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HEALTH SURVEY OF U.S. NAVY DIVERS FROM 1960 TO 1990: A FIRST LOOK

Navy Experimental Diving Unit

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After a records search identified men and women who, on active duty between 1960 and 1990, had served as U.S. Navy divers performing saturation, experimental, or both saturation and experimental dives, their current health status was surveyed. During that period, others from the fleet diver population whom the search did not identify as having performed either saturation or experimental dives served as a fourth group, a reference comparison group. When all the divers (n=5,422) were mailed invitations to participate, 33% (n=1,792) agreed to complete a self-report survey requesting information on their lifestyle behaviors, occupational histories, diving exposures, and the statuses of their current health, physical activity, and cognitive functioning. The final participation rate (surveys used / mailed invitations) was 27.5%.

From this study group of enlisted (60%), warrant officer (5%), and commissioned officer (35%) personnel, the surveys of 1,475 male and 15 female divers (92% military retirees and 8% active duty members) were analyzed. These divers served an average of 24 active duty years, with an average of 18 years of active duty diving. Their average age was 56. Married divers represented 87% of the participants; divorced or widowed, 11%; and never married, 1%. Of all these divers, 60% now receive disability compensation. One in five divers had experienced pain-only decompression sickness (DCS); one in seven, neurological DCS. One in four said that, within 24 hours of a dive, they had suffered pain or neurological symptoms for which they had not sought treatment; symptoms had failed to resolve for 6% of these divers. Overall, 41% of the divers had experienced one or more of nine dive-related injuries. Fifty-four percent of the divers had reported a lost-time (longer than three days) accident at work, and 62% had been deployed to a theater of combat operations.

The most frequently reported medical conditions were joint pain or muscle stiffness (63%), back or neck pain (59%), impaired hearing (39%), and forgetfulness (15%). Divers most frequently were diagnosed with sports injury (65%), arthritis (57%), skin disease (53%), high blood pressure (41%), allergies (40%), and head injury (29%). Seven percent of the reporting divers already had undergone a joint replacement. Their average age at a first joint replacement was 55; 23% of all divers had been told that they would need a total joint replacement in the future. In rating their general health, 86% of the divers said that it was Excellent, Very Good, or Good. In relation to the normative health of the general population, however, these Navy divers reported slightly better mental — but poorer physical — health.

Factors associated with diver reports of poorer health included DCS, number of Navy dives, lost-time accidents at work, underwater explosions, head injuries, and work as a welder. Overall, most health-related comparisons among the four diving groups found no significant differences. However, divers performing both saturation and experimental dives reported significantly higher rates of muscle weakness or tremor, impaired hearing, and pain interfering with their normal work than divers in the other groups.

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INTRODUCTION

Anecdotal reports of health complaints from Navy divers have begun to accumulate as the diver population ages. Although documentation of specific injuries during their active duty is sometimes lacking, some divers complain of difficulty in obtaining care and benefits for what they feel are "service-connected" health problems related to their participation in activities during those careers. These reported health complaints have gained the attention of the Director of the Submarine Warfare Division, who has called for a study of the long-term health effects of diving.[1] A subsequent literature review[2] has revealed insufficient information to determine whether a diving activity that produced no acute injury at the time could be linked to adverse long-term health effects.

To obtain a "snapshot" of the current health status of Navy pioneer saturation and experimental divers who had served between 1960 and 1990, the Navy Experimental Diving Unit (NEDU) surveyed a referent group of divers who had performed standard Navy dives during this period. These years cover the very beginnings of experimental saturation diving procedures and extend through the final adoption of saturation procedures that today result in a low incidence of injury and sickness.

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U.S. NAVY DIVER HEALTH STUDIES

During the past 60 years, volunteer U.S. Navy divers were subjected to environmental stresses including exposure to hydrostatic pressures, extreme temperatures, atmospheric contamination, noise, and decompression. While researchers and operational commanders did their best to conduct these dives as safely as possible with the knowledge available at the time, it was impossible to predict what effects such diving conditions might have over a lifetime.

In seeking to define these so-called "long-term" effects for diving medicine, a 1993 international consensus adopted such diagnostic criteria as a display of effects that "must be outside the range of normal in an appropriately matched population (in some circumstances the subject may be his own control)" and that "must be shown to be related to diving but not related to unsafe practice." "Long-term," this statement continues, is defined as "persisting beyond the acute phase and rehabilitation," and if such effects are "cumulative, with no acute phase, [any] subtle effects must be persistent." Finally, "there should be no non-diving pathology in the individual." *Clinical* effects were recognized as important because they affect the quality of a diver's life; *subclinical* effects were deemed to be abnormalities that do not affect the diver's quality of life.[3]

As subjects of Navy health-related studies, Navy divers have long been attended to and examined by Navy medical staff. Scores of Navy diving medical research studies were conducted to enhance an understanding of the *acute* effects of stressors on divers. Typically these reports detail the medical results of experiments conducted to advance the Navy dive mission. Some examples of Experimental Diving Unit (EDU) reports dating from the 1930s and 1940s address health-related issues such as medical treatments for compressed air illness,[4] blood cell count and hematocrit as a function of diving,[5] and medical selection criteria for dive duty.[6] Few reports assessing possible *chronic* or long-term health effects of Navy dive exposures are available, although a 1971 study of hyperbaric noise and divers' hearing examined possible long-term hearing impairment.[7]

In the 1970s, increasingly detailed medical screening and documentation accompanied the advent of Navy-sponsored deep saturation diving (i.e., >180 meters of seawater [msw], 600 feet of seawater [fsw], or 19 atmospheres absolute [ATA]). Furthermore, during this decade large-scale experimental manned diving studies were conducted to assess the effects of breathing elevated partial pressures of oxygen, substituting helium for air as the diver's inert breathing gas, and accelerating decompression from depth. The accompanying medical observations served as the bases for reports on diver health, reports published months and years after notable exposures.[8–10]

To complement the traditional medical or physiological assessments, in the 1980s neuropsychological studies began to document systematically the cognitive status of Navy divers performing saturation and experimental dives. For any long-term health effects of diving *not* associated with known accidents, findings from these medical or psychological investigations were essentially inconclusive. Neuropsychological findings were published for Navy divers performing saturation dives,[11,12] pure oxygen breathing dives (including some with convulsions),[13,14] and bounce dives to develop decompression tables.[15]

In a series of epidemiological studies in the 1980s, Hoiberg and colleagues at the Naval Health Research Center examined the health risks associated with U.S. Navy diving.[16–18] Their 1985 study examining hospitalization data is germane to the possible long-term effects of diving: In comparing the health risks of Navy dive school graduates and nongraduates (1964–1971), this report finds "no significant difference between the two groups on hospitalizations for all diving-related disorders across the 12-year post-school period."[17]

NON-NAVY STUDIES

Some investigators working with civilian commercial and recreational (and most frequently, Norwegian) divers have reported evidence of deleterious long-term health effects of diving.[19–26] Other investigators also have reported long-term cognitive deficits associated with diving, notably among Polish professional divers,[27] Australian abalone divers,[28] Swiss recreational lake divers,[29] and British Sub-Aqua Club divers.[30] A New Zealand article reported neuropsychological problems for a large percentage of

recreational divers at one year following treatment, even though they had used the U.S. Navy treatment algorithm.[31]

Upon close examination, some of the reported deleterious health findings can be attributed to known diving events such as incomplete decompression, gas embolism, and toxic breathing gas[32] — or astonishingly provocative diving.[28] Drawing different conclusions from those of previous studies, Edmonds and Hayward have thoughtfully reassessed such investigations, all purporting to find intellectual impairment with diving.[33] The Polish study found that 30% of its 150 professional divers had evidence of neurological lesions.[27] And although many divers had also experienced decompression sickness (DCS), whether any had received treatments for the condition was not mentioned. Some studies[29] rely heavily upon correlation analyses among a multitude of measures, and such studies fail to demonstrate cause and effect. Other reports[30] rely heavily upon self-report surveys, illustrating the weaknesses of that methodology in low response rates, lack of external validation, response bias, and an inability to establish causal relationships. Moreover, although a comprehensive *Examination of the Long Term Health Impact of Diving* (ELTHI) survey found increased self-reports of cognitive problems among divers with North Sea commercial diving careers when their reports were compared to those of controls, the finding appears to be unrelated to actual in-water diving exposure.[34]

More recently, first findings from a prospective study of Norwegian occupational divers were reported.[26] In this study of 67 divers followed throughout a decade, those with the greatest diving exposure (>700 dives; 21 subjects) at the 10-year mark were reported to be more likely to have “modest” impairment in some neuropsychological test performance and electroencephalograph (EEG) changes than did those divers (n=17) who had made fewer than 200 dives. And in a later discussion from the ELTHI group, divers were more likely to report “forgetfulness or loss of concentration” than did a group of nondivers.[35]

To understand and interpret these cited study findings is a daunting task. One needs to know what and how many measures were recorded, what the number of findings were, how great their significance was in relation to the overall number of measures, and how the formal criteria were used to weigh and interpret the results. Are standardized criteria for “impairment” specified and used for interpretation? Do the number and magnitude of the unexpected changes constitute true — or chance — findings? For example, while neuropsychological tests are valuable, their results depend largely upon subject cooperation, motivation, and attention. In addition, possible factors such as alcoholism, physical fitness, personality, motivation, financial considerations, social milieus, and unintended investigator bias can confound or contaminate the information being gathered. Dembert[36] has offered a brief, useful commentary on these and other confounds.

Methodologies and findings on long-term health effects of diving continue to be scrutinized, questioned, and debated. The validity, reliability, and interpretation of the measures used are of particular interest. For example, does a change in a diver’s EEG

recording inherently indicate something deleterious? Does a change in an EEG tracing betoken a decreased quality of life? Or is the EEG, as Denison has remarked, "the Scarlet Woman of physiology, available to all and understood by none?"[37]

International conferences in Norway in 1983, 1993, and 2005 brought together dozens of experts in diving and diving medicine to address the body of evidence on whether the long-term health effects of diving are unrecognized.[3,38,39] The consensus adopted in 1993 (and still in effect) states that "There is evidence that changes in bone, the CNS *(Central Nervous System)* and the lung can be demonstrated in some divers who have not experienced a diving accident or other established environmental hazard. The changes are in most cases minor and do not influence the diver's quality of life. However, the changes are of a nature that may influence the diver's future health. The scientific evidence is limited, and future research is required to obtain adequate answers to the questions of long term health effects of diving."[3]

This present study sought to determine whether exposure to Navy saturation or experimental diving is associated with an increased prevalence or severity of reported health problems. The primary hypothesis tested is that the prevalence of such problems for saturation and experimental divers is the same as that reported from Navy fleet divers. To reject this hypothesis requires showing that one or more health conditions has a statistically increased prevalence or severity in any of the study groups.

METHODS

STUDY DESIGN AND ANALYSES

This study employed a cross-sectional design using a one-time survey to gather data about (1) the subjects' occupational exposures including, but not limited to, diving; (2) their demographic and lifestyle factors that could be expected to affect health; and (3) their current health status, to include not only self-reports on various symptoms and diagnoses but also standardized, health-related quality-of-life assessments.

Cross-sectional studies demonstrate associations between exposure and disease at a given moment and generally do not establish definitive cause-and-effect relationships. They often underestimate an association between exposure and disease, since affected workers often quit and permanently leave exposed jobs that cause health problems. In long-latency diseases such as those that may possibly develop across a diving career, cross-sectional studies are also problematic: They neither capture initial health states nor account for intervening, nonoccupational exposures. Finally, surveys such as this one that rely on self-reported data may suffer from "recall bias": Worker-subjects with poor health are more aware of their exposure history than are workers who have never had health problems, and such bias results in overestimating the association between exposure and disease.

Cross-sectional studies can, however, identify occupational groups or job categories that are at substantially increased risk for adverse health outcomes, and they can thus inform future longitudinal studies and perhaps also suggest strategies for preventing such outcomes. For these reasons, the study design was chosen as an appropriate initial step in characterizing whether U.S. Navy saturation or experimental diving may have contributed to adverse health outcomes.

SUBJECT SELECTION, CLASSIFICATION, AND IDENTIFICATION

The study population was drawn from 5,422 retired and currently active duty U.S. Navy officer and enlisted divers who performed Navy-sponsored diving at any time between 1 January 1960 and 31 December 1990. The diving categories of interest were saturation, experimental, saturation combined with experimental, and fleet working divers. These categories were defined as follows:

1. Saturation Diver (SAT; n=80): any diver who performed any in-water or chamber simulation dives (excluding hyperbaric medical treatments and lasting longer than 24 hours), and who did not meet the criteria for Experimental Divers.
2. Experimental Diver (EXP; n=133): any diver who performed any in-water or chamber simulation dives involving formal testing of medical, physiological, and psychological procedures (e.g., dives involving decompression tables, oxygen exposure tables, thermal exposure guidelines, depth limits for narcosis) under the aegis of NEDU, Naval Submarine Medical Research Laboratory (NSMRL), or Naval Medical Research Institute (NMRI) — and who did not meet the criteria for Saturation Divers.
3. Saturation/Experimental Diver (SAT/EXP; n=145): any diver who met the criteria for **both** SAT and EXP Divers.
4. Fleet Working Diver (FLT; n=5,064): any diver who performed any in-water or chamber simulation dives using standard U.S. Navy diving tables (including exceptional exposure tables) and *U.S. Navy Diving Manual*[40] procedures (including testing and evaluation of equipment and equipment procedures) during a mission — and whom the records search did not identify as having participated in either saturation or experimental dives.

These four categories were intended to separate the effects of saturation diving from the effects of experimental diving, as well as to investigate dose-response trends comparing divers who did both types of diving. From previous research, it was hypothesized that the majority of saturation divers were likely also to have been experimental divers. Furthermore, many of the systematically manipulated diving-related stressors (e.g., decompression, noise, temperature extremes) are common to both saturation and experimental diving. And, since the number of saturation divers not also performing experimental dives might be too small for effective analysis, these subjects might possibly be merged into the SAT/EXP group. This decision was made after all the surveys were returned and the total number in each group was fixed, but before any formal analysis was begun. The goal was to include as many exposed divers as possible, in order to minimize “the healthy-worker survivor effect” (where

currently employed population members look healthier than those who, having had the most serious work-related illnesses, have left work).

Permissions were received for contacting only Navy retirees and active duty divers. The names of SAT, EXP, and SAT/EXP divers were gathered from record searches of diving logs and dive medical records originally maintained at NMRI, EDU, NEDU, NSMRL, and Submarine Development Group One. Names of FLTs were obtained from the Defense Manpower Data Center (DMDC).

To participate in the study as a SAT, EXP, or SAT/EXP diver, documentation of the subject's diving had to be found during the records search: No other recruitment or self-referral was permitted.

In the absence of both full names and Social Security numbers (SSNs), additional information (dates of birth, ranks/rates, Navy Enlisted Codes, and dates and types of dives completed) was gathered from the logs to help confirm identities. A list of all U.S. Navy divers who served between 1972 (the first year included in the DMDC database) and 1990 (the last year included in the study) was obtained from the DMDC. This DMDC information included diver names (last and first, with middle initials), dates of birth, ranks/rates, current military statuses (active, retired, or separated), and SSNs. However, those divers whose participation was documented in the diving logs but for whom no DMDC information was available still remained. For such divers, efforts were made to identify and obtain their full names and current mailing addresses through NEDU personnel who were personally familiar with and had remained in contact with them through various diver networking activities and alumni organizations.

Information from these last sources was combined into a database, and a request was submitted to the National Institute for Occupational Safety and Health (NIOSH). NIOSH served as the gatekeeper for health and safety-related information requests in the Internal Revenue Service (IRS) databases. To obtain the full names and current mailing addresses of divers from the IRS, NIOSH granted approval and provided the requested information from the IRS. This information was then used to address the invitations to participate in the study.

THE SURVEY

The survey (Appendix A) was a modified and augmented version of a questionnaire adopted from the 2004 University of Aberdeen study of North Sea divers for the United Kingdom Health Science Executive, a study examining the long-term health impact ("ELTHI")[34] of diving and directed at commercial divers and offshore workers. With the permission of the ELTHI authors, the present survey includes many identical or similar questions, with some modified for the U.S. Navy diving population and its experience. This approach was expected to facilitate a comparison of results between those from the present study and those from the ELTHI.

The Navy diver survey captured basic demographic, lifestyle, and education data, as well as occupational history information that included some diving exposure history. In addition, three standardized survey instruments were incorporated into the final Navy version. The International Physical Activity Questionnaire (IPAQ) was used to evaluate current levels of physical activity.[41] The Cognitive Failures Questionnaire (CFQ) — which has been shown to correlate significantly with other cognitive factors such as distractibility, specific memory for names, and spatial/kinesthetic memory[42,43] — assessed self-reported failures of memory, perception, and motor behavior. The third standardized survey incorporated the Standard Form 12 (SF-12; licensed for the present study from QualityMetric Health Outcomes Solutions [Lincoln, RI]) is an established and validated general survey of health-related quality of life. Not disease-specific, it reliably captures the effects of mental and physical disease and identifies clinically meaningful differences between groups.[44] The Physical and Mental Component Scores from the SF-12 can also be compared to established population norms.

PROCEDURES

Study and Human Use Approvals

Requesting "exempt" status per the definitions in 32 Code of Federal Regulations 219, Section 101, paragraph (b) (3) (ii) regarding surveys conducted under the protection of Federal privacy regulations, the study protocol was submitted to the NEDU Institutional Review Board (IRB) for the protection of human subjects. The IRB initially agreed with the exempt determination. However, when the protocol with supporting documents was forwarded to Dr. Jane Styer, the DMDC Exempt Determination Official, the DMDC requested that the package be resubmitted through the NEDU IRB for full review and then resubmitted to DMDC for approval. Both IRB and DMDC approvals were subsequently granted.

The protocol and survey were then forwarded for approval to the Navy's survey coordinating office, the Navy Survey Resource Center, according to current Navy policy for surveys being distributed to Department of Navy personnel.[45] Its approval was also obtained.

Piloting of Survey

On two occasions at NEDU, the complete, integrated Navy survey instrument (i.e., the ELTHI modification, the IPAQ, the CFQ, and the SF-12) with printed instructions was piloted with former and current Navy divers (total n=16) whose ages and experiences represented those of the subject categories. This survey of the pilot group, a mix of active duty and retired divers who work and live near NEDU, was distributed and completed on site at NEDU in a conference room setting. Completion times for this pilot survey were recorded, and when all respondents were finished, the groups were reconvened to elicit feedback on its length, the clarity of its questions, its ease of use, the completeness of the topics it surveyed, and the problems encountered. The

Principal Investigator (PI) reviewed the surveys to identify questions with systematic problems (e.g., missing, incomplete, or misdirected responses). These steps generated some questions on survey content and some structural modifications to enhance clarity and understanding.

Study Materials and Handling Procedures

To address inquiries of an administrative or procedural nature, the PI fielded subject inquiries about medical, health care, legal, or study methodology and findings, and internal databases were created to establish and track processing steps for each diver participating in the study. As the invitation-to-participate package was prepared, the electronic tracking database was updated and backed up to the project-dedicated, nonnetworked computer. An external hard-drive backup was also created and locked in a safe, the combination to which was known only by the PI and the Associate Investigator (AI).

After contracting with the Defense Automation and Production Service (DAPS) in Pensacola, FL, to print and mail all study materials to potential and subsequently enrolled subjects, NEDU provided DAPS with formatted files of diver names and addresses to which initial invitations to participate were to be mailed. This mailing included a cover letter from NEDU's Commanding Officer, an accept/decline participation form, two consent forms (one of which the subject was to retain), and a franked return envelope. Divers could clearly mark their decisions to participate by returning a signed consent form or by returning the accept/decline participation form. A second mailing of the invitation was sent six weeks later to those potential subjects who had not yet responded to the invitation. Divers who declined or did not respond to the second invitation were not subsequently contacted. The PI addressed each inquiry generated from the invitation mailing by phone, by E-mail, or in person.

When NEDU received the subject's consent form, the diver's decision to decline or to participate was entered into the database. The signed and witnessed consent form — reviewed, signed, and dated by the PI — was then filed, as the subject was officially enrolled in the study. Subjects were subsequently withdrawn from the study if, at any time, they indicated that they were no longer willing to participate — or if evidence of fraudulent responses to survey questions was credible.

Within six weeks, all divers who had consented to be enrolled were then mailed a survey packet in a first mass mailing. Enrolled subjects who did not respond to this initial survey mailing received a second one 21 days later; if necessary, a third mailing was made after yet another 21 days had passed without NEDU having received a response. These second and third mailings were made to preclude nonresponses due to lost or misdirected mail. The third mailing was also planned to address possible response bias by allowing responses between the first and third mailings to be compared. This plan was based on the supposition that, if the study had been limited to one or two mailings, those individuals replying to the third mailing would have been nonrespondents.

Enrolled subjects were assigned a unique four-digit subject number that was then incorporated into the identification (ID) numbers assigned to each survey mailed to them. Each survey ID consisted of six digits: the first digit indicating the subject's dive group (1–4); the second digit, the survey mailing (1–3); and the last four digits, the subject's unique subject number (0001–5000). The sole identifiers on all survey instruments were the unique ID numbers, and a single master file with the key to subject identifiers was maintained in a password-protected database on nonnetworked computers.

Even before the survey had been sent, DAPS had bar-coded the survey pages and printed each subject's survey ID (without personally identifying information) on the document. When the subject returned the completed survey to NEDU, privacy complications were thereby minimized. A chain of custody procedure — including completed surveys being secured after having been logged in as received — was thus established for all returned surveys.

