High Standards in Diving Services and Diving Gear Hygiene, (2) Diving Trip Safety, (3) Diver Training Safety, (4) Social Change for Social Support.

3.1. High standards in diving services and diving gear hygiene
The comments by the participants underlined the need for the regular cleaning of diving equipment parts, especially those in close contact with the mouth, nose and eyes, using bleach, soapy water, quaternary ammonium, and sodium hypochlorite, following the manufacturer’s instructions. A dive instructor/Ear, Nose and Throat specialist noted that virus colonies can form more easily on equipment parts with surfaces that are worn or cracked. The most important equipment parts in this respect are the regulator mouthpiece, snorkel, buoyancy control device, oral inflator, whistle, the inside of the mask and the diving suit. One of the participants emphasized that the use of diving suits and accessories such as gloves, hoods and boots should be minimized depending on
weather conditions, and these pieces of equipment should be disinfected thoroughly. Even though higher temperatures are thought to inactivate the virus, people taking part in the filling of diving cylinders with regular filtered air, enriched air nitrox (higher oxygen and lower nitrogen content) or trimix for technical dives should take strong precautions against contact.

Diving equipment can be disinfected effectively by submerging in a 10 percent bleach solution, or through the use of a cleaning product, such as stermine tablets or any quaternary ammonium compound. Care must be taken to follow the manufacturer’s instructions when using these products, and the equipment should then be rinsed with clean water. (Cemil)

Some soapy water, antibacterial dish soap and a soft sponge should be used to clean mask lenses and the nose pocket, and to kill any viruses that may have attached to the bib. A toothbrush should be used for the area between the lenses and the bib. (Kiraz)

To clean your diving suit, you can use dish soap in a tube filled with fresh water. Prior to hanging the suit out to dry, the suit should be turned inside-out and disinfected. Moreover, I believe it would be useful to avoid the use of such diving equipment as gloves, mask and boots when the water temperature allows. (Yalçın)

If a person who is infected or who is carrying the virus on their hands after having inadvertently touched an infected surface then touches the diving cylinder valve or filling whip during filling, the virus may potentially enter the diving cylinder. (Mustafa)

After disinfesting the diving equipment, care should be taken to avoid re-infecting by touching during storage. Diving store employees should take care to follow good hygiene practices through frequent hand-washing and the regular disinfection of high contact areas, including filling stations. (Yaşar)

The participants also said that divers and people around them should take precautions to prevent the transmission of the virus through droplets. This concern forms the basis of the recommendation that divers should drop the habit of spitting on mask lenses to avoid fogging—a common practice among divers—and instead use anti-fogging agents. “Instead of spitting on their masks, divers should use an anti-fogging agent. This can lower the risk of cross-transmission” (Yaşar). In their comments, the participants emphasized the many advantages of owning one’s own diving equipment. “After learning the basics of SCUBA Diving, the next step should be learning about ownership of personal diving equipment” (Nazif). The participants agree that the familiarity that comes with owning a personal SCUBA gear set means more comfort and a better diving experience. More importantly, most of the participants agreed that in terms of safety, the ownership of personal diving equipment lowers the risk of exposure to ongoing COVID-19. In their comments, the participants frequently mentioned that a disinfectant solution should be carried throughout the dive trip for use in emergencies, and for the disinfection of personal equipment or that of one’s dive buddy. “If divers don’t have access to disinfectants, they should ask the store providing the equipment to disinfect them properly prior to diving” (Yaşar).

Divers who do not have their own equipment should disinfect all rented equipment prior to use. Local diving centers should facilitate this by providing various disinfectants. Moreover, a disinfectant solution should be kept in the diving bag in case an unexpected situation arises during or after diving. (Polat)

Finally, narratives underlining the importance of protecting the health and safety of dive center staff and customers recommend that emergency action plans and all disinfection protocols should be updated in line with COVID-19 precautions. “Managers should update their current emergency action plans to include the possibility of COVID-19 infection in a staff member or customer. They should ensure that all disinfection protocols are outlined and followed diligently by all employees” (Mustafa).
3.2. Diving trip safety
In their comments, the participants noted that unpredictable events, such as illnesses, accidents or epidemics can force divers on a trip to cancel or delay their plans. Therefore, they recommend that all divers keep in mind that they are travelers, and that they should be aware of travel-related medical issues, while avoiding situations that may endanger health and taking personal precautions to minimize risk.