Upon receipt of the survey at NEDU, quality assurance procedures were used to assess the completeness and appropriateness of survey data. The survey's receipt date was logged, a technician visually scanned it to ensure its integrity, and all of it was electronically scanned into a PDF format and filed electronically at NEDU. The last page of the survey, the free-response page, was removed after being scanned, reviewed by the PI, and retained by NEDU. The remaining pages were hand delivered to DAPS for data scanning and scoring. While DAPS was scanning and scoring these pages, NEDU concurrently used the scanned PDF survey images to manually enter the data into an Access database for those questions that had required the subject's written responses. Finally, after DAPS had scanned the surveys, it returned a formatted file of the scanned data to NEDU, where that file was then merged with that manually entered data that NEDU had compiled. This merged data provided the foundation for the survey analyses.

All surveys received by the deadline date had been scanned and entered into those DAPS and NEDU databases. Duplicate surveys resulted when some divers returned more than one survey form — a response that sometimes occurred when NEDU had not yet received a previously sent form by a deadline date and those divers eventually completed and returned a second (or third) form that had been mailed to them. The first survey sent to the diver, if it was returned by the study deadline, took precedence. In some cases when NEDU received more than one survey from the same diver, *missing numerical data* from the first survey were supplemented with data from the second or third surveys. For example, if "year of birth" had been missing from the first mailed survey but was included in the diver's responses on the second survey, that information was entered into the database. *No changes to existing data already recorded* from the first survey were made, even if different data were reported on subsequent surveys from the same diver. Duplicate surveys were then deleted from the database.

Data cleaning and quality assurance procedures were devised and run to discover and address various problems: multiple responses where only one was expected; handwritten responses that were illogical (e.g., first Navy dive: 2007; last Navy dive: 2002), illegible, or contradictory to those given in bubbles; extraneous responses (e.g., written in freehand next to printed-response categories); or bubble marked responses that were faint, outside the bubbles, erased, or crossed out.

Data audits were conducted to ensure proper manual data entry. As identified by entries in the free-response sections or responses comprising significant outlying data, surveys presenting cases of interest were set aside for possible close examination of respondents' diving and medical histories.

Survey entries manually compiled in a database were backed up daily to a clearly identified, password-protected compact disc (CD) and the secured project safe. To minimize accidental physical damage to both the computer and backup CD, daily backup CDs were stored in a secure site away from the computer.

The master list of divers — which contained names, SSNs, and unique subject IDs — was backed up on a CD, labeled, and filed in the NEDU vault so that it was accessible to a list of people whom the PI had designated as approved.

For returned surveys marked *undeliverable,* the post office's reason for that designation was noted, and a log entry was made in the database. The next step was to verify that the address from NEDU records was indeed correct. If a telephone number could be obtained, the subject was called to verify the address. Then the survey was resent to that verified address, and the second mailing date was noted. If the address was indeed incorrect and no other address was available, the description of the problem, the decision about what to do, and the date were noted in the database and tracking log. No further actions were taken on the matter.

For returned surveys that were *incomplete*, the PI evaluated the amount and the criticality of the missing information. For instance, if one or more pages were physically missing, that omission might indicate an inadvertent packaging error at either end of the process. When information that was *incorrect* was returned, these surveys were examined to identify whether the data also raised other flags. For example, an obvious patterning or omission of responses might indicate a lack of motivation or a failure to understand instructions. In such cases the PI, AI, and associated team members discussed the validity of such data and determined whether to include it in the survey.

Archiving of Results

Upon completion of this study, all relevant supporting documents were recorded on CDs and delivered to the NEDU Library. To ensure that all these files can be read and interpreted in the future, the PI cited the software applications (with version numbers) used to create them.

Permanent storage of database survey responses and team materials, including protocol and human use approvals, were also archived in the NEDU Library. Original paper copies of the surveys were to be destroyed, but only after the data they contained had been entered into the database, the database had been backed up and stored in a secure setting, electronic copies of the scanned surveys had been labeled and archived, and both this report and an article had been subsequently published in a peer-reviewed journal.

Disclosure of Information from This Study

The use of information and subject data from this study is governed by the guidance found in NEDU Instruction 3900.2A, "Protection of Diver-Subjects," and in Secretary of the Navy Instruction (SECNAVINST) 5510.36, Chapter 8, under "Controlled Unclassified Data." (Both of these instructions are available in the NEDU *Project Officer and Principal Investigator Handbook* on CD.) The Privacy Act of 1974, 5 U.S.C. Section 552 applications to this study also include the following basic provisions (summarized here):

- Section (b), Conditions of disclosure.
  Disclosure of records may be to those employed by NEDU (including contractors employed by the agency) who have a need for the record in the performance of their duties; disclosure to other individuals or agencies may be granted only pursuant to a written request.
- Section (c), Accounting of certain disclosures.
  NEDU will keep an accurate accounting of disclosures made as a result of a written request by persons outside the agency.
- Section (d), Access to records.
  Individuals and one other person of their choosing may review their particular record and have a copy made, request an amendment to the record, and appeal a decision to amend.
- Section (e), Agency requirements.
  NEDU is required to
    - Maintain records only of that individual information which is relevant to accomplish the purpose of the study;
    - Inform each individual, in writing, of the authority by which the data collection is authorized, of the principal purpose for which the data is to be used, of the routine uses to be made of such data, and of the effects on the individual who chooses *not* to provide all or any part of the requested information.
    - Enforce rules of conduct for persons involved in this system for maintaining and using records.

This study also is under the aegis of the following instructions that apply to the use of human subjects in all research conducted by naval activities or personnel — and in the development, testing, or evaluation of any piece of equipment or other material, even if such personnel are not the direct objects of the research: Bureau of Medicine and

Surgery Instruction 3900.6B, dated 4 October 2001; and SECNAVINST 3900.39C, dated 25 February 2002.

Statistical Procedures

IBM® SSPS® Statistics Version 19 software was used to analyze the data. Response data were categorized (e.g., nominal, ordinal, interval, ratio), and descriptive statistics (measures of central tendency and dispersion) were calculated for all ratio data. To detect differences among the four diver groups, both parametric and nonparametric tests were used. For nominal and ordinal category responses, Pearson's chi-square was used to test for significant differences between expected and observed frequencies. For interval and ratio data, general linear model univariate between-groups analyses of variance (ANOVA) were performed. Levene's test for homogeneity of variance was used to test for equal variances, and appropriate post hoc test statistics (either Bonferroni or Games-Howell) were chosen. Correlation analyses were performed with Pearson's r or Spearman's rho tests. Significance was set at $\alpha = 0.05$, two-tailed.

Graphic and tabular presentations of data were constructed to facilitate comparisons with findings from the ELTHI study.

For assessing possible response bias, completed surveys returned only after the third mailing were compared to a similar number of those among the first returned to NEDU from the initial survey mailings.

RESULTS

The number of diver surveys included in the following analyses is 1,490. Since not all divers answered every question, the number of responses used in calculating the summary statistics for any question may be less than the total. Moreover, some questions allowed for more than one response, so the total percentage may exceed 100%. In the narrative, percentages are rounded to the nearest whole number. In the tables, data are presented for all divers and further broken out for each diver category. For variables where the diver category numbers were too small to analyze, only numbers for the overall diver group are presented. Nonsignificance = "n.s.," while significant results are represented by the actual probability values. The results of post hoc comparisons are presented in the text. Areas of statistical significance are highlighted.

Response Rate (Table 1)

To have their surveys included, respondents must have been either

1. Retired military who had served at least 20 years with survey-response evidence of having been a Navy diver, or who gave evidence that they had been divers

and indicated that they were *medically retired or medically separated* with 18 or more years on active duty, or
2. Active duty (neither retired nor separated from the Navy) personnel, with evidence of being Navy divers.

Sixty-five surveys from individuals who did not meet these two criteria were removed from inclusion in the study, and 5,422 divers were identified as being eligible for participation. Confirmed contact was made with 45% (n=2449), and 33% (n=1792) agreed to participate. After those who failed to meet the study criteria had been excluded, 28% (n=1490) had their surveys used in the final analyses. Table 1 presents the results of the selection methodology.

Table 1. Contact Distribution and Final Sample Size

	All Divers	**Saturation Divers**	**SAT/EXP Divers**	**Experimental Divers**	**Fleet Divers**
Divers Mailed Invitations	5,422	80	145	133	5,064
Divers Returning NEDU Invitations (confirmed contacts)	2,449 **(45%)**	46	79	69	2,255
Divers Excluded from Study	3,630	45	76	80	3,429
Deceased	5	0	0	0	5
Missed Invitation Deadline	336	6	5	9	316
Declined to Participate	221	3	5	5	208
Did Not Return Invitation	2,973	34	66	64	2,809
Other (Including Undeliverable)	95	2	0	2	91
Divers Who Agreed to Participate (enrolled)	1,792**(33%)**	35	69	53	1,635
Divers Mailed Surveys	1,792	35	69	53	1,635
Divers Returning Surveys	1,620	30	62	51	1,477
Surveys NOT Returned	172	5	7	2	158
Divers Missing Survey Deadline	65	0	2	2	61
Surveys Removed from Analysis (did not meet study criteria)	65	0	2	1	62
Surveys Used in Analyses	1,490	30	58	48	1,354
Final Participation Rate (Mailed invitations ÷ surveys used)	**27.5%**	**37.5%**	**40.0%**	**36.1%**	**26.7%**

Response Bias (Table 2, Appendix B)

The characteristics of, and the reasons for, divers not participating in the study are unknown. One may hypothesize that divers returning surveys only after the third mailing would not have responded if they had not received that third mailing. If so, then this late-responding group may be similar to those who never responded. To determine whether the characteristics of those who responded early on significantly differed from those 120 divers who responded only after the third survey was mailed, the responses to several questions were compared. To generate an equivalent early-responder group, the first 120 divers who had responded to the initial survey mailings were identified. Those first 120 divers who had responded were significantly older ($\bar{X}$ age = 57.4) than those who responded only after the third survey had been mailed ($\bar{X}$ age = 53.6; F [1, 235] = 14.38; p=.000). As shown in Table 2, no significant differences between the groups appeared on the highest educational level, receipt of disability compensation, current smoker status, binge drinking, and Health-Related Quality of Life scores from the SF-12 portion of the survey.

Demographic Characteristics (Table 3, Appendix B)

<u>All Divers</u>

Survey respondents were 1,475 male (99%) and 15 female (1%). Active duty members totaled 8% (n=111) of the sample; Retired from Active Duty, 92% (n=1371); and Retired from the Reserves, three divers. Those three who had retired from the reserves were combined with the Retired from Active Duty divers for any analyses concerning retired personnel only or comparing active duty with retired divers. Five divers did not respond to the question on their current military status.

Average, median, and modal ages of the divers were 55.6, 55, and 51, respectively. Divers ranged in age from 39 to 82, with the highest proportion in the age 50–53 range. The military retirees' average age was 55.4.

On average, the divers were 70.5 inches tall (mode, 70 inches; range, 56–83 inches), and weighed 202 lb (mode, 200 lb; range, 112–360 lb). Female divers were significantly shorter [$\bar{X}$ = 66.3 inches; F (1, 1480) = 38.2; p=.000] and lighter ($\bar{X}$ = 168 lb; F (1, 1483) = 17.49; p=.000) than the males.

Hispanic or Latino divers comprised 3% of the respondents (n=39). Racially, 97% of divers classified themselves as White, 4% as American Indian / Alaska Native, 1% as Black / African-American, 0.5% as Asian, and 0.5% as Native Hawaiian / Pacific Islander. Since this question allowed multiple responses, the percentage totals reflect that.

All divers had completed high school, and 90% had continued their educations to the college level. Moreover, one in four reported having completed a master's or a doctorate degree.

Among Diver Groups

All female divers were in the fleet diver category.

Differences in age among the four groups were significant [F (3, 1470) = 4.86; p=.002], with both SAT and SAT/EXP divers averaging approximately three years older than FLT and EXP divers. The SAT/EXP divers were significantly older than the FLT divers (p=.005).

The FLT group contained the highest percentage of nonwhites at 3.6%; 100% of both the SAT and the EXP groups identified themselves as White. Ten percent of the SAT group also provided a second identification of American Indian or Alaska Native racial ancestry.

Lifestyle Characteristics (Table 4, Appendix B)

All Divers

Married divers constituted 87%; divorced or widowed, 11%; and never-married, 1% of the participants.

Most divers (91%) lived with their partners or families; only 8% lived alone.

Seventy-eight percent of the divers were employed full- or part-time; 19% were retired, and 3% were unemployed. To determine the employment status of the military retirees only, the active duty members were subtracted from the sample, and the analyses were rerun. For military retirees only, 76% were found to be employed full- or part-time; 20% were retired, and 4% were unemployed.

During the age range from 20 to 40, nearly 94% of all divers engaged in moderate or heavy regular physical training regimens.

Disability compensation was being received by 60% of the divers: 83% of them reported compensation from the Veterans Administration; 19%, from the Navy; 5%, from other government sources; 0.5%, from private insurance; and 0.7%, from other sources. Since this question allows multiple responses, the total percentages reflect that.

Divers reporting that they had left work with a chronic illness or injury represented 14% of the respondents.

Almost all divers (98%) indicated they have some kind of medical insurance or coverage.

Among Diver Groups

SAT (67%) and SAT/EXP (71%) divers reported having been on disability at percentages higher than the overall average (60%). Findings for those having left a job injured or due to illness were similar.

As shown in Figure 1, employment status was significantly different [χ^2 (9, n=1,467) = 18.10, p=.034] among the groups. SAT divers had much higher rates of being employed full-time than did the SAT/EXP divers (i.e., 83% vs. 51%). Similar results were also obtained for retirees only [χ^2 (9, n=1,353) = 18.66; p=.028], among whom 82% of the SAT divers were employed full-time, whereas only 48% of the SAT/EXP divers were.

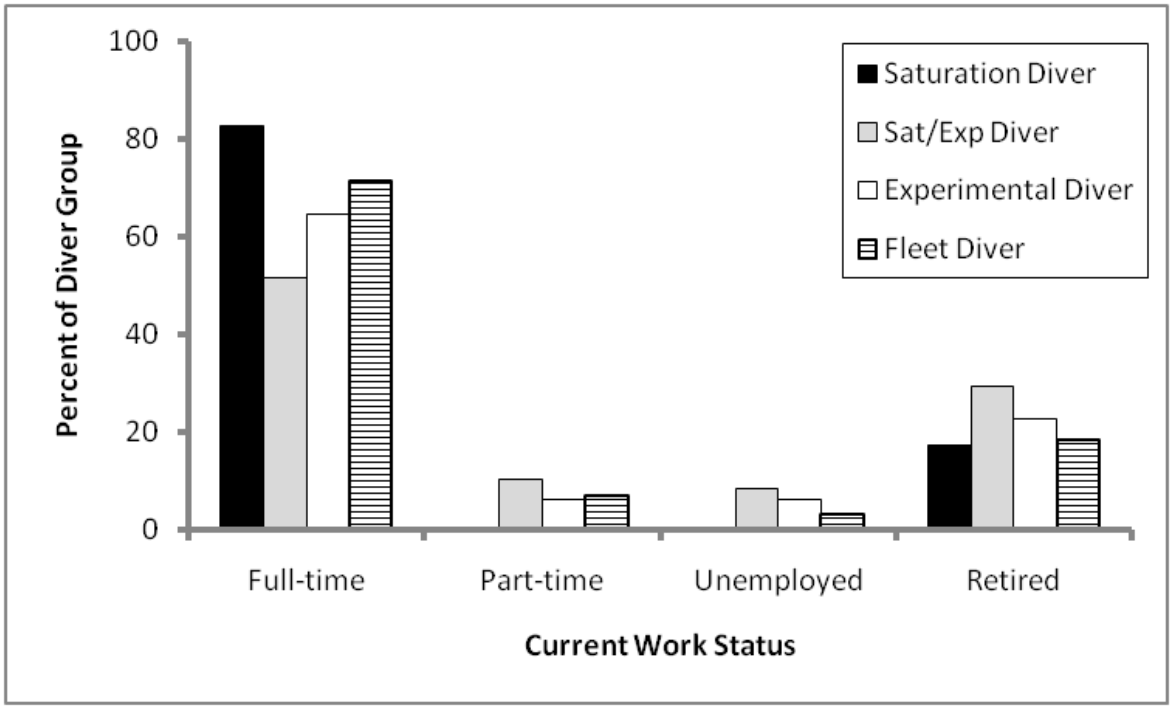

Figure 1. Current work status among the dive groups.

Tobacco and Alcohol Use (Table 5, Appendix B)

All Divers

Forty-five percent of surveyed divers reported that they had smoked more than 100 cigarettes in their lifetimes. Divers classified themselves as Nonsmokers (55%), Ex-smokers (37%), and Current smokers (8%). Current smokers have been smoking for an average of 32 years and smoke an average of 15 cigarettes a day. Ex-smokers had smoked an average of 18 cigarettes per day for 14 years before they quit.

Binge drinking was defined as having six or more drinks ("one drink" comprising one 12 oz beer, one 5 oz glass of wine, or a 1.5 oz shot of 80-proof distilled spirits) on any one occasion. During the past 12 months, most Navy divers (51%) had never consumed six drinks or more on any one occasion. Conversely, 10% of divers reported having six or more drinks on 10 or more occasions each month, with 3% reporting more than six drinks on more than 20 occasions per month.

Of their distant past alcohol consumption, the majority (54%) of Navy divers said that they had consumed more alcohol than they had in the last 12 months. During that distant period, 51% endorsed having six or more drinks on 10 or more occasions per month. The answers given most frequently to the questions of how many years ago this heavy drinking had occurred were 20 years ago (17%); 25 years ago (9%); and 10 years ago (9%).

Among Diver Groups

Among Ex-smokers, significant differences existed in the number of cigarettes smoked per day [F (3, 535) = 2.64; p=.049]. Among these Ex-smokers, EXP divers smoked significantly fewer cigarettes ($\overline{X}$ = 13.5) than both SAT ($\overline{X}$ = 21.7; p=.044) and SAT/EXP divers ($\overline{X}$ = 21.9; p=.012) smoked.

Navy Characteristics (Table 6, Appendix B)

All Divers

A review of diving logs and personnel records shows that those divers who performed *only* standard Navy fleet working dives comprised 91% the study participants. Divers who performed working and saturation dives comprised 2%; those who performed working and experimental dives comprised 3%, and those who performed working, saturation, and experimental dives comprised 4% of the participants.

Divers served an average of 23.6 years on active duty, ranging from 6 years (for one diver who had medically retired) to 43 years. No significant differences in years on active duty were evident among the diver categories.

In the study group consisting of both Retired (92%) and Active duty (8%) divers, the ranks of the study group were Enlisted (60%), Warrant Officer (5%), and Commissioned Officer (35%). Highest pay-grades attained ranged from E-4 (n=2) to O-9 (n=1). Chief Petty Officers (E-7 through E-9) accounted for 51% of all divers.

Among Diver Groups

Divers retired from the reserves (n=3) were only in the FLT group, and the pay grades of E-3, E-4, O-1, and O-2 were found only in the FLT group.

SAT divers included more retirees (96.7%) than did any of the other categories.

Diving History (Table 7, Appendix B)

All Divers

In reporting the different types of diving they had done, 5% of the divers marked saturation and working dives; 19 % marked saturation, experimental, and working dives; 13% marked experimental and working dives; and 52% marked only standard dives. Eleven percent marked the category "None of the above."

Divers had completed their initial dive training at an average age of 23.5; the youngest age for completion (presumably for non-Navy training) was at age 14, and the oldest was at age 47.

While on active duty, divers spent an average of 18.4 years diving (range, 1–40 years). On average, they had performed their first Navy dives 32 years ago (1978); the most recent of such dives was 13 years ago (1997). The earliest first Navy dive among the surveyed subjects was 59 years ago (1951). When diving outside the Navy, they had performed their first dives slightly earlier ($\bar{X}$ = 33 years) than they had their first Navy dives. And they had performed their most recent non-Navy dives slightly later ($\bar{X}$ = 11 years) than they had performed their first Navy dives.

When the first and last dive dates from the Navy and Non-Navy columns in Question 3.2 had been selected, the average total years of diving for all divers was calculated to be 24.

When asked if they had maintained records of dives, 46% said that they had records of their Navy dives, while only 21% said that they had kept their non-Navy dive records.

Almost all divers (91%) reported that their Navy diving had ended permanently, and 48% also indicated that they had stopped diving outside the Navy.

Among Diver Groups

The study's dive groups differed significantly in reporting the types of diving they had accomplished (Question 3.1; [χ^2 (12, n=1,488) = 163.08, p=.000]).

Total years of diving on active duty differed significantly among the groups [F (3, 1478) = 5.34, p=.001]. Active-duty FLT divers averaged two fewer years of diving (18.2) than the other diver categories had averaged ($\bar{X}$ = 20.2 years), and this difference approached significance in comparison to that number for the SAT/EXP divers (p=.057).

The age at which the initial dive training was completed also differed significantly among the groups [F (3, 1479) = 2.80, p=.039]: When FLT divers had received their initial training, they were significantly older than both the SAT/EXP (p=.045) and the EXP divers (p=.032).

The dive groups also significantly differed in how long ago they had made their first Navy dives [F (3, 1459) = 7.29, p=.000]. SAT/EXP divers had made their first Navy dives significantly earlier ($\bar{X}$ = 36 years) than FLT divers ($\bar{X}$ = 32 years; p=.000).

Similarly, dive groups differed in the number of years since their first non-Navy dives [F (3, 999) = 4.19, p=.006]. SAT divers had made their first non-Navy dives significantly earlier ($\bar{X}$=39 years) than both EXP ($\bar{X}$ = 32 years; p=.045) and FLT divers ($\bar{X}$ = 33 years; p=.006).

To determine total years of Navy and non-Navy diving experience among the dive groups, the earlier of the dates for the first dive was subtracted from the later of the dates for the last dive to obtain the total number of diving years for each diver. Figure 2 illustrates that SAT divers averaged 28 years; SAT/EXP divers, 26 years; and EXP and FLT divers, 24 years.

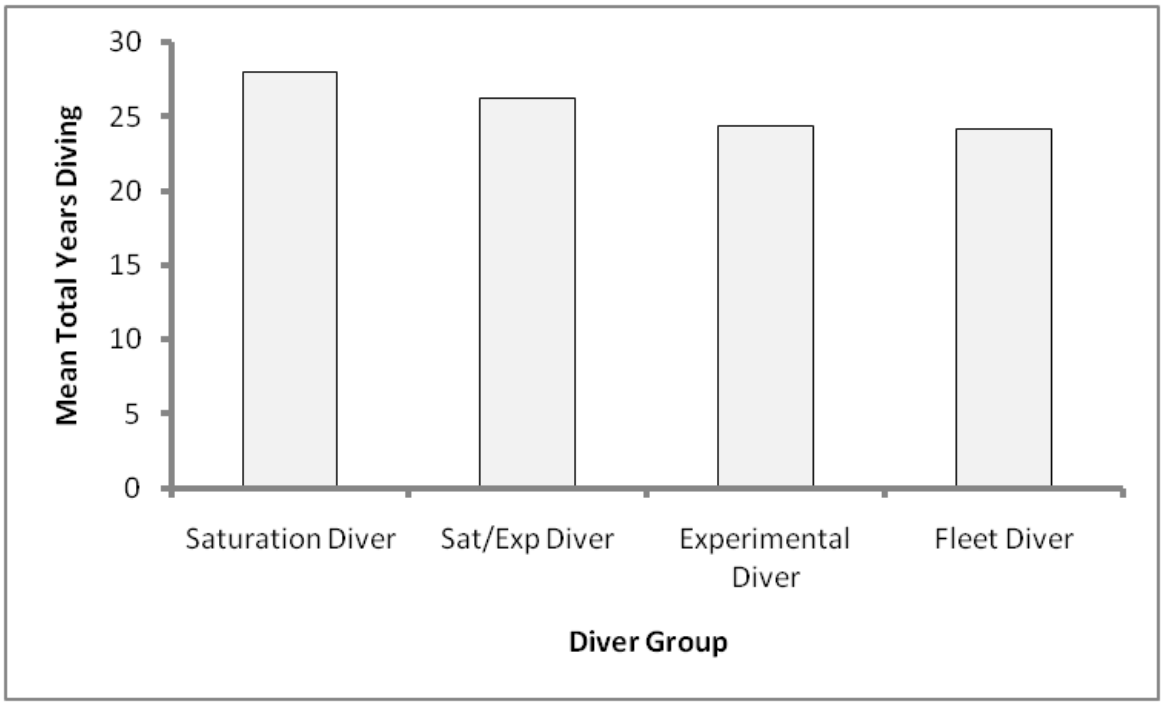

Figure 2. Total Navy and non-Navy diving years of experience among dive groups.

Number and Types of Diving Accomplished (Table 8, Appendix B)

All Divers

Navy diving. For no-decompression diving, most divers (42%) reported that they had performed between 101 and 500 dives; 24% reported between 501 and 1000 dives, and 16% performed more than 1,000 dives. Most divers reported having completed up to

100 dives using decompression (with or without having used surface oxygen for decompression). SAT diving was reported by approximately one in four of the respondents.

Non-Navy diving. Diving outside the Navy was prevalent, as 84% indicated. The majority (52%) accomplished up to 100 no-decompression dives, and 50 divers reported having completed >1,000 such dives. Less than one in four divers (approximately 23.4%) had performed decompression diving outside the Navy, however, and <1% had performed SAT diving outside the Navy.

Among Diver Groups

FLT divers were the only group whose members reported having accomplished 1,000 or more Navy or non-Navy decompression dives. It was also the only group with divers (n=11) reporting that they had performed non-Navy SAT dives.

The four groups significantly differed in the number of Navy dives accomplished with Air or Mixed Gas Decompression [χ^2 (12, n=1433) = 27.36, p=.007], Air or Mixed Gas Surface Decompression with oxygen [χ^2 (12, n=1388) = 30.40, p=.002], and SAT diving [χ^2 (12, n=1361) = 184.75, p=.000]. The percentage of FLT divers who reported having performed SAT dives, dives using Surface Decompression with oxygen, and >100 Air or Mixed Gas Decompression dives was far less than the percentages for other three groups.

Diving Injuries and Treatments (Table 9, Appendix B)

All Divers

One in five Navy divers experienced pain-only decompression sickness, and one in seven experienced neurological DCS. Fourteen percent of the divers reported contaminated gas exposure, and 10% reported compression arthralgia (i.e., aches and pains associated with pressure increases). Nearly 7% (n=100) said that they had loss of consciousness under pressure, a very hazardous condition, and some recounted oxygen poisoning symptoms expressed by seizure (n=37 divers) and lung impairment (n=52 divers). Overall, 41% of the divers indicated that they had experienced one or more of the nine injury/treatment categories in Table 9.

Not all diving-related symptoms were treated, however: One in four divers said that within 24 hours of a dive they had had pain or neurological symptoms for which they had not sought treatment. Moreover, with those symptoms for which treatment had not been sought, 76% (n=280) of the divers said that such symptoms had resolved within one week — and by one month, 90% (n=334) said that their symptoms had resolved. But symptoms did not resolve for 6% of these divers who had experienced pain or symptoms and yet had not sought treatment.

Among Diver Groups

As illustrated in Figure 3, significant differences were found in the percentages of divers who reported having been diagnosed or treated for neurological DCS [χ^2 (6, n=1467) = 13.83, p=.032], pain-only DCS [χ^2 (6, n=1467) = 17.25, p=.008], loss of consciousness under pressure [χ^2 (6, n=1467) = 16.22, p=.013], and compression arthralgia [χ^2 (6, n=1467) = 64.99, p=.000]. More SAT and SAT/EXP divers reported neurological and pain-only DCS than FLT divers. Fewer FLT divers reported compression arthralgia and loss of consciousness under pressure than the other groups reported.

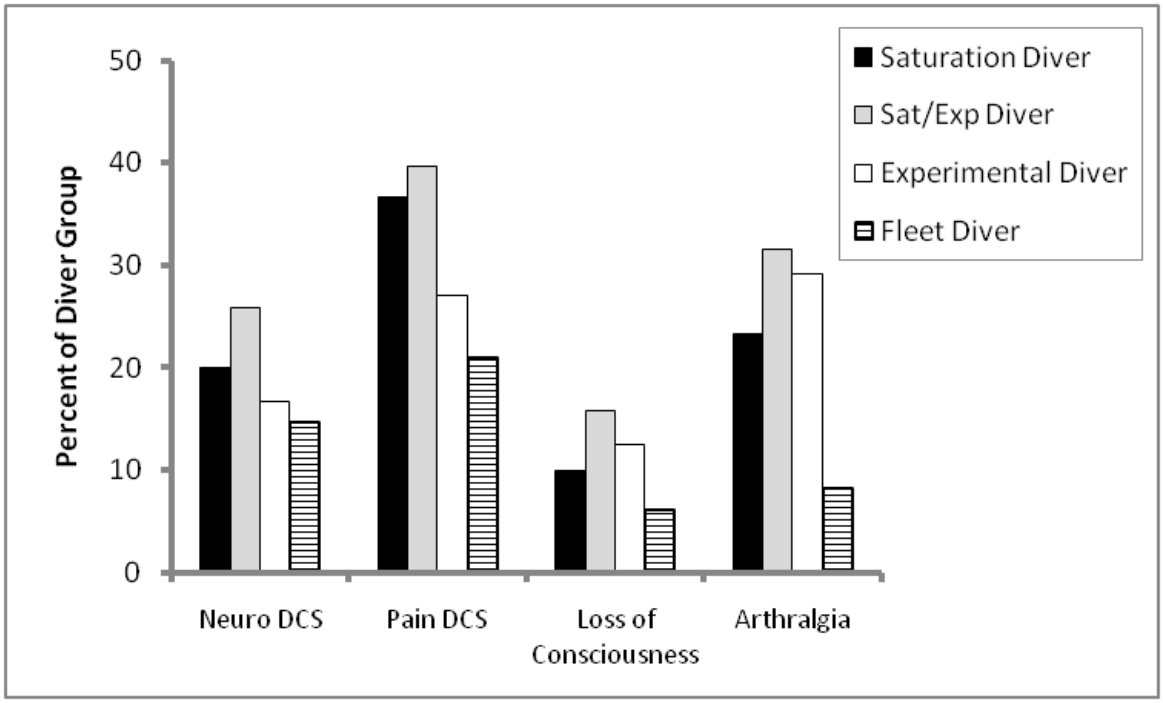

Figure 3. Percentage of dive-group divers diagnosed or treated for dive injuries.

The number of episodes requiring recompression to treat neurological DCS [χ^2 (3, n=1,488) = 8.80, p=.032], Pain-only DCS [χ^2 (3, n=1,488) = 8.13, p=.043], and "Other" maladies [χ^2 (3, n=1,488) = 10.21, p=.017] showed significant differences among the dive groups.

Occupational Exposures (Table 10, Appendix B)

All Divers

On average, divers had had their last medical exams for fitness to work four years before this survey; however, these dates ranged from the 2010 year to 1971. Fifty-four percent of the divers reported having had a lost-time (more than three-day) accident or injury at work. And the majority of survey responders (62%) had been assigned or deployed to a theater of combat operations at some time during their careers.

When divers were asked to rate both their Navy and non-Navy exposures to 11 potentially hazardous factors during their diving careers, more than 90% of them reported that they had been exposed to solvents, radiation, lead, and noise. More than 80% noted their exposures to paints or chromium, asbestos, pesticides, and carbon monoxide. Fifty-eight percent of the divers reported mercury exposures, and >40% noted exposures to contaminated gas and to hydrogen sulfide.

Among Diver Groups

Half of the SAT/EXP divers reported having lost three days of work *more than once* because of an accident or illness at work, whereas only 35% of all divers reported this same work loss *more than once*. Overall, however, no statistically significant differences in occupational exposures were found among the groups.

Welding History (Table 11, Appendix B)

All Divers

Nearly one in three divers (31%) reported having worked as a welder, and of those who welded, 82% had permanently stopped welding at work. These welder-divers, on average, had begun welding 32 years ago (~1978), and had finished their last welding jobs 17 years ago (~1993). Welding work was performed, in total, for an average of 13 years.

Navy welder-divers welded outdoors (80% responded “yes”), in well-ventilated indoor areas (78% said “yes”), and in poorly ventilated indoor areas (54% said “yes”). When asked to estimate the percentage of their time spent welding in different locations, these divers responded that 34% had been spent outdoors, 32% indoors in well-ventilated environments, 15% indoors in poorly ventilated environments, 19% in wet pressurized situations, and 1% in dry pressurized settings.

These welders’ protective breathing gear included simple dust masks (n=145), filter respirators (n=99), and supply respirators (n=120). Most divers (n=377) had used arc welding for the longest total time (an average of nearly 800 days) in their careers. Metal inert gas welding (n=215 divers; $\bar{X}$ = 573 days) and tungsten inert gas welding (n=170 divers; $\bar{X}$ = 532 days) were techniques also used frequently.

Among Diver Groups

More SAT divers (43%) had worked as welders than had those from any other group (overall average, 31%), and SAT divers had also worked between 3.9 and 6.1 years longer as welders than had the divers from other groups.

The dive groups differed significantly in the number of years since they had begun welding [$F(3, 462) = 2.67$, $p=.047$]: Beginning dates for SAT divers averaged 37.7 years ago, compared to the FLT diver average of 31.6 years ago. In addition, the

percentage of divers reporting that they had experienced welding in a dry pressurized environment differed among the groups [χ^2 (3, n=463) = 8.03, p=.045], although the number of positive reports in each group is extremely small.

Welding Injuries (Table 12, Appendix B)

All Divers

While welding, 201 welder-divers (43% of the total) had suffered at least one injury. The most common injury (experienced by 37% of welder-divers) was eye damage, followed by metal fume fever (13%), nonminor burns (11%), and major electric shock (7%).

Among Diver Groups

No statistically significant differences were found among the dive groups.

Medical History (Table 13, Appendix B)

All Divers

Divers were asked to report whether they had regularly suffered from 12 medical conditions. Responses marked either "Moderately" or "Extremely" were aggregated with a previously published scoring schema.[34] By far, the most common medical conditions reported were joint pain/muscle stiffness (63%) and back or neck pain (59%), followed distantly by impaired hearing (39%) and forgetfulness (15%). No other condition was reported by >10% of the divers.

Among Diver Groups

Significant differences were found in the percentages of divers who reported *suffering* from muscle weakness/tremor [χ^2 (9, n=1,476) = 18.46, p=.030] and impaired hearing [χ^2 (9, n=1,484) = 31.58, p=.000]. Instances of muscle weakness/tremor were greater among SAT/EXP divers (21%) than among the entire body of divers surveyed (an average of 10%). Impaired hearing was also more evident among SAT/EXP divers: 72% of that group, as compared to the 39% average for all the diver participants, reported suffering from this condition. Figure 4 illustrates these differences.

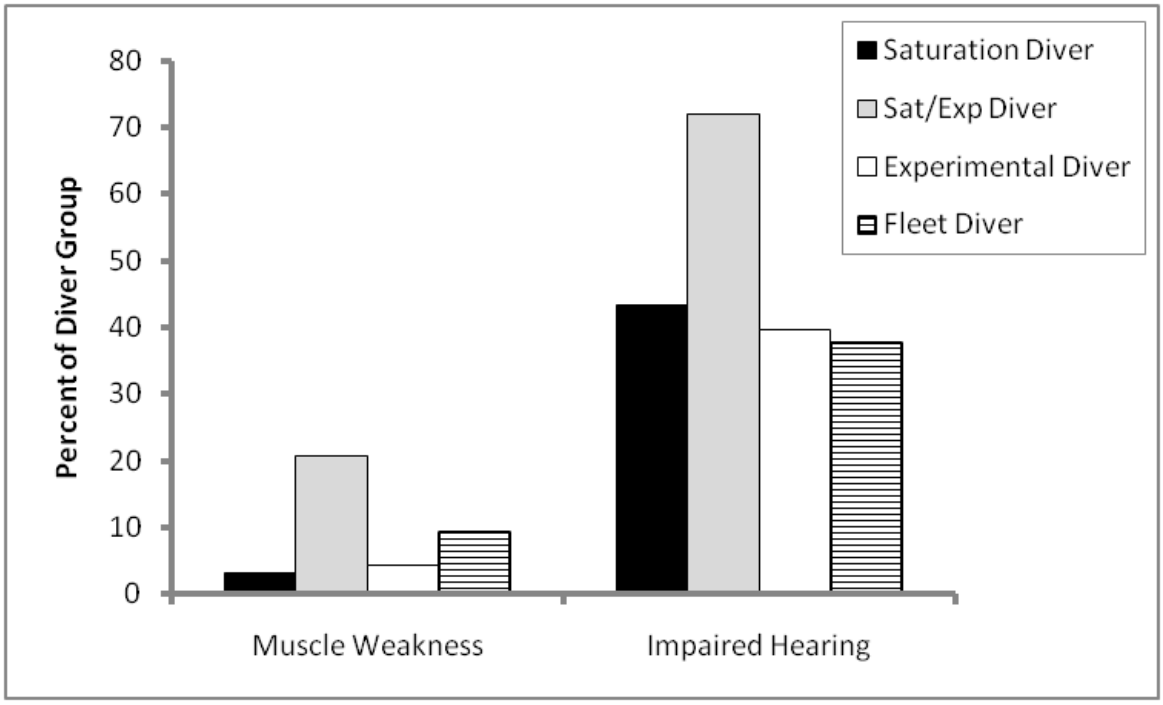

Figure 4. Percentages of dive-group divers suffering from muscle weakness/tremor or impaired hearing.

Medical History Continued: Diagnoses (Table 14, Appendix B)

All Divers

In answering the question on whether they had ever been *diagnosed with* any of 22 medical conditions, divers most frequently named sports injury (65%), arthritis (57%), skin disease (53%), high blood pressure (41%), and allergies or hay fever (40%). Head injury had been diagnosed in 29% of the divers. The least-reported diagnoses included vibration white finger (2%), stroke (2%), and epilepsy (1%).

Among Diver Groups

As shown in Figure 5, statistically significant differences among the dive groups were detected for only two medical conditions. Diabetes [χ^2 (3, n=1,478) = 8.32, p=.040] was reported by 20% of SAT divers, while less than 9% in each of the other dive groups had received this diagnosis. Arthritis or joint disease [χ^2 (3, n=1,473) = 9.24, p=.026] was reported by 56% of FLT divers, whereas a range of 65% to 73% of divers in the other three groups reported these diagnoses.

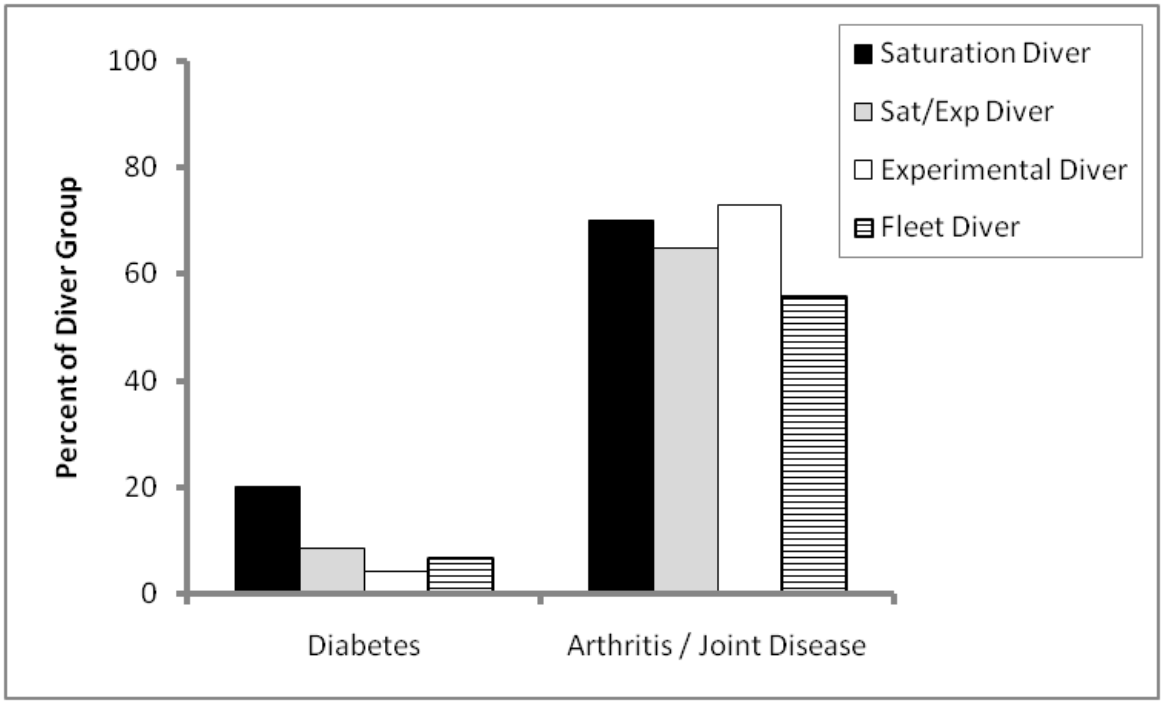

Figure 5. Percentage of dive-group divers diagnosed with diabetes or arthritis/joint disease.

Medical History Continued: Other Lung Disease (Table 15, Appendix B)

All Divers

In the Medical History section of the survey, divers were allowed to write in their responses under the heading "Other lung disease." As Table 15 shows, "Pneumonia" was the most common response (n=19), with "Chronic Obstructive Pulmonary Disease" (n=10) the next most frequently reported.

Medical History Continued: Joint Replacement (Table 16, Appendix B)

All Divers

Divers who had already had a joint replaced, or were scheduled to have one replaced, represented 7% of the survey. The average age at a first joint replacement was 55; the most frequent reason cited for the joint replacement was pain or activity limitations.

When all divers were asked if they had been told that they would need a total joint replacement *in the future*, 23% answered that they would. Within this group needing future replacements, 73% reported that they would need a knee replacement; 22%, a hip replacement; 10%, a shoulder replacement; and 5%, a different joint replacement. This question allowed multiple responses, and the percentage totals reflect that.

Current Physical Activity (Table 17, Appendix B)

All Divers

When asked to use the IPAQ Short Form to supply information on their physical activity over the last seven days, divers responded in ways that allowed them to be classified as populations having High (53%), Moderate (31%), or Low (16%) levels of physical activity during that period. Next, the volume of diver activity was calculated by weighting that individual's type of activity by its energy requirements (MET = metabolic equivalent of the task: 1 MET = 1 kcal/kg/hour, roughly equivalent to the energy cost of sitting quietly). The overall average for the divers was 4,106 MET-min/week.

Among Diver Groups

No significant differences in level of activity were evident among the dive groups, although EXP divers during the past week had expended an average of 31% more energy ($\bar{X}$ = 5,315 MET-min/week) than the FLT divers ($\bar{X}$ = 4,056 MET-min/week) had expended.