All dives involve some sort of a travel, be it a 10-hour flight to Thailand or a 10-minute drive to the beach. Therefore, travel safety should be considered a key aspect of the divers’ mission in the fight against the virus. When planning diving trips to national or international destinations, careful preparations should be made, including drawing up a diving trip checklist, a travel preparation timetable, health and safety tips, and equipment maintenance instructions. (Mustafa)

The participants noted that some devastating events, such as illness, injury or death, may be covered by travel or diving insurance. “Throughout their trip, divers should keep their diving certificates and diving and travel insurance up-to-date, and should carry the related documents with them” (Yalçın). The participants had a vast amount of international diving experience among them, and recommended that a comprehensive diving trip should involve also planning for potential illness, injury or emergency, and insurance should cover transportation to the closest and most appropriate medical facility, help returning home if necessary for medical reasons, and travel costs of a companion for the trip back home. Moreover, they recommend closely examining the coverage of any policy they are considering buying related to COVID-19.

If you want to purchase dive insurance, you should work with a reliable travel insurance company. Some travel insurance companies are refusing to pay for COVID-19-related damages. You need to make sure you know the extent of the coverage provided by your travel insurance company regarding virus treatment, quarantine costs for 14 days and refunds for cancelled trips. (Şamil)

Prior to embarking on their travel, divers should check the official website of the origin country for the latest travel recommendations. This not only helps keep divers healthy, it is also an indispensable part of the efforts to slow down the spread of this pandemic, both locally and globally. (Kiraz)

3.3. Diver training safety
First of all, the participants agreed that learning SCUBA Diving is one of the most beneficial activities one can do in life, and participating in a certificate program can change one’s perception of the world, both above and under the surface, forever. They stated that the risk of COVID-19 infection and epidemic during SCUBA Diving training can be mitigated by following a special diving curriculum that is safe, comprehensive and has the highest standards, and creating an additional safety algorithm. “In this process, the diving sector should emphasize independent work for SCUBA Diving training, and dive volunteers should be encouraged to contact stores over the Internet and use digital products” (Nazif). Moreover, all of the participants agree that social distance should be maintained during all stages of the certificate program, namely during knowledge development, confined water dives and open water dives. For example, “the buddy checks that must be performed prior to each dive and that are based on mutual contact should be completed while maintaining social distance between divers, through individual guidance and observation” (Yaşar). This view supports a transition to digital training for part of the program.

Unless there is an emergency that demands otherwise, social distancing should be maintained for buddy checks, air sharing practices and the learning of various first aid skills. Trainers should create additional curricula based on course credits for these topics, and offer them once the risk of epidemic declines or disappears. (Polat)
3.4. Social change for social support

In their comments on the effects of the COVID-19 disease and epidemic on social life and mental health, the participants emphasized that social distancing rules and social change in the aftermath will be needed as social support to ensure people do not feel lonely or desperate, and are able to return to their diving adventures. “If divers have questions or concerns, in order to help others, they should talk about what they do to stay safe at times like these. In this context, various forum pages, journals, and support lines should be utilized” (Mustafa). The participants frequently mentioned the importance of utilizing various means of “virtual social support”.

There has never been a generation better prepared for distance socialization over digital tools such as social media, Skype, text, phone, etc. As contact is critical for emotional health, when we reach out to others to help, we also help ourselves. Having a virtual presence will make you feel better, and virtual social support may also satisfy one needs. (Nazif)

Social media posts and favorite SCUBA Diving blogs should be followed on a regular basis, and people should try to keep an open perspective. It is only natural to talk about the pandemic, but it is just as important for mental health to focus on underwater-related fields of interest, passions, jokes, shared memories and future dreams. (Samil)

4. Discussion

In light of the COVID-19 disease, and lately the pandemic, the questions of what additional safety precautions the SCUBA Diving community should take, and how divers can keep their commitment to and interest in the underwater world alive are in the minds of everyone involved in leisure, travel and diving activities. The present study problematizes these questions around these four themes: (1) High Standards in Diving Services and Diving Gear Hygiene, (2) Diving Trip Safety, (3) Diver Training Safety, (4) Social Change for Social Support.