Current Physical Activity Continued (Table 18, Appendix B)

All Divers

The average amount of time (in days and minutes) that divers had engaged in vigorous or moderate exercise, walking, and sitting during the last seven days before they had submitted the survey was calculated. Those divers who had exercised vigorously did so an average of 3.6 days per week, for an average of 103 minutes on each of those days. Divers who exercised moderately did so an average of 3.8 days per week, for 118 minutes on each of those days. The divers had walked, on average, 5.2 days a week — and for a total of 102 minutes per day: This included walking to travel from place to place, as well as any other walking done solely for recreation, sport, exercise, or leisure. On average, nearly 6 hours per day (351 min) was spent sitting.

Among Diver Groups .

Compared to the other groups, EXP divers spent the most time (min) in performing vigorous and moderate exercise and in walking. The differences among the groups in time spent sitting was significant [F (3, 1392) = 2.72, p=0.43], with the FLT divers spending an average of 75 min/day more time sitting than the SAT divers spent.

Cognitive Performance (Table 19, Appendix B)

All Divers

The CFQ assessed failures in perception, memory, and motor function. A higher score suggests an increasing difficulty in maintaining attention, recognition, and remembering; a lower score indicates a less perceived difficulty. The mean score for Navy divers was 34.3. For reference, British male skilled workers and production workers have average scores of 36.6 and 35.0, respectively.[42] The average score of North Sea divers was 39.5,[34] 15% higher than the Navy divers' score. Navy diver CFQ total scores were significantly and positively correlated ($r=.620$, $p<0.01$) with their responses to the Forgetfulness/Loss of Concentration item (Question 4.1) from their medical histories.

Among Diver Groups

While SAT/EXP and EXP diver responses ($\bar{X}$=37.5 and $\bar{X}$=36.5, respectively) indicated that they were having more cognitive difficulty than the other two groups, no statistically significant differences were detected.

Overall Health (Table 20, Appendix B)

All Divers

In rating their general health, 86% of the divers said that it was Excellent, Very Good, or Good; only 2% indicated their health to be Poor. Overall, 39% of the divers reported that their health limits them either "a little" or "a lot" in performing moderate activities such as moving a table or playing golf, and 43% similarly reported that they are limited in climbing several flights of stairs.

Among Diver Groups

As illustrated in Figure 6, no significant differences in health ratings were evident among the diver groups.

Figure 6. Current health ratings among the diver groups.

Health Problems (Table 21, Appendix B)

All Divers

Survey responses from the SF-12 in Section 7 were analyzed to learn how general mental and physical health problems were affecting the divers' activities of daily living (ADLs). First, divers were asked to indicate how much their *physical health* had limited them in their work or other regular ADLs during the past four weeks. Fifteen percent responded that they had accomplished less than they would like to have achieved — and were limited in the kinds of activities they had performed either "All of the time" or "Most of the time." Conversely, more than four times as many divers (65%) responded to the same questions with "None of the time" or "A little of the time."

Second, divers were asked to indicate how much their *emotional problems* had limited them in the past four weeks. Seven percent said that they had accomplished less than they would have liked "All" or "Most of the time," and 3% reported having done work less carefully than usual "All" or "Most of the time."

In response to the question about how much pain interfered with their normal work, 38% of the divers answered either "Extremely," "Quite a bit," or "Moderately." Over the immediately preceding four weeks, 63% of the divers had felt calm and peaceful "All" or "Most of the time," and 48% had felt much energy "All" or "Most of the time." Six percent of the divers noted feeling downhearted or depressed "All" or "Most of the time."

And 7% of the divers experienced physical health or emotional problems interfering with their social activities “All” or “Most of the time,” while 77% reported having such feelings “None” or “A little of the time.”

Among Diver Groups

The percentages of divers reporting pain interfering with their normal work [χ^2 (12, n=1,486) = 23.69, p=.022] differed significantly among the dive groups. As seen from Figure 7, SAT/EXP divers reported degrees of such interference being at the highest levels of “Quite a bit” and “Extremely” (34.4%); SAT diver (13.3%) and FLT diver (17.8%) responses were much less pronounced at these same levels.

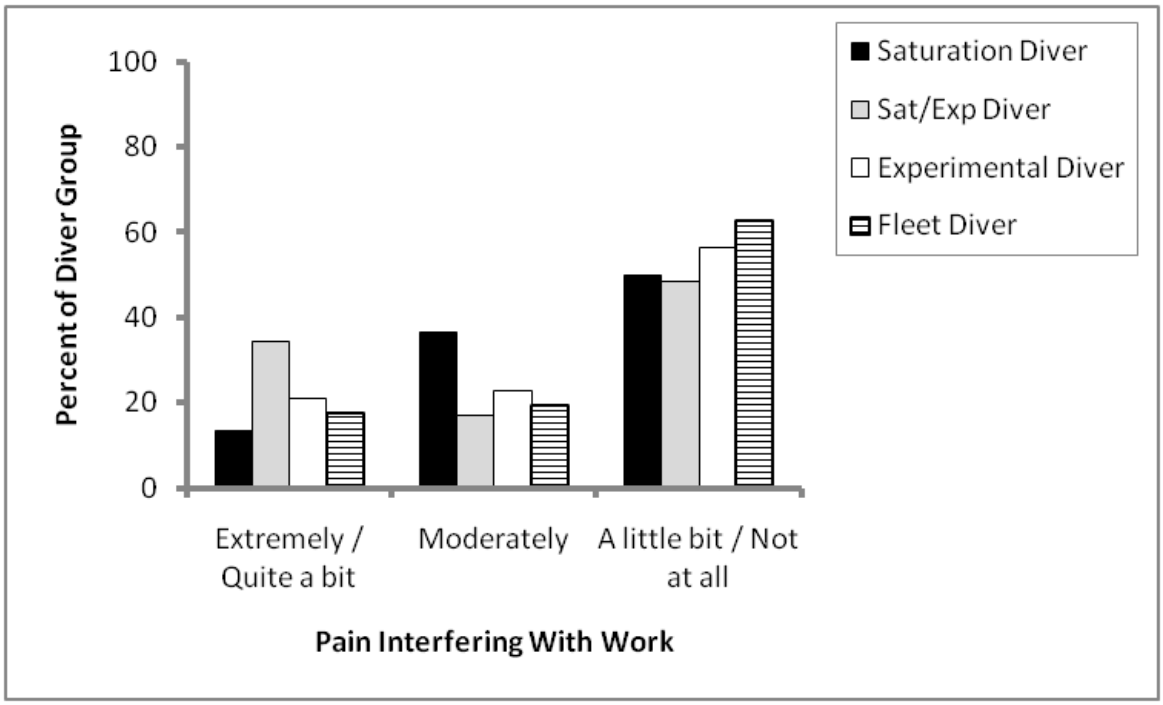

Figure 7. Percentages of diver groups reporting pain interfering with their work.

Physical and Mental Health (Table 22, Appendix B)

From Survey Section 7, average scores were calculated for both a physical component (PCS; 45.6) and a mental component (MCS; 51.2). The mean score for the U.S. population is 50 on both components, with a standard deviation of 10; a one-point difference above or below 50 equals one-tenth of a deviation. So overall, Navy divers report slightly better mental — and poorer physical — health than the normative population reports.

Among Diver Groups

The diver groups differed significantly in physical health [F (3, 1,453) = 2.78, p=.040]. Compared to the average PCS for FLT divers (45.8), that for SAT/ EXP divers was significantly poorer ($\bar{X}$ PCS = 41.9; p=.044).

Correlations and Relationships among Variables

Number of Dives Calculation

Within four categories designating particular types of diving (e.g., Air or Mixed Gas no-decompression), the survey requested divers to select a category with an assigned range of dive numbers (e.g., 1–100, 101–500, etc.). To compute a relative measure of the number of such dives, a response to the category marked "None" was assigned a "0"; from "1–100 dives," a "1"; from "101–500 dives," a "2"; from "501–1000 dives," a "3"; and to "more than 1000 dives," a "4." A similar methodology was used to rank the different ranges within the SAT diving category. The scores were then summed to provide an index of the relative number of dives within both Navy (0–16) and non-Navy (0–16) diving and yield a total range from "0" to "32." For example, a diver reporting Navy diving of 101–500 Navy no-decompression dives (2), 101–500 decompression dives (2), 1–100 surface decompression with oxygen dives (1), and no saturation dives (0) was assigned a score of 5 (2+2+1+0) for total Navy dives. The same scoring was used for non-Navy dives. "Overall Total" dives equal the sum of both Navy and non-Navy dives.

Number of Dives vs. Diving Injuries and Later Symptoms (Table 23, Appendix B)

Table 23 shows that both the number of Navy dives and the Overall Total number of dives were significantly associated with the occurrence of neurological DCS, pain-only DCS, loss of consciousness under pressure, and compression arthralgia (all comparisons yielded p=.000). The greater the number of dives performed, the greater the number of divers who reported having experienced these conditions. For non-Navy dives, greater diving numbers were significantly associated with neurological DCS and pain-only DCS (p=.001).

Reports of muscle weakness or tremor and of impaired hearing were significantly correlated (p=.000) with both increased Navy and increased Overall Total diving. Non-Navy diving was not significantly associated with either of these symptoms.

Muscle Weakness or Tremor, and Impaired Hearing (Table 24, Appendix B)

The dive groups differed significantly in their reporting of these two conditions (Table 13, Appendix B). SAT/EXP divers reported these two conditions much more frequently than the other groups did. Although many correlations presented in Table 24 (see Appendix B) tended to be small, they were statistically significant. These values were calculated using Spearman's Rho (rho) to demonstrate the association between variables. The

highest correlations were those comparing a Lost-Time Accident with Muscle Weakness or Tremor (rho=.229**) and Impaired Hearing (rho =.180**).

Diabetes and Arthritis or Other Joint Pain (Table 25, Appendix B)

Reporting of diabetes was significantly correlated with both the number of years since the first Navy dive (rho=.216) and the estimated age of the divers (rho=.209), both at p<0.01. The variables of a Lost-Time Accident (rho=.191) and Head Injury (rho=.161) were both significantly correlated (p<0.01) with the presence of arthritis or other joint disease. Table 25 reveals that, whereas almost half of the correlations were statistically significant, the magnitudes of rho were small.

Positive Physical and Mental Health (Table 26, Appendix B)

Average scores for both the Physical and Mental Health components were correlated with several key variables, as displayed in Table 26. Good physical health was associated with the absence of a Lost-Time Accident (rho=–.293), fewer Navy dives (rho=–.206), absence of Head Injury (rho=–.191), and absence of DCS (rho=–.159). Nine other variables were significantly correlated at magnitudes lower than those for these four factors. The top three associations with positive mental health included advanced Age (rho=.168), absence of a Head Injury (rho=–.135), and increased number of years since the first Navy dive (rho=.133) — all significant at p<0.01.

Pain Interfering with Work (Table 27, Appendix B)

In the survey's Section 7 (SF-12), SAT/EXP divers reported greater levels of interference from pain at work than the other groups reported. Correlation analyses revealed substantial significant associations between pain at work and reports of previous Lost-Time Accidents of three or more days (rho=.317), number of Navy dives performed (rho=.219), and Head Injury (rho=.203) — all significant correlations at p<0.01. Table 27 also presents the correlations between 16 other variables and the extent to which pain interfered at work.

Forgetfulness

Divers reporting in Survey Question 4.1 that they suffered either "Moderately" or "Extremely" from forgetfulness or loss of concentration also scored high on the CFQ (rho=.587; p≤0.01).

Navy vs. North Sea Diver Comparison (Tables A1–A6; "A" prefix for University of Aberdeen)

To facilitate a comparison of findings, relevant portions of the tables in the University of Aberdeen Report[34] were replicated and populated with data from Navy divers alongside that from the North Sea divers. Apparent differences between the groups are highlighted in the following tables.

Demographics

Table A1 reveals that Navy divers in this NEDU study are, on average, 10 years older than their North Sea counterparts and had attained longer diving careers at the time the studies were reported. However, almost all Navy divers in this study had retired from the Navy, whereas more North Sea divers were still actively diving. As shown in Table A1, in comparison to North Sea divers, fewer Navy divers are current smokers and binge drinkers. Navy divers also report a much lower percentage of exposure to contaminated gas, welding accidents/disease, and diving accidents than North Sea divers do. Reports of decompression illness (DCI) are similar from both populations.

Table A1. Navy vs. North Sea Divers: Demographics
(Highlighted fields demonstrate statistics of interest)

	North Sea Divers		**Navy Divers**
Number of divers	**1540**		**1490**
Age (mean)	45.2 yrs		55.6 yrs
Smoking			
Less than 100 lifetime	46%		55%
Ex-smoker	34%		37%
Current smoker	20%		8%
Binge drinking			
Never	14%		51%
Less than monthly	22%		18%
1–9 times/month	45%		21%
10–20 times/month	13%		6%
More than 20 times/month	5%		3%
Currently employed	88%		78%
Diving			
Years diving (mean)	14.9 yrs		18.4 yrs*
>1 year since last dive	45%		92%
Decompression illness			
None	68%		63%
Pain-only, no Neuro	22%		22%
Neuro + Neuro and Pain	10%		15%
Cerebral gas embolism	1%		4%
Contaminated gas	35%		14%
LOC under pressure	7%		7%
Underwater explosion	13%		6%
Lost >3 days	47%		54%
Worked as welder	23%		31%

Welding accident /disease	90%		43%
Diving accident	63%		42%
			* on active duty

Health-Related Symptoms

In general, Navy divers have a higher incidence of reporting health-related symptoms than North Sea divers do (Table A2). This difference in reporting is most pronounced for joint pain or muscle stiffness, back or neck pain, and impaired hearing. For the remaining eight categories of symptoms, data from the diver groups are remarkably similar.

Table A2. Navy vs. North Sea Divers: Symptoms Reported as "Moderate or Extreme"

Symptom	North Sea Divers (%)		Navy Divers (%)
Joint pain or muscle stiffness	30		63
Back pain or neck pain	31		59
Breathlessness	3		9
Cough or wheeze	3		7
Abdominal pain, diarrhea, constipation, or nausea	6		7
Muscle weakness or tremor	4		10
Unsteadiness when walking, dizziness or poor balance	2		7
Forgetfulness or loss of concentration	18		15
Impaired vision (not corrected by spectacles)	4		8
Impaired hearing	16		39
Skin rash or itch	7		7

Welding, Accidents, and Head Injury

One finding of interest in the North Sea study population was that welding, accidents, and head injury were significantly related to forgetfulness or loss of concentration, joint pain or muscle stiffness, and impaired hearing. Comparisons between North Sea and Navy divers for these variables are shown in Table A3. High percentages of Navy divers who welded, had a three-day lost-time accident, or suffered a head injury also reported joint pain or muscle stiffness. Only for the symptom of "Forgetfulness or loss of concentration" did a higher percentage of North Sea welder-divers report having experienced a symptom "moderately or extremely."

Table A3. Navy vs. North Sea Divers: Welding, Accidents, and Head Injury

Factor and Symptom	North Sea Divers		Navy Divers
	n (%)		n (%)
Welding and:			
Joint pain or muscle stiffness	155 (39%)		334 (72%)
Forgetfulness or loss of concentration	100 (25%)		94 (20%)
Impaired hearing	90 (23%)		212 (46%)
3-day Lost-Time Accident and:			
Joint pain or muscle stiffness	380 (38%)		580 (74%)
Forgetfulness or loss of concentration	180 (18%)		143 (18%)
Impaired hearing	178 (23%)		363 (46%)
Head Injury and:			
Joint pain or muscle stiffness	123 (37%)		317 (75%)
Forgetfulness or loss of concentration	67 (20%)		92 (22%)
Impaired hearing	69 (21%)		213 (50%)

Welder Diver vs. Non-welder Diver

A comparison of symptoms reported by welder and non-welder divers in Table A4 finds consistently higher reporting of symptoms by the welder divers, both Navy and North Sea. Navy divers, again, generally have overall higher percentages for symptom reporting — except for the symptom of "Forgetfulness or loss of concentration."

Table A4. Navy vs. North Sea Divers: Welder and Non-welder Reports of Symptoms as "Moderate or Extreme"

	North Sea Divers	North Sea Diver		Navy diver	Navy diver
Symptom	**Not-welder**	**Welder**		**Not-welder**	**Welder**
Joint pain or muscle stiffness	27%	37%		59%	72%
Forgetfulness or loss of concentration	29%	40%		12%	20%
Back or neck pain	15%	28%		54%	68%
Impaired hearing	14%	21%		36%	46%

Medical Diagnoses

The percentage of Navy divers diagnosed with 13 of 14 medical conditions was higher than it was among the North Sea divers. Only "vibration white finger" was more prevalent among the North Sea than among the Navy divers (Table A5).

Table A5. Navy vs. North Sea Divers Diagnosed with a Medical Condition

	North Sea divers		All Navy divers
Type of Medical Condition	**% (n)**		**% (n)**
Diabetes	1% (n=19)		8% (n=124)
Heart attack or heart disease	2% (n=31)		10% (n=148)
Stroke	0.5% (n=7)		2% (n=24)
High blood pressure	10% (n=156)		41% (n=605)
Migraine	7% (n=105)		12% (n=170)
Epilepsy	0.5% (n=7)		1% (n=21)
Cancer (including leukemia)	2% (n=30)		15% (n=219)
Ulcer (stomach or peptic)	6% (n=91)		9% (n=126)
Dermatitis	9% (n=145)		53% (n=785)
Asthma	5% (n=78)		8% (n=124)
Depression or anxiety	9% (n=140)		19% (n=278)
Arthritis	9% (n=136)		57% (n=840)
Vibration white finger	3% (n=38)		2% (n=32)
Head injury	17% (n=262)		29% (n=426)

Physical and Mental Health

From the SF-12 general health assessments, the North Sea diver reports of their physical health were substantially higher than those of the Navy divers. Mental health scores for the two groups were the same, as Table A6 shows.

Table A6. Navy vs. North Sea Divers: SF-12 Physical and Mental Component Mean Scores (SD)

SF-12 Component Score	North Sea divers		All Navy divers
Physical	52.1 (7.9)		45.6 (10.9)

Mental	51.6 (9.1)		51.2 (9.8)

DISCUSSION

The impetus for this survey was the concern that, in comparison to Fleet divers using standardized diving methods from the same era, pioneer Navy divers who had performed saturation and experimental diving procedures may now be at increased risk for health problems. Now, 20–50 years after these divers had performed these procedures, four diving groups were assessed to determine whether any significant differences were evident in self-reported health status. Overall, most comparisons of health-related outcomes found no significant differences among the groups: Despite differences in diving techniques and equipment these Navy divers had used from 1960 to 1990, all groups of this survey mostly report similar health status.

Where health outcomes differ, these differences lie in the SAT/EXP group, and to a lesser extent in the SAT diver group. Divers performing *both* saturation and experimental diving reported significantly higher rates of muscle weakness/tremor and impaired hearing. Furthermore, SAT/EXP divers reported pain interfering with their normal work to a greater degree than did those in the other three groups. And compared to FLT divers, SAT/EXP divers also had significantly more reports of arthritis or joint disease — and poorer physical health. Both SAT and EXP groups also reported significantly higher rates of suffering from arthritis or joint disease than did FLT divers.

These findings may be related to the dive histories of personnel comprising the SAT and the SAT/EXP dive groups. Both groups reported significantly higher rates of neurological DCS, pain-only DCS, loss of consciousness under pressure, and compression arthralgia than the other two groups did. And these four dive events were significantly correlated with an increased number of Navy and Total dives. SAT divers also had worked significantly longer as welders than had the divers in the other groups.

SAT divers, who performed only saturation and *no* experimental diving, reported significantly higher rates of being diagnosed with diabetes than the other groups did. This finding was anticipated, however, since the SAT group was also found to be significantly older than the other groups, and age was found to be significantly correlated with diabetes.

Throughout a Navy diving career, four of 10 divers occasionally suffered with one or more diving-related maladies ranging from compression arthralgia to loss of consciousness under pressure. Of particular note is the finding that one in four divers reported not having sought treatment for an incident of pain or neurological DCS within 24 hours of a dive. Whether these divers later reported to medical or supervisory staff for subsequent medical treatment is unknown; whether they treated themselves (e.g., with pain relievers) is also unknown. Despite any 24-hour delay and any uncertainty about subsequent medical assistance, however, most divers (77%) indicated that their

symptoms had resolved with one week, and 90% of the divers reported that their symptoms had resolved after a month. Unfortunately, symptoms never resolved for 6% of the divers. Whether prompt medical attention would have resolved those cases remains undetermined, as they were not examined by medical staff. Moreover, whether these divers failed to recognize residual signs and symptoms — and, if such signs and symptoms were present, what effects these residuals may have had on future health — are questions for which answers remain unknown.

If we momentarily set aside chronologically dependent variables such as age, years since the first dive, etc., poor health outcomes were generally associated with an increased number of Navy and Total dives, DCS occurrence, lost-time accidents at work, head injuries, underwater explosions, and work as a welder. These events in a Navy diving career are associated with future self-reports of diminished physical health.

Through the mid-1980s the number of female Navy divers on active duty at any given time remained a handful. The recruitment of female Diving Officers and Diving Medical Officers and their accompanying public visibility during the late 1980s and 1990s enhanced the recruitment of additional females into the enlisted diving ranks. Nevertheless, Navy diving, in comparison to other naval occupations, has historically attracted few minorities into its ranks, and women today still comprise only a small percentage of Navy divers.

During the 1970s, extensive research into and development of deep saturation diving and special warfare diving procedures to address Cold War challenges was undertaken with human subjects in aggressive testing of compression and decompression schedules, oxygen exposure tables, breathing gas mixtures, and thermal guidance and hyperbaric treatment regimens. Most survey respondents, with an average and median age of ~55 years in 2010, were on active duty in the mid to late 1970s. These men and women who performed SAT and EXP dives thus served as human test subjects during what is arguably the decade of the greatest diving advances in U.S. Navy history.

The surveyed divers are well educated. Since far more divers are found in the enlisted ranks (for which a college degree is not an entry requirement) than in the officer ranks, the finding that more than half of them have a bachelor's, master's, or doctorate degree is surprising. Significant continuing education both inside and outside the service may provide the basis for this finding.

The 3% unemployment rate among surveyed divers (4% for military retirees only) is far less than the current 2011 average of ~9% for American civilian workers. Only one of five respondents indicated that he or she is fully retired and unemployed, so the majority of survey participants continue to work even after having retired from the Navy.

Since Navy divers who are retired (for regular or medical reasons) or who are on active duty are automatically eligible for coverage by TRICARE (or, later, Medicare), it is unclear why 2% of them report that they do not have medical insurance of any kind.

The percentage of survey divers reporting that they are current smokers (8%) is far less than both the Navy's published 41% smoking rate from 1987[46] and its decline to 29% in 1994.[47] However, 37% of the surveyed divers classified themselves as ex-smokers, so combining the ex- and the current smoker figures yields a 45% smoking rate among active duty personnel, a rate similar to that of other Navy-specific reports. The overall military smoking rate going back to 1980 was >50%.[48]

Divers in this study participate less in binge drinking than they did in the past. Factors contributing to this reduction may be the Navy's diminished tolerance for alcohol abuse, the reduced status associated with social drinking in relation to engaging in healthy lifestyle behaviors, and fewer Navy-related drinking opportunities for both the active duty and retired populations (e.g., the absence of on-base enlisted and officer club "Happy Hours," and hail and farewell parties serving alcohol). Nevertheless, 3% of the divers report that they presently engage in heavy and frequent drinking — i.e., six drinks at a sitting more than 20 times per month. Compared to North Sea divers, Navy divers engage far less frequently in binge drinking. This is especially evident among those divers who report binge drinking one or more times per month: 31% of Navy divers, 63% of North Sea divers.

Military retirees averaging nearly 24 years of active-duty service comprised the bulk of the study group, with only one in 12.5 divers still on active duty at the time of the survey. With an average active-duty career spanning 23.6 years, Navy divers spent an average of 78% of their careers in diving. Before they became Navy divers, many participants were already diving, and many continued diving after they had concluded their Navy careers. Perhaps partially because of needs to document their disability compensation, divers were twice as likely to maintain their military diving records as they were to maintain their non-Navy records.

Navy divers in this study and the North Sea divers examined by the University of Aberdeen differed demographically. Navy divers were older, engaged in less binge drinking, were less likely to be current smokers, had longer diving careers, and experienced fewer exposures to contaminated gas, underwater explosions, other diving accidents, and welding accidents/disease.

In comparison to the North Sea diver reports, greater percentages of Navy divers reported suffering "moderately" or "extremely" from nine of eleven health symptoms (although five symptoms resulted in differences ≤5%). Moreover, higher percentages of Navy divers reported having been diagnosed with a medical condition in 13 of 14 categories (although in six categories the difference was again ≤5%). Navy divers also scored substantially lower than North Sea divers on the physical component of the SF-12; mental component scores showed no differences. The subset of Navy divers who were welders reported higher percentages of joint pain and impaired hearing than the North Sea welder-divers did.

The higher percentages of Navy divers reporting health problems may result from real changes in physical health associated with their greater ages (55 versus 45 years) and

longer diving careers than those of North Sea divers. In addition, cultural expectations in reporting symptoms, in the frequency and thoroughness of medical evaluations, and in financial considerations for continued employment or disability compensation (among various factors) may influence differences among these two dive populations.

But Navy and North Sea divers respond with remarkably similar patterns to questions on welding and symptoms of joint pain, forgetfulness, back or neck pain, and impaired hearing. For both dive populations and across the four symptom categories, welder-divers consistently report higher percentages of "moderate" or "extreme" symptoms than non-welding divers report. Thus, a career as a welder-diver is associated with more health problems than a dive career without welding work.

One of this study's strengths was its avoidance of bias associated with subject self-selection: Divers in the SAT, EXP, and SAT/EXP groups were identified objectively from the diving records. Scores of divers, earnestly requesting to participate in the study, contacted the investigators, but if their names were not on the list from the records search, their requests were denied in accordance with the protocol. In addition, criteria for eligibility as a subject included that of being employed as a Navy diver for at least 10 years before the study began, a criterion that should help minimize survivor bias and the influence of the "healthy worker" effect. And analyses of responses following the return of the third survey mailing supplied evidence that the study sample may be representative of the Navy diver population from 1960 to 1990.

Among the weaknesses of the study was its request for subjective self-report data that lacked additional verification. Moreover, this cross-sectional survey could take only a snapshot of self-reported health at a given moment: It has neither tracked changes over time nor provided information on trends. This methodology also does not support causal inferences between events and health outcomes.

The study originally was planned to enroll those divers who had separated from the military before retirement age. Unfortunately, permissions were not obtained from federal agencies in a timely manner to solicit the participation of separated members. Thus, the available pool of divers for this study was greatly reduced, and invitations to participate were limited to only those divers for whom the following documentation existed:

1. adequate identifying information (e.g., Social Security numbers; or first, last, and middle names; and identification as divers);

2. a written, institutional-file record of their having performed the appropriate types of diving;

3. government permissions for the study to contact them (retirees and active duty only); and

4. valid mailing addresses.

These criteria restricted the pool of eligible subjects and eliminated those divers who had separated from the Navy before having completed 20 years for retirement, had performed as reservists on active duty, were civilian divers, or lacked adequate identification. For example, divers with only their last names in the log for an experimental dive done in 1972 at NEDU were unlikely to be included if that was the sole identifying information available. And death excluded some otherwise eligible divers from that era.

Many Navy divers who performed SAT or EXP dives between 1960 and 1990 were also not included in the study groups. For example, though 80 SAT divers were identified through log and record searches, 341 respondents said that they had made a SAT dive. Presumably, some of these unidentified divers who had made SAT dives were officers and enlisted who had not carried a Naval Officer Billet Code or Navy Enlisted Classification for SAT diving; or who had performed their SAT dives outside NEDU, NMRI, and NSMRL; or who did not have log entries stating that they had performed SAT diving.

Although the survey was piloted with current and former Navy divers, diver responses to several survey questions indicated their confusion or their differing interpretations about what information was sought. For example, six reported that they had done no air or mixed gas no-decompression dives. But all Navy divers accomplish air no-decompression dives as part of their most basic Navy dive training. As another example, more than one in 10 divers responded that “none of the categories” fit the types of diving that they had performed, although all Navy divers were expected to have been able to mark category 3 — “using standard U.S. Navy diving tables and procedures” — as one of their responses. Such results suggest that many found the question’s wording to be confusing.

CONCLUSIONS

Despite differences in diving techniques and equipment the Navy divers had used from 1960 to 1990, in this survey those divers generally report similar health statuses. However, the inherent nonresponse error associated with mail-out surveys is important to note. Furthermore, due to time and financial constraints, the surveyed population did not include separated Navy divers from this 30-year period. This report’s conclusions should therefore be interpreted with caution, since we do not know how responses from nonresponding or nonretired divers might have influenced the results. No causal relationships can be established with the findings, and statistically significant findings pertain only to the respondents in this study.

Characteristics of a Navy Diver

Throughout a Navy diving career,

1. Four of 10 divers occasionally suffered with one or more diving-related maladies ranging from compression arthralgia to loss of consciousness under pressure.

2. One in four divers reported not having sought treatment for an incident of pain or neurological DCS within 24 hours of a dive. (Whether these divers later reported to medical or supervisory staff for medical treatment is unknown; whether they treated themselves — e.g., with pain relievers — is also unknown.)

3. Seventy-seven percent of the divers indicated that their symptoms had resolved with one week.

4. Ninety percent of the divers reported that their symptoms had resolved after a month. Unfortunately, symptoms had never resolved for 6% of the divers.

Increasingly poor health outcomes were generally associated with an increased number of Navy and Total dives, DCS occurrence, lost-time accidents at work, head injuries, underwater explosions, and work as a welder. These considerations (as well as age and years since the first dive in a Navy diving career) are associated with future self-reports of reduced physical health.

The surveyed divers are a well-educated cadre. And, since far more divers are found among the enlisted (for which a college degree is not an entry requirement) than among the officer ranks, the finding that more than half of those surveyed have a bachelor's, master's, or doctorate degree is surprising. Significant continuing education both inside and outside the service may explain this finding.

Among surveyed divers, the unemployment rate of 3% (4% for military retirees only) is far less than the current 2011 average of ~9% for American civilian workers. Only one of five respondents indicated that he is fully retired and unemployed, so the majority of survey participants — even after having retired from the Navy — continue to work.

Since Navy divers who retire for regular or medical reasons or who are on active duty are automatically eligible for health care coverage by TRICARE (or, later, Medicare), it is unclear why 2% of them report that they lack medical insurance of any kind.

The percentage of survey divers reporting that they are current smokers (8%) is far less than both the Navy's published 41% smoking rate from 1987[46] and the reduced rate of 29% in 1994.[47] Thirty-seven percent of the surveyed divers classify themselves as ex-smokers, so combining the ex- and the current smoker figures yields a 45% smoking rate among active-duty personnel, a rate similar to that in other Navy-specific reports. Through the years back to 1980, the overall military smoking rate was >50%.[48]

Survey results show that, while 20% of SAT divers had diabetes, only 9% of FLT divers had that disease. The U.S. population has an 11.3% prevalence of diabetes in patients older than age 20, and a prevalence of 26.9% in those older than age 65.[49] It is also important to recognize that the modal age of SAT divers is 66, whereas that of FLT

divers is 51 — and the mean age for SAT divers is 58, whereas that for FLT divers is 55.4: Such modal ages suggest that the surveyed divers have a lower incidence of diabetes than the average U.S. citizen does.

Arthritis or joint disease was reported in 57% of the surveyed population having an age range from 39 to 82 and an average age of 55.4. This prevalence of reported arthritis or joint disease is significantly higher than that among U.S. adults (22.2%) and higher than the prevalence of arthritis among adults 65 years or older (50%).[50] However, U.S. veterans have been found to be more likely than their civilian counterparts to report arthritis (32% versus 22%), and more veterans who use the VA health care system report arthritis than do those who do not use that system (43% versus 30%).[51]

Comparison of cohorts

A significantly greater number of SAT/EXP divers reported rates of muscle weakness/tremor and impaired hearing than did divers in the other groups.

SAT/EXP divers reported pain interfering with their normal work in degrees of intensity that were greater than those reported in the other three dive groups.

SAT/EXP divers also reported significantly more arthritis or joint disease — and poorer physical health — than did FLT divers. In fact, both SAT and EXP groups reported suffering from arthritis or joint disease at rates significantly higher than those reported by FLT divers.

The SAT and SAT/EXP dive groups reported significantly higher rates of neurological DCS, pain-only DCS, loss of consciousness under pressure, and compression arthralgia than the two other dive groups reported. And these four dive events were significantly correlated with an increased number of Navy and Total dives.

SAT divers also had worked significantly longer as welders than had divers in the other groups.

SAT divers reported being diagnosed with diabetes at rates significantly higher than those of the other groups. (The SAT group, however, was also significantly older than the other groups, and old age was found to be significantly correlated with diabetes.)

Navy vs. North Sea Divers

Three percent of the divers report that they presently engage in heavy and frequent drinking: i.e., six drinks at a sitting, more than 20 times per month. But Navy divers engage far less frequently in binge drinking than do North Sea divers. This is especially evident among those who report binge drinking one or more times per month — 31% of Navy divers, and 63% of North Sea divers.

Navy divers in this study and North Sea divers examined by the University of Aberdeen differed demographically. In contrast to the North Sea divers, Navy divers were older, engaged in binge drinking less frequently, were less likely to be current smokers, had longer diving careers, and experienced fewer exposures to contaminated gas, underwater explosions, other diving accidents, and welding accidents/disease.

Compared to the report data from North Sea divers, greater percentages of Navy divers reported suffering "moderately" or "extremely" from nine of eleven health symptoms (although five symptoms resulted in differences ≤5%). Moreover, higher percentages of Navy divers reported having been diagnosed with a medical condition in 13 of 14 categories (although in six categories the difference was again ≤5%). On the physical component of the SF-12, however, Navy divers scored substantially lower than North Sea divers; the mental component scores showed no differences between these two groups. The subset of Navy divers who were welders reported higher percentages of joint pain and impaired hearing than the North Sea welder divers reported.

The higher percentages of Navy divers reporting health problems may result from changes in physical health associated with their greater ages (55 versus 45 years) and longer diving careers than those of North Sea divers. In addition, cultural expectations in their reporting of symptoms, the frequency and thoroughness of their medical evaluations, and financial considerations for their continued employment or disability compensation (among various factors) may influence differences in resulting data among these two dive populations.

Navy and North Sea divers respond with remarkably similar patterns to questions on welding and symptoms of joint pain, forgetfulness, back or neck pain, and impaired hearing. For both dive populations and across the four symptom categories, welder divers consistently report higher percentages of "moderate" or "extreme" symptoms than non-welding divers report. Thus, a career as a welder diver is associated with more health problems than one without welding work.

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Appendix A

The Survey

Subject ID# _____

U.S Navy Diver Health Effects Questionnaire

PRIVACY ACT STATEMENT

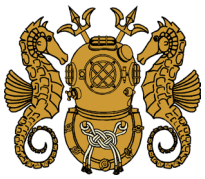
Authority to request this information is granted under 10 U. S. C. 5031 and 5032, 5 U. S. C. 301, and Executive Order 9397. License to administer this survey is granted per OPNAVINST 5300.8C under OPNAV Report Control Symbol: 1544-1 which expires 3/31/11. Personal identifiers will be used to avoid repetitious survey contacts and ensure proper subject classification.

PURPOSE: The purpose of this questionnaire is to collect information and report on the health status of currrent and former U.S. Navy divers. It will also attempt to determine if there are significant differences in health associated with certain types of diving when compared to each other and to the general public. Associations between health and selected occupational exposures will also be explored.

ROUTINE USES: The information provided in this questionnaire will be analyzed by the Navy Experimental Diving Unit (NEDU), Panama City, FL. The data files will be maintained by the NEDU where they may be used for determining changing trends in the Navy.

ANONYMITY: All responses will be held in confidence by NEDU. Information you provide will be statistically summarized with the responses of others, and will not be attributable to any single individual.

PARTICIPATION: Completion of this questionnaire is entirely voluntary. Failure to respond to any of the questions will NOT result in any penalties except the possible lack of representation of your views in the final results and outcomes.



Section 1: Demographics and Lifestyle

1.1) Year of Birth (yyyy): _____

1.2) Male ◯ Female ◯

1.3) What is your CURRENT marital status?
Never married ◯ Married ◯ Divorced or widowed ◯

1.4) What is your CURRENT living situation?
Living alone ◯ Living with partner/family ◯ Living with friends ◯

1.5) What is the highest educational qualification you have gained?
No High School ◯ High School ◯ Some college ◯
Bachelors ◯ Masters ◯ Doctorate ◯

1.6) Which of the following describes your current work status?
Employed (Full-time) ◯ Employed (Part-time) ◯
Unemployed ◯ Retired ◯

1.7) Are you currently receiving any disability compensation from any source?
Yes ◯ No ◯
If yes, from which source and for what reason?_____
_____

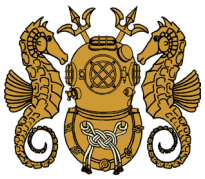
1.8) Have you ever permanently left a particular type of work with a chronic illness or injury? Yes ◯ No ◯
If yes, please explain._____

1.9) Do you have medical insurance/coverage of any kind? Yes ◯ No ◯

1.10) Race/Ethnicity (Please answer BOTH questions).

A. Are you Hispanic or Latino? (choose only one)
◯ No, not Hispanic or Latino
◯ Yes, Hispanic or Latino (A person of Cuban, Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.)

B. What is your race? (choose one or more)
◯ American Indian or Alaska Native (A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.)
◯ Asian (A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam)



Section 1: Demographics and Lifestyle

- ◯ Black or African American (A person having origins in any of the black racial groups of Africa.)
- ◯ Native Hawaiian or Other Pacific Islander (A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.)
- ◯ White (A person having origins in any of the original peoples of Europe, the Middle East, or North Africa)

1.11) How much do you currently weigh?_____lbs

1.12) How tall are you?_____ft_____in

1.13) Have you smoked more than 100 cigarettes IN TOTAL in your life? Yes ◯ No ◯

If no, skip to question 1.14). If yes, complete the following:

Current smokers

1.13a) How many years in total have you smoked?_____
1.13b) How many cigarettes do you smoke per day?_____

Ex-Smokers

1.13c) When did you stop smoking? Year_____
1.13d) How many years in total did you smoke?_____
1.13e) How many cigarettes did you smoke per day?_____

1.14) In the last 12 months, how often have you had 6 drinks or more of an alcoholic beverage on any one occasion? (Note: one drink = one 12-oz. domestic beer = one 5-oz glass of wine = one 1.5-oz. shot of 80-proof distilled spirits (large shot)).

Never ◯ More than 20 times a month ◯
10-20 times a month ◯ 1-9 times a month ◯
If less than monthly, how many times a year?_____

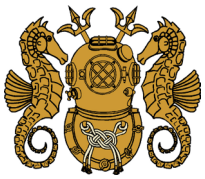
1.15) Have you ever had a period of time in the past where you used alcohol more frequently than the past 12 months? Yes ◯ No ◯ If yes, complete the following:

1.15a) How many years ago?_____
1.15b) Describe your alcohol use during that time.

More than 20 times a month ◯ 10-20 times a month ◯ 1-9 times a month ◯

If less than monthly, how many times a year?_____

1.16) Did you participate in a regular Physical Training ("PT") program between the ages of 20 and 40? Yes ◯ No ◯



1.16a) If you answered yes to the above, choose one of the following descriptions of your average exercise regimen during those years.

- ◯ Light: Up to 30 minutes of group calisthenics and/or less than two miles running two to three days per week.
- ◯ Moderate: Group calisthenics combined with running two to five miles, or other comparable activity for thirty minutes or greater, at least 3-4 days per week.
- ◯ Heavy: Combinations of extended Calisthenics, weight lifting, running the equivalent of greater than five miles or other strenuous activity for over an hour a day on most days. Any participation in marathons or triathlons.

Section 2: Occupational History

2.1) Are you currently: Active Duty ◯ Retired from Active Duty ◯
Separated (<20 years AD) ◯ Medically Discharged ◯ Administratively Discharged ◯
Other ◯
(Please describe_____)

2.2) How many years did you spend on active duty ?_____

2.3) What was your highest Navy paygrade?_____ - _____

2.4) What was your primary diving rate (NEC/NOBC, if you had one)?_____

2.5) List any other warfare or diving qualifications you have:_____

2.6) How old were you when you completed your initial dive training?_____

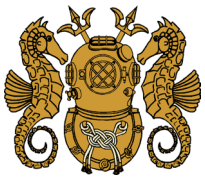
2.7) How many years total did you spend diving while on active duty?_____

Section 2: Occupational History

2.8) During the years that you have been diving, have you been exposed to any of the following?: Mark under each setting in which the exposure occurred: Navy and Non Navy. Use the following descriptions to guide your responses:

No, not at all: You have no particular reason to believe you were exposed.
Yes, a little: You know the exposure was present, but not to a great degree and/or not on a regular basis.
Yes, a lot: You know the exposure was present to a great degree, on a regular basis, and/or you required monitoring, special procedures, or protective equipment.

		No, not at all	Yes, a little	Yes, a lot	Don't know
Solvents (including exposure to/immersion in petroleum products)	Navy	○	○	○	○
	Non Navy	○	○	○	○
Hydrogen sulfide	Navy	○	○	○	○
	Non Navy	○	○	○	○
Radiation sources	Navy	○	○	○	○
	Non Navy	○	○	○	○
Lead *(soldering, paints including anti-fouling paint, weight casting etc)*	Navy	○	○	○	○
	Non Navy	○	○	○	○
Paints with chromium additives	Navy	○	○	○	○
	Non Navy	○	○	○	○
Mercury	Navy	○	○	○	○
	Non Navy	○	○	○	○
Asbestos	Navy	○	○	○	○
	Non Navy	○	○	○	○
Pesticides	Navy	○	○	○	○
	Non Navy	○	○	○	○
Carbon Monoxide	Navy	○	○	○	○
	Non Navy	○	○	○	○
Noise (loud enough to make conversation difficult)	Navy	○	○	○	○
	Non Navy	○	○	○	○
Contaminated breathing gas	Navy	○	○	○	○
	Non Navy	○	○	○	○



Section 2: Occupational History

2.9) Have you ever been assigned/deployed to a theater of combat operations?
Yes ◯ No ◯

If yes, when, where, and for how long?_____

2.10) Have you had a lost time (more than 3 days) accident or injury at work?
No ◯ Once ◯ More than once ◯

2.11) When was your last medical examination of fitness to work?_____(year)

2.12) Have you ever worked as a welder? Yes ◯ No ◯
(If no, please go to section 3)

2.13) In what year did you START welding at work?_____

2.14) In what year was your MOST RECENT welding job?_____

2.15) How many years in total have you carried out welding work?_____

2.16) Have you permanently stopped welding at work? Yes ◯ No ◯

2.17) What percent of your welding was done in the following work areas?