The findings underline the need for the regular cleaning of dive equipment parts, especially those in close contact with mouth, nose and eyes (regulator mouthpiece, snorkel, buoyancy control device, oral inflator, whistle, and the inside of the mask), using bleach, soapy water, quaternary ammonium and sodium hypochlorite, following the manufacturer’s recommendations. The findings also emphasize the need for divers to use special anti-fogging agents instead of spitting on the mask lenses prior to diving, and for local diving centers to provide such products. Moreover, the participants noted the need to minimize—weather permitted—the use of diving suits that help balance and protect body temperature, as well as auxiliary parts such as the hood, gloves and boots, and to make sure that they are thoroughly and diligently disinfected. Coronaviruses belong to a group of enveloped viruses that have a fatty lipid layer that preserves the form of the virus when it is outside the host cell (Fehr & Perlman, 2015). As is the case with most enveloped viruses, damaging or destroying this lipid layer inactivates the virus. Studies of other coronaviruses have shown that the infectiousness of this virus may be mitigated by heat, ultraviolet light, and alkali or acidic conditions (Chan et al., 2011). This is why enveloped viruses are usually easy to inactivate, and surfaces can be disinfected using household cleaning products (CDC, 2019). Moreover, quaternary ammonium compounds, or quats, are a group of chemicals that are widely used as active components in cleaning solutions. These agents are hydrophobic (repel water), and thus are effective against enveloped viruses. Quats are thought to destabilize the virus by entering into a reaction with the viral envelope, causing the contents of the virus to leak and deform. Moreover, there is very little evidence of viral resistance against these compounds (Gerba, 2014). Studies have shown that quats are effective against SARS-CoV-1 (Delanno et al., 2009), and the WHO (2020) has recommended the use of cleaning products that contain these compounds in its 2019 biosafety guides for laboratories regarding coronavirus diseases. Products containing quaternary ammonium are commonly used in the SCUBA Diving sector to disinfect equipment and parts. However, these compounds damage the environment, and products containing them must be used and disposed of with care (Zhang et al., 2015). Previous studies have examined many different concentrations of bleach or sodium hypochlorite, and have demonstrated their effectiveness as a strong oxidizer that works by destroying the viral genome (Lycke & Norrby, 2014). WHO
recommends, for general disinfection purposes, a 1:100 dilution of 5% sodium hypochlorite. This dilution results in a 0.05% solution of the active component, or 50 ppm, and requires a waiting period of 30 minutes on the object in question. If the object is submerged in the solution, or if the solution is sprayed onto a non-porous surface, the waiting period is a minimum of 10 minutes (NCBI, 2014). A study that focused specifically on SARS-CoV-2 found that a bleach concentration of 0.1% or 1,000 ppm was required to minimize infectiousness when sprayed onto a hard, non-porous surface (Kampf et al., 2020). Another study on the same virus found that 0.1% sodium hypochlorite inactivates the virus within a minute. In another study on SARS-CoV-1, both 1:50 (0.1%) and 1:100 (0.05%) dilutions of sodium hypochlorite were found to inactivate the virus after a 5-minute submersion (Lai et al., 2005). The use of gloves, masks and eye protection is recommended when using bleach. Solutions should be mixed in well-ventilated areas using cold water, as warm temperatures can separate the active component. Bleach should never be mixed with other chemicals, and all organic materials should be removed from the objects to be disinfected in order to avoid the neutralization of the active component (Kampf et al., 2020). Products disinfected with bleach must be rinsed thoroughly and dried prior to use, as bleach is corrosive to stainless steel (at high concentrations) and irritates the mucous membranes, skin and eyes (NCBI, 2014; UNMC, 2015). Bleach solutions at high concentrations were found to damage life support units, cause metal fatigue, and in some cases, have a negative effect on anthrax attacks. As such, these solutions are not recommended by EPA (2016) in the presence of effective alternatives. Moreover, washing hands and surfaces with soap and water is one of the most effective means of protection against the virus. The type of soap used does not matter. Washing with soap and water does not kill microorganisms, but physically removes them from surfaces. Flowing water by itself can be effective in removing some unwanted microorganisms from the surfaces of objects, but soap physically pulls the microorganism away from the object and the skin toward the water (Harward Medical School, 2007). DAN (2020) questions why soap and water, recommended for hands, is not appropriate for diving equipment. Soap and water, as mentioned above, must be coupled with mechanical movement to be fully effective. Submerging diving equipment in soapy water is not an effective means of disinfection. If soapy water is coupled with a mechanical effect, it can theoretically be more effective. However, diving equipment has parts that are difficult to access without dismantling, such as the inside of a regulator. As the diver breathes, the virus would pass through the regulator and come into contact with the diaphragm and other internal surfaces. As such, submerging the regulator in a disinfectant solution may be a better option. This is a topic that concerns millions of divers, diving centers and resorts, dive leaders and trainers, and diving communities.