A) Outdoors _____%
B) Indoors in a well ventilated area _____%
C) In a small, poorly ventilated area _____%
D) In a dry pressurized environment (i.e. caisson) _____%
E) In a wet pressurized environment (i.e. while diving) _____%

2.18) Over what percent of your welding career have you used the following personal protective breathing equipment while welding?

A) Simple dust mask _____%
B) Filter respirator _____%
C) Atmosphere supply respirator (e.g. Aga mask) _____%
D) Other, please name:_____ _____%

Section 2: Occupational History

2.19) At work, have you used the following welding techniques?

	Yes	No	How many years have you used this technique?	On average, how many days per year have you used it?
Arc	○	○		
Metal Inert Gas (MIG)	○	○		
Tungsten Inert Gas (TIG)	○	○		
Other, please name	○	○		

2.20) While welding, have you ever been diagnosed with or treated for the following?

		If yes, how many times?
A) Metal fume fever	Yes ○ No ○	_____
B) Major electric shock	Yes ○ No ○	_____
C) Burns (other than minor)	Yes ○ No ○	_____
D) Eye damage (burns/abrasions)	Yes ○ No ○	_____

Section 3: Diving History

3.1) While performing Navy directed dives, have you ever (mark all that apply):

- ○ Performed any in-water or chamber simulation dive (excluding medical treatments) lasting longer than 24-hours (i.e. saturation dives)?
- ○ Performed any in-water or chamber simulation dive involving formal testing of medical, physiological, and psychological procedures (e.g. decompression tables, oxygen exposure tables, thermal exposure guidelines, depth limits for narcosis) performed by EDU, NEDU, NSMRL or NMRI (i.e. experimental diving)?
- ○ Performed any in-water or chamber simulation dive using standard U.S. Navy diving tables and procedures (including exceptional exposure tables) as outlined in the USN Diving Manual while in the performance of the Navy mission (including testing and evaluation of equipment and equipment procedures)? (Ship's husbandry, salvage, EOD, SPECWAR, Construction, etc.)
- ○ I have not performed any of the above types of diving.
  Comment: _____
  _____

3.2) Please complete the following dive history

	Navy		Non Navy	
In what year was your FIRST dive done?	yyyy		yyyy	
What year did you last dive?	yyyy		yyyy	
Have you permanently stopped diving?	Yes	No	Yes	No
	○	○	○	○
Do you have records of these dives?	Yes	No	Yes	No
	○	○	○	○

Section 3: Diving History

3.3) For each of the following types of diving, how many NAVY dives have you done.

Air or mixed gas: no-D		Air or mixed gas: Surface/In-water decompression		Air or mixed gas: Sur-D O2		Saturation Dive*	
None	○	None	○	None	○	None	○
1 - 100	○	1 - 100	○	1 - 100	○	1 - 10	○
101 -500	○	101 -500	○	101 -500	○	11 -50	○
501 - 1000	○	501 - 1000	○	501 - 1000	○	51 - 100	○
more than 1000	○	more than 1000	○	more than 1000	○	more than 100	○

*Count saturation dives so that all operations from initial press to final decompression count as one sat dive.

3.4) For each of the following types of diving, how many NON NAVY dives have you done.

Air or mixed gas: no-D		Air or mixed gas: Surface/In-water decompression		Air or mixed gas: Sur-D O2		Saturation Dive*	
None	○	None	○	None	○	None	○
1 - 100	○	1 - 100	○	1 - 100	○	1 - 10	○
101 -500	○	101 -500	○	101 -500	○	11 -50	○
501 - 1000	○	501 - 1000	○	501 - 1000	○	51 - 100	○
more than 1000	○	more than 1000	○	more than 1000	○	more than 100	○

*Count saturation dives so that all operations from initial press to final decompression count as one sat dive.

Section 3: Diving History

3.5) While working as a diver, have you ever been diagnosed with or treated for any of the following (mark all that apply):

	Never	Once	More than once
Neurological decompression sickness	○	○	○
Pain-only decompression sickness	○	○	○
Arterial gas embolism (AGE)	○	○	○
Underwater explosion	○	○	○
Loss of consciousness while under pressure	○	○	○
Contaminated gas exposure	○	○	○
Oxygen toxicity-seizure	○	○	○
Compression Arthralgia (Joint pain during descent)	○	○	○
Oxygen toxicity-lungs	○	○	○

3.6) Have you ever had pain or neurological symptoms within 24 hours of a dive for which you did not seek treatment? Yes ○ No ○ If yes, answer question 3.7, otherwise skip to 3.8.

3.7) If your symptoms went away, how long did it take?

<1 week ○ 1week-1 month ○ 2-6 months ○
7 to 12 months ○ >1 year ○ Never resolved ○

3.8) For how many episodes of the following did you receive recompression treatments?

A) Neurological decompression sickness #_____
B) Pain-only decompression sickness #_____
C) Arterial gas embolism #_____
D) Other (CO, bad gas, unexplained loss of consciousness) #_____

Section 4: Medical History

4.1) Do you regularly suffer from any of the following? Use the following guidelines for your responses:

Slightly: Does not interfere with any work/recreational/family activities that you would otherwise participate in.
Moderately: Causes you to avoid or alter your activities on some days
Extremely: Prevents you from participating in activities, or causes significant changes in your life (i.e. cannot climb stairs, must park close to an entrance to a store, etc) all the time.

	Not at all	Slightly	Moderately	Extremely
Joint pain or muscle stiffness	○	○	○	○
Back or neck pain	○	○	○	○
Breathlessness	○	○	○	○
Cough or wheeze	○	○	○	○
Abdominal pain, diarrhea, constipation, or nausea	○	○	○	○
Muscle weakness or tremor	○	○	○	○
Unsteadiness when walking, dizziness, or poor balance	○	○	○	○
Forgetfulness or loss of concentration	○	○	○	○
Poor eyesight NOT corrected with glasses/contact lenses	○	○	○	○
Impaired hearing	○	○	○	○
Skin rash or itch	○	○	○	○
Reduced or abnormal skin sensation	○	○	○	○

Section 4: Medical History

4.2) Have you ever been diagnosed with any of the following conditions?

	Yes	No		Yes	No
Asthma or obstructive lung disease	○	○	Ulcer (stomach or peptic)	○	○
Chronic bronchitis	○	○	Skin disease (psoriasis, athlete's foot, eczema, etc)	○	○
Other lung disease:_____ _____	○	○	Allergies or hayfever	○	○
Heart attack or heart disease	○	○	Head injury	○	○
Stroke	○	○	Dysbaric bone necrosis (death of bone, related to diving and/or decompression illness)	○	○
High blood pressure	○	○	Arthritis or other joint disease	○	○
Cancer (including leukemia)	○	○	Epilepsy	○	○
Depression or anxiety	○	○	Migraines	○	○
Any other mental illness	○	○	Sensory or motor neuropathy	○	○
Diabetes	○	○	Vibration white finger	○	○
Sports injury	○	○	Chronic infectious disease (Hepatitis, Lyme, etc)	○	○

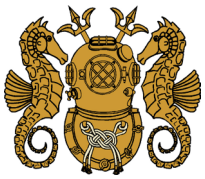
4.3) Have you had or are scheduled to have a total joint replacement? Yes ○ No ○
If yes, which joint(s)? _____

4.4) Have you been told that you need, or in the future will likely need, a total joint replacement? Yes ○ No ○
If yes, which joint(s)?_____

4.5) At what age did you receive your first total joint replacement? Age_____N/A_____

4.6) What was/is the main reason or indication for your total joint replacement?

Pathologic fracture (fractures that occur without any serious force to the bone)_____
_____
Pain/activity limitations_____
Other_____
N/A_____



Section 5: CURRENT PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days.** Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

5.1) During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____**days per week**

○ No vigorous physical activities ⟶ **Skip to question 5.3**

5.2) How much time did you usually spend doing vigorous physical activities on one of those days?

_____**hours per day**
_____**minutes per day**

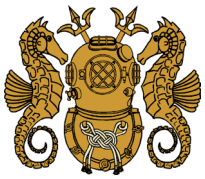
○ Don't know/Not sure

Think about all the **moderate** activities that you did in the last **7 days. Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

5.3) During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____**days per week**

○ No moderate physical activities ⟶ **Skip to question 5.5**



Section 5: CURRENT PHYSICAL ACTIVITY QUESTIONNAIRE

5.4) How much time did you usually spend doing **moderate** physical activities on one of those days?

_____**hours per day**
_____**minutes per day**

◯ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5.5) During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____**days per week**

◯ No walking ⟶ **Skip to question 5.7**

5.6)How much time did you usually spend **walking** on one of those days?

_____**hours per day**
_____**minutes per day**

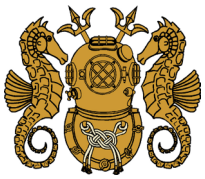
◯ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days.** Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

5.7) During the **last 7 days**, how much time did you spend **sitting** on a **week day?**

_____**hours per day**
_____**minutes per day**

◯ Don't know/Not sure



Section 6: Cognitive Performance Questionnaire

	Very often	Quite often	Occasionally	Very rarely	Never
Do you read something and find you haven't been thinking about it and must read it again?	○	○	○	○	○
Do you find you forget why you went from one part of the house to another?	○	○	○	○	○
Do you fail to notice signposts on the road?	○	○	○	○	○
Do you find you confuse right and left when giving directions?	○	○	○	○	○
Do you bump into people?	○	○	○	○	○
Do you find you forget whether you've turned off a light or a fire or locked the door?	○	○	○	○	○
Do you fail to listen to people's names when you are meeting them?	○	○	○	○	○
Do you say something and realize afterwards that it might be taken as insulting?	○	○	○	○	○
Do you fail to hear people speaking to you when you are doing something else?	○	○	○	○	○
Do you lose your temper and regret it?	○	○	○	○	○
Do you leave important letters unanswered for days?	○	○	○	○	○
Do you find you forget which way to turn on a road you know well but rarely use?	○	○	○	○	○
Do you fail to see what you want in a super-market (although it's there)?	○	○	○	○	○
Do you find yourself suddenly wondering whether you've used a word correctly?	○	○	○	○	○

continued on next page

Section 6: Cognitive Performance Questionnaire

	Very often	Quite often	Occasionally	Very rarely	Never
Do you have trouble making up your mind?	○	○	○	○	○
Do you find you forget appointments?	○	○	○	○	○
Do you forget where you have put something like a newspaper or a book?	○	○	○	○	○
Do you find you accidentally throw away the thing you want and keep what you meant to throw away – as in the example of throwing away the matchbox and putting the used match in your pocket?	○	○	○	○	○
Do you daydream when you ought to be listening to something?	○	○	○	○	○
Do you find you forget people's names?	○	○	○	○	○
Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	○	○	○	○	○
Do you find you can't quite remember something although it's on the tip of your tongue?	○	○	○	○	○
Do you find you forget what you came to the shops to buy?	○	○	○	○	○
Do you drop things?	○	○	○	○	○
Do you find you can't think of anything to say?	○	○	○	○	○

Section 7: YOUR HEALTH AND WELL-BEING

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities.

For each of the following questions, please mark in the one box that best describes your answer.

7.1) In general, would you say your health is:

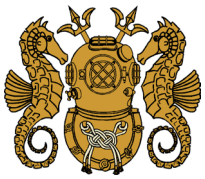
Excellent	Very Good	Good	Fair	Poor
○	○	○	○	○

7.2) The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?:

	Yes, limited a lot	Yes, limited a little	No, not limited at all
Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	○	○	○
Climbing several flights of stairs	○	○	○

7.3) During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
Accomplished less than you would like	○	○	○	○	○
Were limited in the kind of work or other activities	○	○	○	○	○



Section 7: YOUR HEALTH AND WELL-BEING

7.4) During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
Accomplished less than you would like	○	○	○	○	○
Did work or other activities less carefully than usual	○	○	○	○	○

7.5) During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

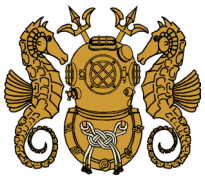
Not at all	A little bit	Moderately	Quite a bit	Extremely
○	○	○	○	○

7.6) These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
Have you felt calm and peaceful?	○	○	○	○	○
Did you have a lot of energy?	○	○	○	○	○
Have you felt down-hearted and depressed?	○	○	○	○	○

7.7) During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

All of the time	Most of the time	Some of the time	A little of the time	None of the time
○	○	○	○	○



Free Response Section

Please provide comments here on anything else you feel might be important to the study as you understand it (other types of health problems, diving or other occupational exposures, fitness and activity issues, operational considerations). Describe any important considerations you feel may have been missed by this survey. Please do **not** include sensitive or classified information.

Appendix B

Tables of Results

Table 1. Contact Distribution and Final Sample Size

	All Divers	Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers
Divers Mailed Invitations	5,422	80	145	133	5,064
Divers Returning NEDU Invitations (confirmed contacts)	2,449 **(45%)**	46	79	69	2,255
Divers Excluded from Study	3,630	45	76	80	3,429
Deceased	5	0	0	0	5
Missed Invitation Deadline	336	6	5	9	316
Declined to Participate	221	3	5	5	208
Did Not Return Invitation	2,973	34	66	64	2,809
Other (Including Undeliverable)	95	2	0	2	91
Divers Who Agreed to Participate (consented)	1,792**(33%)**	35	69	53	1,635
Divers Mailed Surveys	1,792	35	69	53	1,635
Divers Returning Surveys	1,620	30	62	51	1,477
Surveys NOT Returned	172	5	7	2	158
Divers Missing Survey Deadline	65	0	2	2	61
Surveys Removed from Analysis (did not meet study criteria)	65	0	2	1	62
Surveys Used in Analyses	1,490	30	58	48	1,354
Final Participation Rate (Mailed invitations ÷ surveys used)	**27.5%**	**37.5%**	**40.0%**	**36.1%**	**26.7%**

Table 2. Comparison of Early and Late Responders: Key Variables

Question	Variable	Early Responder (n=117–120)	Late Responder (n=117–120)	F or X^2	Significance
1.1	Age (years)	57.36	53.58	F = 14.38	**P=.000**
1.5	Education			X^2 = 3.08	n.s.
	HS	11.1%	12.7%		
	Some college	43.6%	48.0%		
	Bachelor's	25.6%	26.3%		
	Master's	18.8%	16.9%		
	Doctorate	0.9%	4.2%		
1.7	On disability	55.5%	58.0%	X^2 = 0.15	n.s.
1.13	Current smoker	10.8%	12.5%	X^2 = 0.162	n.s.
1.14	Binge drinker			X^2 = 2.53	n.s.
	Never	52.1%	42.9%		
	< than monthly	17.6%	20.2%		
	1–9 x/month	20.2%	26.1%		
	10–20 x/month	6.7%	8.4%		
	> 20 x/month	3.4%	2.5%		
7	PCS score	46.30	44.25	F = 2.12	n.s.
7	MCS score	51.35	52.03	F = 0.29	n.s.

Table 3. Demographic Characteristics of Survey Respondents

Question	Characteristics	All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
		n=1490		n=30	n=58	n=48	n=1354	
1.1	**Age (years)[1]**	n=1474		n=30	n=58	n=47	n=1339	**P=.002**
	Mean	55.6		58.0	58.8	55.0	55.4	
	Median	55.0		60.0	59.0	54.0	54.0	
	Mode	51		66	52	46	51	
	Min	39		41	43	41	39	
	Max	82		70	76	74	82	
	Retirees $\bar{X}$ age (years)	55.4						
1.11	**Weight (lb)**	n=1485		n=30	n=58	n=48	n=1349	**n.s.**
	Mean	202.3		208.2	199.3	202.5	202.2	
	Median	200.0		200.5	195.0	200.0	200.0	
	Mode	200		190	200	200	200	
	Min	112		165	125	137	112	
	Max	360		260	305	258	360	
1.12	**Height (in)**	n=1482		n=30	n=58	n=48	n=1346	**n.s.**
	Mean	70.5		70.6	70.7	70.4	70.5	
	Median	70.0		70.0	70.0	70.5	70.0	
	Mode	70		70.0	70	-	70	
	Min	56		68	63	65	56	
	Max	83		75	78	75	83	
		n (%)		**n (%)**	**n (%)**	**n (%)**	**n (%)**	
1.2	**Gender**							
	Female	15 (1%)		0	0	0	15 (1.1%)	
	Male	1475 (99%)		30 (100.0%)	58 (100.0%)	48 (100.0%)	1339 (98.9%)	
1.5	**Education**							**n.s.**
	No High School	0		0	0	0	0	
	High School	143 (9.7%)		2 (6.7%)	8 (13.8%)	6 (12.8%)	127 (9.5%)	
	Some college	577 (39.3%)		15 (50.0%)	29 (50.0%)	20 (42.6%)	513 (38.4%)	
	Bachelor's	357 (24.3%)		6 (20.0%)	14 (24.1%)	15 (31.9%)	322 (24.1%)	
	Master's	333 (22.7%)		6 (20.0%)	4 (6.9%)	5 (10.6%)	318 (23.8%)	
	Doctorate	60 (4.1%)		1 (3.3%)	3 (5.2%)	1 (2.1%)	55 (4.1%)	
1.10	**Race / Ethnicity[2]**							**n.s.**
	Hispanic or Latino	39 (2.7%)		0	2 (3.6%)	0	37 (2.8%)	
	American Indian / Alaska Native	52 (3.5%)		3 (10.0%)	2 (3.4%)	0	47 (3.5%)	
	Asian	8 (0.5%)		0	1 (1.7%)	0	7 (0.5%)	
	Black/ African American	20 (1.4%)		0	0	0	20 (1.5%)	
	Native HI / Pacific Island	7 (0.5%)		0	1 (1.7%)	0	6 (0.4%)	
	White	1429 (96.6%)		30 (100.0%)	57 (98.3%)	48 (100.0%)	1294 (96.4%)	

[1] Age was calculated by subtracting year of birth from the current year. [2] Race/Ethnicity was a multiple response question, and thus the counts total >100%.

Table 4. Lifestyle Characteristics

Quest	Characteristics	All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
		n=1490		n=30	n=58	n=48	n=1354	
		n (%)		**n (%)**	**n (%)**	**n (%)**	**n (%)**	
1.3	**Marital Status**							**n.s.**
	Never Married	20 (1.4%)		0	1 (1.7%)	1 (2.1%)	18 (1.3%)	
	Married	1289 (87.3%)		26 (86.7%)	51 (87.9%)	42 (87.5%)	1170 (87.3%)	
	Divorce/Widow	167 (11.3%)		4 (13.3%)	6 (10.3%)	5 (10.4%)	152 (11.3%)	
1.4	**Living Situation**							**n.s.**
	Living alone	121 (8.2%)		3 (10.0%)	6 (10.3%)	4 (8.3%)	108 (8.1%)	
	Living / family	1344 (91.4%)		27 (90.0%)	52 (89.7%)	44 (91.7%)	1221 (91.5%)	
	Living / friends	5 (0.3%)		0	0	0	5 (0.4%)	
1.6	**Current work**							**P=.034**
	Employed FT	1037 (70.7%)		24 (82.8%)	30 (51.7%)	31 (64.6%)	952 (71.5%)	
	Employed PT	102 (7.0%)		0	6 (10.3%)	3 (6.3%)	93 (7.0%)	
	Unemployed	49 (3.3%)		0	5 (8.6%)	3 (6.3%)	41 (3.1%)	
	Retired	279 (19.0%)		5 (17.2%)	17 (29.3%)	11 (22.9%)	246 (18.5%)	
	Retirees only	**1353**		**28**	**54**	**44**	**1227**	**P=.028**
	Employed FT	926 (68.4%)		23 (82.1%)	26 (48.1%)	27 (61.4%)	850 (69.3%)	
	Employed PT	100 (7.4%)		0	6 (11.1%)	3 (6.8%)	91 (7.4%)	
	Unemployed	49 (3.6%)		0	17 (31.5%)	3 (6.8%)	41 (3.3%)	
	Retired	278 (20.5%)		5 (17.9%)	5 (9.3%)	11 (25%)	245 (20.0%)	
1.16	**Reg PT 20–40 yr**							**.**
	Yes	1459		29	57	47	1326	**n.s**
		n=1451		n=29	n=57	n=47	n=1318	**n.s.**
	Light	92 (6.3%)		3 (10.3%)	2 (3.5%)	2 (4.3%)	85 (6.4%)	
	Moderate	678 (46.7%)		16 (55.2%)	33 (57.9%)	23 (48.9%)	606 (46.0%)	
	Heavy	681 (46.9%)		10 (34.5%)	22 (38.6%)	22 (46.8%)	627 (47.6%)	
1.7	**On disability?**							**n.s.**
	Yes	884 (59.9%)		20 (66.7%)	41 (70.7%)	30 (62.5%)	793 (59.2%)	
1.8	**Left job injured?**							
	Yes	200 (13.7%)		5 (16.7%)	11 (19.3%)	6 (12.5%)	178 (13.4%)	**n.s.**
1.9	**Medically insured?**							**n.s.**
	Yes	1443 (98.3%)		30 (100.0%)	58 (100.0%)	48 (100.0%)	1307 (98.1%)	

Table 5. Tobacco and Alcohol Use

Question		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
	Current smoker	**n=118**		**n=2**	**n=5**	**n=4**	**n=107**	
1.13a	**Total years smoked**	**n=116**		**n=2**	**n=5**	**n=4**	**n=105**	**n.s.**
	Mean	32.0		35.5	40.0	34.5	31.5	
	Median	33.0		35.5	39.0	32.5	32.0	
	Mode	20		—	—	—	20	
	Min	2		21	30	18	2	
	Max	63		50	56	55	63	
1.13b	**Cigarettes/day**	**n=11**		**n=2**	**n=5**	**n=4**	**n=100**	**n.s.**
	Mean	15.1		17.5	19.6	11.8	14.9	
	Median	15		17.5	20.0	12.5	15.0	
	Mode	20		—	20	—	20	
	Min	1		15	3	2	1	
	Max	40		20	40	20	40	
	Ex-smoker	**n=546**		**n=12**	**n=24**	**n=24**	**n=486**	
1.13c	**Years since last smoke**	n=542		n=12	n=24	n=24	n=482	**n.s.**
	Mean	23.8		24.0	24.9	24.4	23.7	
	Median	26.0		26.5	26.0	26.0	26.0	
	Mode	30		—	—	—	30	
	Min	<1		1	3	2	<1	
	Max	50		50	45	41	50	
1.13d	**Total years smoked**	n=538		n=12	n=24	n=23	n=479	**n.s.**
	Mean	14.3		19.2	16.1	12.5	14.2	
	Median	10.0		21.0	14.5	13.0	10.0	
	Mode	10		—	—	—	10	
	Min	1		1	1	1	1	
	Max	59		31	41	30	59	
1.13e	**Cigarettes/day**	n=539		n=12	n=24	n=24	n=479	**P=.049**
	Mean	17.7		21.7	21.9	13.5	17.6	
	Median	20.0		20.0	20.0	10.0	20.0	
	Mode	20		—	20	10	20	
	Min	1		5	5	1	1	
	Max	60		40	40	40	60	
		n (%)		**n (%)**	**n (%)**	**n (%)**	**n (%)**	
1.13	**Smoked >100 cigs/life**	**673 (45.2%)**		**14 (46.7%)**	**29 (50%)**	**29 (60.4%)**	**601 (44.4%)**	**n.s.**
1.14	**Alcohol binge drinking**							**n.s.**
	Never	757 (51.2%)		17 (56.7%)	34 (59.6%)	22 (45.8%)	684 (50.9%)	
	Less than monthly	269 (18.2%)		4 (13.3%)	8 (14.0%)	6 (12.5%)	251 (18.7%)	
	1–9 times / month	309 (20.9%)		8 (26.7%)	10 (17.5%)	15 (31.3%)	276 (20.6%)	
	10–20 times / month	95 (6.4%)		0	4 (7.0%)	1 (2.1%)	90 (6.7%)	
	>20 x month	48 (3.2%)		1 (3.3%)	1 (1.8%)	4 (8.3%)	42 (3.1%)	
1.15	**Alcohol > past (Yes)**	803 (54.1%)		17 (56.7%)	37 (64.9%)	22 (45.8%)	727 (53.9%)	**n.s**
1.15a	**> How many years ago**	$\bar{X}$=18.6 years		$\bar{X}$=19.8 years	$\bar{X}$=20.7 years	$\bar{X}$=17.0 years	$\bar{X}$=18.5 years	**n.s**
1.15b	**Describe frequency**							**n.s.**
	>20 times / month	186 (23.3%)		5 (29.4%)	9 (24.3%)	4 (18.2%)	168 (23.2%)	
	10–20 times / month	221 (27.7%)		6 (35.3%)	10 (27.0%)	7 (31.8%)	198 (27.4%)	
	1–9 times / month	320 (40.1%)		5 (29.4%)	18 (48.6%)	10 (45.5%)	287 (39.7%)	
	Less than monthly	72 (9.0%)		1 (5.9%)	0	1 (4.5%)	70 (9.7%)	

Table 6. Navy Characteristics of Survey Respondents

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
2.2	**Yrs on active duty**	**n=1484**		**n=30**	**n=58**	**n=47**	**n=1349**	**n.s.**
	Mean	23.6		24.8	24.5	24.3	23.5	
	Median	23		24.5	23.5	23	23	
	Mode	20		20	20	20	20	
	Min	6		18	20	20	6	
	Max	43		31	33	36	43	
		n (%)		**n (%)**	**n (%)**	**n (%)**	**n (%)**	
2.1	**Current status**	**n=1485**		**n=30**	**n=58**	**n=48**	**n=1349**	**n.s.**
	Active Duty	111 (7.6%)		1 (3.3%)	4 (6.9%)	4 (8.3%)	102 (7.6%)	
	Retired from AD	1371 (91.9%)		29 (96.7%)	54 (93.1%)	44 (91.7%)	1244 (92.1%)	
	Ret. from Reserves	3 (0.2%)		0	0	0	3 (0.2%)	
2.3	**Highest pay grade**	**n=1486**						**n.s.**
	Officer	**n=526 (35.4%)**		**n=9**	**n=19**	**n=12**	**n=486**	
	O-1	1 (0.1%)		0	0	0	1(0.1%)	
	O-2	11 (0.7%)		0	0	0	11 (0.8%)	
	O-3	75 (5.0%)		0	5 (8.6%)	2 (4.3%)	68 (5.0%)	
	O-4	189 (12.7%)		6 (20.0%)	7 (12.1%)	4 (8.5%)	172 (12.7%)	
	O-5	134 (9.0%)		0	5 (8.6%)	5 (10.6%)	124 (9.2%)	
	O-6	109 (7.4%)		3(10.0%)	2 (3.4%)	1 (2.1%)	103 (7.6%)	
	O-7	5 (0.3%)		0	0	0	5 (0.4%)	
	O-8	1 (0.1%)		0	0	0	1 (0.1%)	
	O-9	1 (0.1%)		0	0	0	1 (0.1%)	
	Warrant	**n=76 (5.1%)**		**n=4**	**n=3**	**n=3**	**n=66**	
	W-1	0		0	0	0	0	
	W-2	11 (0.7%)		1 (3.3%)	0	0	10 (0.7%)	
	W-3	22 (1.5%)		0	1 (1.7%)	2 (4.3%)	19 (1.4%)	
	W-4	40 (2.7%)		3 (10.0%)	2 (3.4%)	1 (2.1%)	34 (2.5%)	
	W-5	3 (0.2%)		0	0	0	3 (0.2%)	
	Enlisted	**n=884 (59.5%)**		**n=17**	**n=36**	**n=32**	**n=799**	
	E-4	2(0.1%)		0	0	0	2 (0.1%)	
	E-5	7 (0.5%)		0	0	0	7 (0.5%)	
	E-6	116 (7.8%)		0	2 (3.4%)	4 (8.5%)	110 (8.1%)	
	E-7	292 (19.6%)		5 (16.7%)	4 (6.9%)	12 (25.5%)	271 (20.1%)	
	E-8	211 (14.2%)		5 (16.7%)	10 (17.2%)	6 (12.8%)	190 (14.1%)	
	E-9	256 (17.2%)		7 (23.3%)	20 (34.5%)	10 (21.3%)	219 (16.2%)	

Table 7. Diving History

Ques		All Divers		Sat Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
		n (%)		n (%)	n (%)	n (%)	n (%)	
3.1	**Type of Navy diving**	**n=1488**		**n=30**	**n=58**	**n=48**	**n=1352**	**P=.000**
	Saturation	n=69 (4.6%)		5 (16.7%)	11 (19.0%)	4 (8.3%)	49 (3.6%)	
	Sat / Exp	n=281 (18.9%)		16 (53.3%)	24 (41.4%)	24 (50.0%)	217 (16.1%)	
	Experimental	n=189 (12.7%)		3 (10.0%)	11 (19%)	13 (27.1%)	162 (12.0%)	
	Standard	n=780 (52.4%)		5 (16.7%)	10 (17.2%)	6 (12.5%)	759 (56.1%)	
	None of the above	n=169 (11.4%)		1 (3.3%)	2 (3.4%)	1 (2.1%)	165 (12.2%)	
3.2	**Perm stopped diving**							
	Navy (n=1464) Yes	1324 (90.6%)		27 (90.0%)	52 (89.7%)	41 (87.2%)	1204 (90.6%)	**n.s.**
	NN* (n=1078) Yes	518 (48.1%)		10 (41.7%)	19 (48.7%)	18 (50.0%)	471 (48.1%)	**n.s.**
3.2	**Records of dives**							
	Navy **(**n=1452) Yes	672 (46.0%)		14 (46.7%)	27 (46.6%)	24 (53.3%)	607 (46.0%)	**n.s.**
	NN (n=1088) Yes	228 (21.0%)		6 (24.0%)	13 (32.5%)	9 (25.7%)	200 (20.2%)	**n.s.**
2.6	**Age 1st dive training**	**n=1483**		**n=30**	**n=58**	**n=47**	**n=1348**	**P=.039**
	Mean (years)	23.5		23.7	22.5	22.3	23.6	
	Median	23.0		23.0	22.0	22.0	23.0	
	Mode	21		20	23	23	21	
	Min	14		18	19	14	15	
	Max	47		34	36	31	47	
2.7	**Yrs diving Active Duty**	**n=1482**		**n=30**	**n=57**	**n=47**	**n=1348**	**P=.001**
	Mean (years)	18.4		20.7	20.3	20.2	18.2	
	Median	19.0		20.5	20.0	20.0	19.0	
	Mode	20		25	20	18	20	
	Min	1		12	5	4	1	
	Max	40		29	31	36	40	
3.2	**Yrs ago 1st Navy dive**	**n=1463**		**n=30**	**n=58**	**n=48**	**n=1327**	**P=.000**
	Mean (years)	31.9		34.3	36.0	32.2	31.6	
	Median	31.0		35.5	37.0	33.0	30.0	
	Mode	27		41	40	21	27	
	Min	13		21	13	20	20	
	Max	59		50	54	55	59	
3.2	**Yrs ago 1st NN dive**	**n=1003**		**n=24**	**n=40**	**n=28**	**n=911**	**P=.006**
	Mean (years)	33.2		39.2	35.0	32.4	33.0	
	Median	33.0		38.0	36.0	31.0	33.0	
	Mode	34		34	33	36	34	
	Min	0		23	10	6	0	
	Max	65		51	52	52	65	
3.2	**Yrs Last Navy dive**	**n=1425**		**n=29**	**n=57**	**n=47**	**n=1292**	**n.s.**

	Mean (years)	13.1		13.6	15.4	12.0	13.0	
	Median	14.0		12.0	17.0	13.0	13.0	
	Mode	0		0	17	8	0	
	Min	0		0	0	0	0	
	Max	38		28	30	26	38	
3.2	**Yrs ago Last NN dive**	**n=976**		**n=26**	**n=37**	**n=29**	**n=884**	**n.s.**
	Mean (years)	11.3		11.5	9.3	10.9	11.4	
	Median	10.0		8.0	5.0	7.0	10.0	
	Mode	0		0	0	0	0	
	Min	0		0	0	0	0	
	Max	51		51	45	40	50	

* NN indicates “non-Navy.”

Table 8. Quantity of Navy and Non-Navy Dives by Type of Diving

Ques		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
3.3	**Navy dives**			**n (%)**	**n (%)**	**n (%)**	**n (%)**	
	Air or MG No-D	**n=1464**		**n=30**	**n=58**	**n=48**	**n=1328**	**n.s.**
	None	6 (0.4%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (0.5%)	
	1–100	268 (18.3%)		3 (10.0%)	3 (5.2%)	7 (14.6%)	255 (19.2%)	
	101–500	609 (41.6%)		15 (50.0%)	28 (48.3%)	19 (39.6%)	547 (41.2%)	
	501–1000	346 (23.6%)		7 (23.3%)	17 (29.3%)	13 (27.1%)	309 (23.3%)	
	>1000	235 (16.1%)		5 (16.7%)	10 (17.2%)	9 (18.8%)	211 (15.9%)	
	Air or MG Decomp	**n=1433**		**n=30**	**n=58**	**n=48**	**n=1297**	**P=.007**
	None	131 (9.1%)		0 (0.0%)	2 (3.4%)	2 (4.2%)	127 (9.8%)	
	1–100	1060 (74.0%)		21 (70.0%)	41 (70.7%)	31 (64.6%)	967 (74.6%)	
	101–500	204 (14.2%)		9 (30.0%)	13 (22.4%)	14 (29.2%)	168 (13.0%)	
	501–1000	25 (1.7%)		0 (0.0%)	2 (3.4%)	1 (2.1%)	22 (1.7%)	
	>1000	13 (0.9%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	13 (1.0%)	
	Air or MG Sur D O_2	**n=1388**		**n=30**	**n=57**	**n=47**	**n=1254**	**P=.002**
	None	471 (33.9%)		3 (10.0%)	10 (17.5%)	8 (17.0%)	450 (35.9%)	
	1–100	819 (59.0%)		27 (90.0%)	44 (77.2%)	35 (74.5%)	713 (56.9%)	
	101–500	78 (5.6%)		0 (0.0%)	2 (3.5%)	4 (8.5%)	72 (5.7%)	
	501–1000	15 (1.1%)		0 (0.0%)	1 (1.8%)	0 (0.0%)	14 (1.1%)	
	>1000	5 (0.4%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.4%)	
	Saturation	**n=1361**		**n=30**	**n=57**	**n=47**	**n=1227**	**P=.000**
	None	1020 (74.9%)		7 (23.3%)	22 (38.6%)	20 (42.6%)	971 (74.9%)	
	1–10	233 (17.1%)		17 (56.7%)	12 (21.1%)	16 (34.0%)	188 (17.1%)	
	11–50	94 (6.9%)		5 (16.7%)	19 (33.3%)	11 (23.4%)	59 (6.9%)	
	51–100	12 (0.9%)		1 (3.3%)	4 (7.0%)	0 (0.0%)	7 (0.9%)	
	>100	2 (0.1%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.1%)	
3.4	**Non-Navy dives**							
	Air or MG No-D	**n=1463**		**n=30**	**n=58**	**n=48**	**n=1327**	**n.s**
	None	241 (16.5%)		0 (0.0%)	11 (19.0%)	8 (16.7%)	222 (16.7%)	
	1–100	760 (51.9%)		14 (46.7%)	28 (48.3%)	31 (64.6%)	687 (51.8%)	
	101–500	334 (22.8%)		10 (33.3%)	13 (22.4%)	6 (12.5%)	305 (23.0%)	
	501–1000	78 (5.3%)		4 (13.3%)	3 (5.2%)	2 (4.2%)	69 (5.2%)	
	>1000	50 (3.4%)		2 (6.7%)	3 (5.2%)	1 (2.1%)	44 (3.3%)	
	Air or MG Decomp	**n=1370**		**n=28**	**n=56**	**n=47**	**n=1239**	**n.s.**
	None	1049 (76.6%)		18 (64.3%)	47 (83.9%)	41 (87.2%)	943 (76.1%)	
	1–100	295 (21.5%)		10 (35.7%)	9 (16.1%)	6 (12.8%)	270 (21.8%)	
	101–500	20 (1.5%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	20 (1.6%)	
	501–1000	2 (0.1%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.2%)	
	>1000	4 (0.3%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (0.3%)	
	Air or MG Sur-D O_2	**n=1352**		**n=28**	**n=56**	**n=47**	**n=1221**	**n.s.**
	None	1307 (96.7%)		27 (96.4%)	56 (100.00%)	46 (97.9%)	1178 (96.5%)	
	1–100	39 (2.9%)		1 (3.6%)	0 (0.0%)	1 (2.1%)	37 (3.0%)	
	101–500	3 (0.2%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.2%)	
	501–1000	3 (0.2%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.2%)	

	Saturation	**n=1347**		**n=28**	**n=56**	**n=47**	**n=1216**	**n.s.**
	None	1336 (99.2%)		28 (100.0%)	56 (100.0%)	47 (100.0%)	1205(99.1%)	
	1–10	8 (0.6%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (0.7%)	
	11–50	2 (0.1%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.2%)	
	51–100	1 (0.1%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.1%)	
	>100	0 (0.0%)		0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	

Table 9. Diving Injuries (Incurred One or More Times) and Treatments

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
3.5	**Diagnosed or treated for**	**n=1467**		**n=30**	**n=56–58**	**n=48**	**n=1308–1331**	
				n (%)	**n (%)**	**n (%)**	**n (%)**	
	Neurological DCS	224 (15.3%)		6 (20.0%)	15 (25.9%)	8 (16.7%)	195 (14.6%)	**P=.032**
	Pain-only DCS	327 (22.3%)		11 (36.7%)	23 (39.7%)	13 (27.1%)	280 (21.0%)	**P=.008**
	Air gas embolism	58 (4.0%)		0 (0.0%)	3 (5.4%)	2 (4.2%)	53 (4.0%)	**n.s.**
	Underwater explosion	93 (6.4%)		2 (6.7%)	3 (5.3%)	5 (10.4%)	83 (6.3%)	**n.s.**
	LOC under pressure	100 (6.9%)		3 (10.0%)	9 (15.8%)	6 (12.5%)	82 (6.2%)	**P=.013**
	Contaminated gas	195 (13.5%)		9 (30.0%)	9 (15.8%)	4 (8.3%)	173 (13.2%)	**n.s.**
	O_2 toxicity – seizure	37 (2.6%)		1 (3.3%)	2 (3.5%)	0 (0.0%)	34 (2.6%)	**n.s.**
	Compression arthralgia	148 (10.2%)		7 (23.3%)	18 (31.6%)	14 (29.2%)	109 (8.3%)	**P=.000**
	O_2 toxicity – lungs	52 (3.6%)		1 (3.3%)	3 (5.3%)	2 (4.2%)	46 (3.5%)	**n.s.**
	1 or more of above	587 (41.3%)		19 (63.3%)	33 (76.8%)	28 (58.3%)	507 (39.4%)	
3.6	**Symptoms not treated**	**n=1481**		**n=30**	**n=48**	**n=58**	**n=1345**	**n.s.**
	Yes	n=372 (25.1%)		6 (20.0%)	21 (36.2%)	15 (31.3%)	330 (24.5%)	
3.7	**Symptoms resolved**	**n=371**		**n=6**	**n=21**	**n=15**	**n=329**	**n.s.**
	<1 week	280 (75.5%)		5	16	8	251	
	1 week to 1 month	54 (14.6%)		0	2	4	48	
	2–6 months	7 (1.9%)		0	0	0	7	
	6–12 months	1 (0.3)		0	0	0	1	
	>1 year	6 (1.6%)		1	0	0	5	
	Never	23 (6.2%)		0	3	3	17	
3.8	**Episodes requiring recompression for:**	**n=1488**		**n=30**	**n=58**	**n=48**	**n=1352**	
	Neuro DCS	200		3	15	8	174	**P=.032**
	Pain DCS	273		9	16	12	236	**P=.043**
	AGE	48		0	3	2	43	**n.s.**
	Other	78		4	7	3	64	**P=.017**

Table 10. Occupational Exposures (Navy and Non-Navy)

Ques		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
2.9	**In combat theater**	**n=1475**		**n=30**	**n=58**	**n=47**	**n=1340**	**n.s.**
	Yes	910 (61.7%)		19 (63.3%)	35 (60.3%)	26 (55.3%)	830 (60.3%)	
2.11	**Yrs since last exam**	**n=1429**		**n=30**	**n=57**	**n=44**	**n=1298**	**n.s.**
	Mean (years)	3.8		4.2	4.1	5.1	3.8	
	Median	1.0		1.5	1	1	1	
	Mode	0		0	0	0	0	
	Min	0		0	0	0	0	
	Max	39		23	24	39	33	
2.10	**Lost 3 days work**	**n=1465**		**n=29**	**n=58**	**n=46**	**n=1332**	**n.s.**
		n (%)		**n (%)**	**n (%)**	**n (%)**	**n (%)**	
	No	676 (46.1%)		13 (44.8%)	20 (34.5%)	22 (47.8%)	621 (46.6%)	
	Once	279 (19.0%)		6 (20.7%)	9 (15.5%)	8 (17.4%)	256 (19.2%)	
	More than once	510 (34.8%)		10 (34.5%)	29 (50.0%)	16 (34.8%)	455 (34.2%)	
2.8	**Exposed to:**	**n=827–1490**		**n=19–30**	**n=30–58**	**n=24–48**	**n=827–1485**	
	Solvents	1309 (91.2%)		28 (93.3%)	53 (93.9%)	42 (91.3%)	1186 (91.0%)	**n.s.**
	Hydrogen sulfide	347 (42.0%)		10 (52.6%)	17 (56.7%)	11 (45.8%)	309 (41.0%)	**n.s.**
	Radiation	1287 (92.1%)		28 (93.3%)	48 (92.3%)	42 (93.3%)	1169 (92.0%)	**n.s.**
	Lead	1306 (92.6%)		30 (100.0%)	53 (91.4%)	42 (93.3%)	1181 (92.4%)	**n.s.**
	Paints / chromium	783 (80.9%)		21 (95.5%)	40 (87.0%)	27 (87.1%)	695 (80.0%)	**n.s.**
	Mercury	550 (57.9%)		17 (77.3%)	27 (71.1%)	15 (57.7%)	491 (56.8%)	**n.s.**
	Asbestos	1128 (88.9%)		26 (96.3%)	47 (90.4%)	35 (87.5%)	1020 (88.7%)	**n.s.**
	Pesticides	990 (81.5%)		22 (91.7%)	45 (90.0%)	32 (86.5%)	891 (80.8%)	**n.s.**
	Carbon monoxide	1065 (82.0%)		25 (89.3%)	44 (86.3%)	35 (87.5%)	961 (81.4%)	**n.s.**
	Noise	1480 (99.7%)		30 (100.0%)	58 (100.0%)	48 (100.0%)	1344 (99.6%)	**n.s.**
	Contaminated gas	484 (47.2%)		13 (65.0%)	21 (52.5%)	17 (58.6%)	433 (46.3%)	**n.s.**