Comments that call attention to the relationship between hygiene and diving equipment that has partially lost its function note that coronaviruses can form colonies more easily in diving equipment parts with surfaces that are worn or have cracks (buoyancy control device, diving suit, hood, gloves, boots, mask, etc.). This indicates that it is best to avoid, when possible, renting or using second-hand diving equipment, or frequently using old diving equipment and parts. There are ongoing studies on SARS-CoV-2, and the issue of how long the virus can remain active on surfaces is still subject to debate. The latest studies have shown that this virus can remain active for 3 hours in airborne (aerosol) droplets (e.g., sneezing), for 4 hours on copper surfaces, for 24 hours on carton surfaces, and for 2–3 days on plastic and stainless steel surfaces (NIH, 2020). It is not clear, however, how long SARS-CoV-2 remains active in water. Studies of the SARS virus referred to as SARS-CoV-1 that caused an epidemic in 2003 have shown that it remained infectious in surface waters (lakes, rivers, wetlands, etc.) for a long time, and was found in pasteurized settled sewage both at ambient and lower temperatures (Casanova et al., 2009). CDC (2020) found SARS-CoV-2 to be inactivated in pools and hot tubs containing chlorine or bromine.

By shedding light on the results, the participants agreed that people who operate the compressors used to fill the diving cylinder, be it with regular filtered air, enriched air nitrox (higher oxygen and lower nitrogen content) or trimix (combination of three gases) for technical dives, should take strong precautions against contact. We have limited data on SARS-CoV-2, and most of these data are of a preliminary nature. In the case of the novel coronavirus, some of the reports are based on SARS-CoV-1, as it is harder to kill than the novel coronavirus. A study found that SARS-CoV-1 lost its infectiousness when kept at 56°C (Chan et al., 2011) for 15 minutes, and WHO (2003) reported this
temperature and timing. Another study found that the SARS-CoV-1 virus remained stable between 4°C and 40°F (37°C), and lost its infectiousness when kept at 56°C for 30 minutes (Duan et al., 2003). DAN (2020) carried out a study of viruses that enter the diving cylinder as a result of contaminated air being sucked into the compressor. The ideal gas equation T2 = T1 x (P2/P1) (n-1)/n can be used for ambient air with an entry pressure of 1 ATA and a temperature of 80°F when making calculations for a four-stage compressor as it compresses air. Up until 29 ATA, or approximately 426 PSI, it would have an inter-stage temperature of 224°F. This calculation is very simple, and explains nothing other than the ideal conditions. However, it also shows the momentary temperature under peak pressure. In reality, the exit valve temperature would probably be between 170°F and 190°F, and the gas temperature in each part of the compressor would be about 150°F (in other words, assuming exit temperatures for each stage, there would be four identical cycles for a four-stage compressor). As this temperature is high enough to kill SARS-CoV-2, it is not very likely that COVID-19 will remain active in this process in the event of a cough by an infected person during compression. It is important to note that infectious droplets released by a person can be as small as 0.5 micron, and filter systems alone will not eliminate them; however, the virus would be inactivated at this stage (DAN, 2020). Nevertheless, if a person is carrying the virus on their hands because they are infected, or have inadvertently touched an infected surface, and they then touch the cylinder valve or filling whip, the virus may potentially enter the diving cylinder. Some studies have shown that viruses are highly resistant to pressure, although these studies were conducted on noroviruses, which are non-enveloped and are harder to kill (DiCaprio et al., 2019; Lou et al., 2012). Other studies on enveloped viruses, such as influenza viruses, have examined only the effectiveness of high hydrostatic pressure at 42,003 PSI (Lou et al., 2012). Thus, it is very important to wash and disinfect high contact areas, including the cylinders and filling stations, as the virus can remain active at diving gas storage pressures.

The participants noted that all divers are travelers, and to minimize health risks including COVID-19, they should take such personal precautions as taking out diving and travel insurance, in addition to date, destination and travel cost assurances. Travel and diving insurance provides protection against unpredictable situations, from cancelled flights to serious illness, and in rare situations including acts of terrorism or obligations of a travel provider. If an illness, accident or another unexpected condition forces a diver to cancel or disrupt his/her plans, the diver can potentially face two large financial losses. The first of these are the non-refundable costs paid upfront, and the other is healthcare costs that in many cases are not covered by health insurance. Having said that, illness and injury, unfavorable weather conditions and job loss are among the most common unusual events that a diver can encounter during SCUBA diving travel. All of these point to the importance of having travel and diving insurance (DAN, 1980). Diving and travel insurance usually cover some such events, but their coverage of COVID-19 disease and epidemic with regards to a quarantine period of 14 days and other related procedures should be examined in detail.

Most participants agree that the risk of COVID-19 disease and epidemic during SCUBA Diving training can be mitigated through the creation of a special diving curriculum that is safe, comprehensive and has the highest standards, as well as an additional safety algorithm, and that emphasize the importance of digital training, having a course credit system, and keeping social distance during the knowledge development, confined water dives and open water dives sections of the relevant SCUBA Diving certificate program. The courses offered by most dive centers around the world are based on theoretical and applied activities, and help divers proceed at their own speed. This type of learning allows the training of proficient and well-prepared divers. The time it takes to complete the course varies depending on whether it is digital, credit-based, or conducted at a local diving center, as well as on other conditions, and usually lasts from 4 to 7 days (Johansen, 2013). Many institutions and national education councils that confirm the quality of the diver training system of Professional Association of Diving Instructors PADI (2020) recommend SCUBA Diving courses for college credit, professional certification or financing education. This credit-based digital training system may become more common worldwide in the fight against COVID-19.
In their comments on physical and mental health and maintaining an interest in the underwater world amid the COVID-19 outbreak, the participants emphasized that under social distancing conditions, as well as in the aftermath of the pandemic, social change is needed to provide virtual social support so that people do not feel lonely and desperate, and are able to return to their diving adventures. Social media, digital diving journals and diving forums are considered to be potential tools that can help in this process. A social science study featuring a minority model of a critical mass shows that a critical mass comprising roughly 25% of the world’s population can tip the opinion of the majority in a new direction and thus initiate social change. Thus, when minority groups reach a critical mass in the initiation of social change, they can permanently reverse an entrenched behavior (Centola et al., 2018). When this happens, divers can find a deeper purpose, and can help others find their own deep purposes.

5. Conclusion thoughts
This study has focused on bringing together safety tips for leisure-adventure experiences and SCUBA diving during and after the COVID-19 pandemic, and strengthening divers’ commitment to and interest in the underwater world. To this end, COVID-19 is experienced as a life-changing event that shows a kaleidoscopic view of leisure-adventure limitation. We stress that the conceptualization of limitation must be considered due to its service philosophy and sociopolitical aspirations.

The study demonstrates that when selecting a disinfectant for diving gear in regions recommended for diving during the COVID-19 pandemic, it is very important to use products that are proven to be effective against SARS-CoV-2, or against SARS-CoV-1, which is more difficult to kill. After disinfecting dive equipment, care should be taken to avoid re-infecting through touch during storage. To prevent the virus from entering the breathing systems, diving store employees recommended to wash their hands when it comes to diving cylinder fillings, valve and regulator maintenance or o-ring replacement. In order to reduce the risk of virus transmission, diving boats should dive with fewer passengers and take into account the effect of wind as well as distance. While wearing diving equipment and entering the water, techniques for sitting alone and donning the diving suit without help should be used. In cases where diving buddy assistance is required, the buddies must wear their masks and regulators while helping each other. Local diving centers should consider updating their current emergency action plans to include the potential COVID-19 infection of a member of staff or diver. Managers should ensure that all disinfection protocols are outlined and followed diligently by all employees. Safety protocols—such as having travel and diving insurance for SCUBA Diving—proposed by non-profit organizations including DAN, which is committed to improving diving safety for all divers, should be taken into account, as well as the safe travel recommendations made by WHO, the CDC and EPA. Due to the COVID-19 disease and pandemic, institutions worldwide should reach their diver training goals through comprehensive diving curricula that places utmost emphasis on safety, and that are based on digital platforms and a course credit system. Finally, virtual social support can serve as the foundation for transformation during and after COVID-19, through which everyone can explore their underwater passions, find self-fulfillment and build connection to the world around them.
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