Table 11. Welding History

Ques		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
				n (%)	n (%)	n (%)	n (%)	
2.12	**Worked as welder**	**n=1488**		**n=30**	**n=48**	**n=58**	**n=1352**	**n.s.**
	Yes	466 (31.3%)		13 (43.3%)	21 (36.2%)	18 (37.5%)	414 (30.6%)	
2.16	**Permanently stopped**	**n=477**		**n=13**	**n=20**	**n=18**	**n=426**	**n.s.**
	Yes	392 (82.2%)		10 (76.9%)	16 (80.0%)	14 (77.8%)	352 (82.6%)	
2.13	**Yrs since started weld**	**n=466**		**n=13**	**n=21**	**n=18**	**n=414**	**P=.047**
	Mean (years)	32.0		37.7	33.8	33.6	31.6	
	Median	32.0		36.0	36.0	33.5	32.0	
	Mode	31		Multiple	42	Multiple	31	
	Min	1		22	19	16	1	
	Max	55		52	45	54	55	
2.14	**Yrs since last weld job**	**n=460**		**n=13**	**n=21**	**n=17**	**n=409**	**n.s.**
	Mean (years)	16.8		15.5	14.7	20.5	16.8	
	Median	19.0		19.0	15.0	20.0	19.0	
	Mode	0		20	0	Multiple	0	
	Min	0		0	0	1	0	
	Max	50		38	42	40	50	
2.15	**Total years welding**	**n=460**		**n=13**	**n=21**	**n=18**	**n=408**	**n.s.**
	Mean (years)	13.2		18.7	18.3	12.5	12.8	
	Median	10.0		17	18.0	9.0	10.0	
	Mode	1		Multiple	3	1	1	
	Min	0		1	1	0	0	
	Max	51		46	40	31	51	
2.17	**% weld by location:**	**n=469**		**n=13**	**n=21**	**n=18**	**n=417**	
	Outdoors (Yes)	377 (80.4%)		12 (92.3%)	20 (95.2%)	13 (72.2%)	332 (79.6%)	**n.s.**
	% time weld outdoors							
	Mean (%)	33.5		37.8	40.9	20.2	33.6	**n.s.**
	Median	25.0		33.0	30.0	14.5	25.0	
	Mode	0		10	Multiple	0	0	
	Min	0		0	0	0	0	
	Max	100		99	100	75	100	
	Indoors, well ventilated	**n=467**		**n=13**	**n=21**	**n=18**	**n=415**	
	Indoors (Yes)	364 (77.9%)		11 (84.6%)	18 (85.7%)	12 (66.7%)	323 (77.8%)	**n.s.**
	% time weld indoors							
	Mean (%)	32.0		30.5	33.1	25.0	32.4	**n.s.**
	Median	25.0		25.0	25.0	25.0	25.0	
	Mode	0		multiple	10	0	0	
	Min	0		0	0	0	0	
	Max	100		85	80	100	100	
	Poor ventilation	**n=464**		**n=13**	**n=21**	**n=18**	**n=412**	
	Indoors (Yes)	249 (53.7%)		8 (61.5%)	11 (52.4%)	9 (50.0%)	221 (53.6%)	**n.s**
	% time weld indoors							
	Mean (%)	14.6		14.8	10.0	10.0	15.0	**n.s.**
	Median	5.0		5.0	5.0	2.5	5.0	
	Mode	0		0	0	0	0	
	Min	0		0	0	0	0	

	Max	100		60	90	50	100	
	Dry pressurized	**n=463**		**n=13**	**n=21**	**n=18**	**n=411**	
	(Yes)	41 (8.9%)		3 (23.1%)	1 (4.8%)	4 (22.2%)	33 (8.0%)	**P=.045**
	% time weld dry press							
	Mean (%)	0.9		1.8	0.2	2.22	0.8	**n.s.**
	Median	0.0		0.0	0.0	0.0	0.0	
	Mode	0		0	0	0	0	
	Min	0		0	0	0	0	
	Max	35		20	5	15	35	
	Wet pressurized	**n=468**		**n=13**	**n=21**	**n=18**	**n=468**	
	(Yes)	310 (66.2%)		10 (76.9%)	15 (71.4%)	15 (83.3%)	270 (64.9%)	**n.s.**
	% time weld wet press							
	Mean (%)	19.4		16.2	22.7	37.3	18.6	**n.s.**
	Median	3.0		5.0	5.0	15.0	2.0	
	Mode	0		Multiple	0	Multiple	0	
	Min	0		0	0	0	0	
	Max	100		85	100	100	100	
2.18	**Use protective gear**							
	Simple dust mask	**n=448**		**n=13**	**n=20**	**n=18**	**n=397**	
	Yes	145 (32.4%)		5 (38.5%)	9 (45.0%)	3 (16.7%)	128 (32.2%)	**n.s.**
	Mean (%)	15.3		14.3	21.0	5.8	15.4	**n.s.**
	Median	0.0		0.0	0.0	0.0	0.0	
	Mode	0		0	0	0	0	
	Min	0		0	0	0	0	
	Max	100		97	100	50	100	
	Filter respirator	**n=448**		**n=13**	**n=20**	**n=18**	**n=397**	
	Yes	99 (22.1%)		1 (7.7%)	4 (20.0%)	4 (22.2%)	90 (22.7%)	**n.s.**
	Mean (%)	6.6		2.3	2.6	5.3	7.0	**n.s.**
	Median	0.0		0.0	0.0	0.0	0.0	
	Mode	0		0	0	0	0	
	Min	0		0	0	0	0	
	Max	100		30	30	50	100	
	Supply respirator	**n=449**		**n=13**	**n=20**	**n=18**	**n=398**	
	Yes	120 (26.7%)		3 (23.1%)	3 (15.0%)	6 (33.3%)	108 (27.1%)	**n.s.**
	Mean (%)	7.4		4.3	4.8	8.1	7.6	**n.s.**
	Median	0.0		0.0	0.0	0.0	0.0	
	Mode	0		0	0	0	0	
	Min	0		0	0	0	0	
	Max	100		40	80	80	100	
2.19	**Welding techniques**							
	Arc	**n=377**		**n=12**	**n=17**	**n=12**	**n=336**	
	Total days used							
	Mean (days)	798.6		1129.8	981.2	631.3	783.5	**n.s.**
	Median	210.0		490.0	640.0	155.0	205.0	
	Mode	60		multiple	30	multiple	60	
	Min	1		7	5	12	1	
	Max	13260		6000	2475	5200	13260	
	MIG	**n=215**		**n=6**	**n=8**	**n=7**	**n=194**	
	Total days used							
	Mean (days)	573.2		1156.7	559.8	353.9	563.6	**n.s.**
	Median	140.0		200.0	350.0	30.0	145.0	
	Mode	10		200	Multiple	Multiple	10	

	Min	1		10	5	2	1	
	Max	6000		6000	2475	2250	6000	
	TIG	**n=170**		**n=6**	**n=4**	**n=6**	**n=154**	
	Total days used							
	Mean (days)	532.0		832.5	936.2	477.5	511.9	**n.s.**
	Median	100.0		150.0	820.0	45.0	100.0	
	Mode	5		Multiple	Multiple	Multiple	Multiple	
	Min	1		10	5	5	1	
	Max	6000		4000	2100	2250	6000	

Table 12. Welding Injuries

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
2.20	**Diagnosed/Treated for:**	**n=458**		**n=13**	**n=20**	**n=18**	**n=407**	
	Metal fume fever (Yes)	58 (12.7%)		2	4	2	50	**n.s.**
	Mean (# times)	5.1						
	Median	2						
	Mode	1						
	Min	1						
	Max	101						
		n=453						
	Major electric shock (Yes)	31 (6.8%)		1	0	2	28	**n.s.**
	Mean (# times)	2.1						
	Median	1						
	Mode	1						
	Min	1						
	Max	10						
		n=451						
	Nonminor burns (Yes)	50 (11.1%)		0	3	1	46	**n.s.**
	Mean (# times)	8.1						
	Median	4						
	Mode	1						
	Min	1						
	Max	101						
		n=464						
	Eye damage (Yes)	173 (37.3%)		4	9	6	154	**n.s.**
	Mean (# times)	3.7						
	Median	2						
	Mode	1						
	Min	1						
	Max	101						
	Suffered at least 1 welding	**n=468**		**n=13**	**n=18**	**n=21**	**n=416**	
	injury (Yes)	201 (42.9%)		5 (38.5%)	10 (47.6%)	6 (33.3%)	180 (43.3%)	**n.s.**

Table 13. Medical History: Conditions Marked “Moderately” or “Extremely”

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
4.1	**Do you suffer from:**	**n=1466–1486**		**n=29–30**	**n=57–58**	**n=47–48**	**n=1332–1351**	
		N (%)		**N (%)**	**N (%)**	**N (%)**	**N (%)**	
	Joint pain/muscle stiff	933 (62.8%)		16 (53.3%)	41 (70.1%)	34 (70.8%)	842 (62.4%)	**n.s.**
	Back or neck pain	870 (58.6%)		18 (60.0%)	42 (72.4%)	32 (66.7%)	778 (57.7%)	**n.s.**
	Breathlessness	127 (8.7%)		3 (10.3%)	4 (6.9%)	3 (6.4%)	117 (8.8%)	**n.s.**
	Cough or wheeze	107 (7.2%)		2 (6.7%)	3 (5.2%)	3 (6.2%)	99 (7.4%)	**n.s.**
	Abdom pain, diarrhea	110 (7.4%)		0 (0.0%)	4 (6.9%)	4 (8.5%)	102 (7.6%)	**n.s.**
	Muscle weak / tremor	140 (9.5%)		1 (3.3%)	12 (20.7%)	2 (4.3%)	125 (9.3%)	**P=.030**
	Unsteady/dizzy/balance	106 (7.2%)		2 (6.7%)	5 (8.8%)	5 (10.4%)	94 (7.0%)	**n.s.**
	Forgetfulness	216 (14.6%)		2 (6.9%)	14 (24.1%)	10 (20.8%)	190 (14.1%)	**n.s.**
	Poor eyesight	114 (7.7%)		2 (6.7%)	7 (12.3%)	7 (14.6%)	98 (7.3%)	**n.s.**
	Impaired hearing	581 (39.2%)		13 (43.3%)	41 (71.9%)	19 (39.6%)	508 (37.7%)	**P=.000**
	Skin rash or itch	107 (7.2%)		2 (6.7%)	5 (8.6%)	5 (10.6%)	95 (7.0%)	**n.s.**
	Abnormal skin sense	137 (9.2%)		3 (10.0%)	7 (12.1%)	6 (12.5%)	121 (8.9%)	**n.s.**

Table 14. Medical History: Diagnosed Conditions

Quest	Have you been diagnosed with:	All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
		n=1440–1484		n=29–30	n=57–58	n=46–48	n=1308–1348	
	(Answered "Yes")							
		n (%)		n (%)	n (%)	n (%)	n (%)	
4.2	Asthma / obstr lung dis	124 (8.4%)		3 (10.0%)	5 (8.6%)	4 (8.3%)	112 (8.3%)	n.s.
	Chronic bronchitis	99 (6.7%)		3 (10.0%)	5 (8.6%)	2 (4.2%)	89 (6.6%)	n.s.
	Other lung disease	88 (6.1%)		1 (3.4%)	4 (7.0%)	3 (6.5%)	80 (6.1%)	n.s.
	Heart attack / disease	148 (10.0%)		6 (20%)	8 (13.8%)	5 (10.4%)	129 (9.6%)	n.s.
	Stroke	24 (1.6%)		0 (0.0%)	0 (0.0%)	1 (2.1%)	23 (1.7%)	n.s.
	High blood pressure	605 (40.8%)		15 (50.0%)	31 (53.4%)	22 (45.8%)	537 (39.8%)	n.s.
	Cancer	219 (14.8%)		2 (6.7%)	5 (8.6%)	10 (20.8%)	202 (15.0%)	n.s.
	Depression / anxiety	278 (18.8%)		6 (20.0%)	18 (31.0%)	7 (14.6%)	247 (18.4%)	n.s.
	Other mental illness	62 (4.2%)		0 (0.0%)	6 (10.3%)	1 (2.1%)	55 (4.1%)	n.s.
	Diabetes	106 (7.2%)		6 (20.0%)	5 (8.6%)	2 (4.3%)	93 (6.9%)	P=.040
	Sports injury	958 (64.9%)		17 (56.7%)	34 (59.6%)	30 (65.2%)	877 (65.3%)	n.s.
	Ulcer	126 (8.6%)		2 (6.7%)	10 (17.5%)	4 (8.3%)	110 (8.3%)	n.s.
	Skin disease	785 (53.3%)		16 (53.3%)	36 (63.3%)	29 (60.4%)	704 (52.7%)	n.s.
	Allergies / hay fever	581 (39.7%)		7 (23.3%)	29 (50.9%)	19 (41.3%)	526 (39.5%)	n.s.
	Head injury	426 (29.0%)		11 (36.7%)	24 (41.4%)	12 (25.5%)	379 (28.4%)	n.s.
	Dysbaric bone necros	68 (4.6%)		3 (10.0%)	4 (6.9%)	5 (10.4%)	56 (4.2%)	n.s.
	Arthritis / joint disease	840 (57.0%)		21 (70.0%)	37 (64.9%)	35 (72.9%)	747 (55.8%)	P=.026
	Epilepsy	21 (1.4%)		0 (0.0%)	3 (5.2%)	0 (0.0%)	18 (1.3%)	n.s.
	Migraines	170 (11.6%)		1 (3.3%)	6 (10.3%)	6 (12.5%)	157 (11.8%)	n.s.
	Sensory / motor neurop	183 (12.5%)		3 (10.0%)	12 (21.1%)	2 (4.2%)	166 (12.5%)	n.s.
	Vibration white finger	32 (2.2%)		0 (0.0%)	2 (3.4%)	1 (2.1%)	29 (2.2%)	n.s.
	Chronic infect disease	91 (6.2%)		0 (0.0%)	2 (3.4%)	2 (4.2%)	87 (6.5%)	n.s.

Table 15. Other Lung Disease

Ques 4.2	Other Lung Diseases (n=70)	n
Write-ins	Pneumonia	19
	Chronic Obstructive Pulmonary Disease	10
	Reactive Airway Disease	8
	Pulmonary Embolism	6
	Asbestosis	5
	Bronchitis	4
	Cancer	3
	Tuberculosis	3
	Emphysema	2
	Pneumothorax	2
	Amyloidosis	1
	Atelectasis	1
	Bleb	1
	Granulomatous Disease	1
	Histoplasmosis	1
	Pertussis	1
	Pleurisy	1
	Pulmonary Overinflation Syndrome	1
	Sarcoidosis	1
	Tumor	1
TOTAL:		72*

* Two divers experienced more than one lung disease.

Table 16. Joint Replacement

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
				n (%)	**n (%)**	**n (%)**	**n (%)**	
4.3	**Had/scheduled to replace joint**	**n=1482**		**n=29**	**n=58**	**n=47**	**n=1348**	
	Yes	102 (6.9%)		1 (3.4%)	3 (5.2%)	5 (10.6%)	93 (6.9%)	**n.s.**
	If yes, which?							
	Knee							
	Single	39						
	Both	11						
	Hip							
	Single	20						
	Both	11						
	Shoulder							
	Single	6						
	Both	4						
	Other joint							
	Single	5						
	Multiple	1						
4.4	**Need joint replaced in future**	**n=1478**		**n=30**	**n=58**	**n=47**	**n=1343**	
	Yes	342 (22.9%)		5 (16.7%)	15 (25.9%)	15 (31.9%)	307 (22.9%)	**n.s.**
	If yes, which?							
	Knee							
	Single	141						
	Both	109						
	Hip							
	Single	54						
	Both	20						
	Shoulder							
	Single	24						
	Both	10						
	Other joint							
	Single	13						
	Multiple	5						
4.5	**Age at 1st replacement**	**n=83**		**n=1**	**n=1**	**n=4**	**n=77**	
	(% of diver group)	(5.6%)		(3.3%)	(1.7%)	(8.3%)	(5.7%)	
	Mean (years)	54.8		65.0	69.0	62.2	54.1	
4.6	**Reason for replacement**	**n=273**		**n=4**	**n=11**	**n=14**	**n=244**	
	Pathologic fracture	9		0	1	1	7	
	Pain / activity limits	180		3	8	9	160	
	Other	33		0	1	3	29	
	Multiple categories used	51		1	1	1	48	

Table 17. International Physical Activity Questionnaire: Total Physical Activity

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
5								
	Activity Level	**n=1490**		**n=30**	**n=58**	**n=48**	**n=1354**	**n.s.**
	High	793 (53.2%)		15 (50.0%)	29 (50.0%)	31 (64.6%)	718 (53.0%)	
	Moderate	456 (30.6%)		11 (36.7%)	18 (31.0%)	10 (20.8%)	417 (30.8%)	
	Low	241 (16.2%)		4 (13.3%)	11 (19.0%)	7 (14.6%)	219 (16.2%)	
	MET-min/week	**n=1296**		**n=28**	**n=53**	**n=43**	**n=1172**	**n.s.**
	Mean	4105.6		4228.9	4155.3	5314.9	4056.0	
	Median	3192.0		3189.0	3039	3996.0	3177.0	
	Mode	0		0	0	Multiple	0	
	Minimum	0		0	0	0	0	
	Maximum	19278.0		15918	18090	19278	19278	

Table 18. International Physical Activity Questionnaire: Current Physical Activity, Last 7 Days

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
5.1	**Vigorous days/wk**	**n=1006**		**n=16**	**n=38**	**n=35**	**n=917**	**n.s.**
	Mean (days)	3.6		4.1	3.2	3.9	3.6	
	Median	3.0		4.0	3.0	4.0	3.0	
	Mode	3		5	2	5	3	
	Min	1		2	1	1	1	
	Max	7		7	7	7	7	
5.2	**Vigorous min/day**	**n=990**		**n=17**	**n=36**	**n=34**	**n=903**	**n.s.**
	Mean (min)	102.7		97.4	88.1	123.9	102.6	
	Median	60.0		60.0	90.0	90.0	60.0	
	Mode	60		60	90	60	60	
	Min	10		30	15	30	10	
	Max	600		480	300	480	600	
	Not sure	20 (1.4%)		0 (0.0%)	2 (3.5%)	1 (2.1%)	17 (1.3%)	
5.3	**Moderate days/wk**	**n=1127**		**n=20**	**n=45**	**n=39**	**n=1023**	**n.s.**
	Mean (days)	3.8		3.6	3.9	3.9	3.7	
	Median	3.0		3.0	4.0	4.0	3.0	
	Mode	2		3	5	5	2	
	Min	1		1	1	1	1	
	Max	7		7	7	7	7	
5.4	**Moderate min/day**	**n=1096**		**n=20**	**n=42**	**n=37**	**n=997**	**n.s.**
	Mean (min)	117.5		90.0	118.3	132.0	117.5	
	Median	60.0		60.0	120.0	120.0	60.0	
	Mode	60		60	120	120	60	
	Min	5		30	25	30	5	
	Max	720		240	480	360	720	
	Not sure	47 (3.2%)		0 (0.0%)	3 (5.2%)	2 (4.3%)	42 (3.2%)	
5.5	**Walking days/wk**	**n=1312**		**n=27**	**n=54**	**n=40**	**n=1191**	**n.s.**
	Mean (days)	5.2		5.3	5.3	5.4	5.2	
	Median	6.0		7.0	6.0	7.0	6.0	
	Mode	7		7	7	7	7	
	Min	1		1	1	1	1	
	Max	7		7	7	7	7	
5.6	**Walking min/day**	**n=1262**		**n=26**	**n=52**	**n=38**	**n=1146**	**n.s.**
	Mean (min)	101.6		120.2	108.7	158.4	99.0	
	Median	60.0		60.0	60.0	75.0	60.0	
	Mode	30		Multiple	Multiple	30	30	
	Min	7		15	7	8	8	
	Max	840		480	600	720	840	
	Not sure	48 (3.3%)		0 (0.0%)	3 (5.2%)	2 (4.3%)	43 (3.2%)	
5.7	**Sitting min/day**	**n=1099**		**n=28**	**n=55**	**n=43**	**n=1270**	**P=.043**
	Mean (min)	351.4		282.3	327.3	311.6	357.7	
	Median	300.0		270.0	300.0	300.0	315.0	
	Mode	240		Multiple	Multiple	120	240	
	Min	30		80	60	20	30	
	Max	900		720	900	840	1440	

	Not sure	81 (5.5%)		2 (6.7%)	3 (5.2%)	5 (10.4%)	71 (5.3%)	

Table 19. Performance on Cognitive Failures Questionnaire

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
6	**Score**	**n=1436**		**n=28**	**n=57**	**n=46**	**n=1305**	**n.s.**
	Mean	34.3		33.0	37.5	36.5	34.1	
	Median	32.0		36.0	38.0	36.0	32.0	
	Mode	Multiple		38	34	28	30	
	Minimum	0		9	2	9	0	
	Maximum	100		53	74	88	100	

Table 20. Overall Health (from the SF-12 Survey)

Ques		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
7.1	**In general, my health is:**	**n=1485**		**n=29**	**n=58**	**n=48**	**n=1350**	**n.s.**
	Excellent	189 (12.7%)		6 (20.7%)	3 (5.2%)	4 (8.3%)	176 (13.0%)	
	Very Good	548 (36.9%)		7 (24.1%)	19 (32.8%)	19 (39.6%)	503 (37.3%)	
	Good	541 (36.4%)		10 (34.5%)	26 (44.8%)	21 (43.8%)	484 (35.9%)	
	Fair	172 (11.6%)		6 (20.7%)	7 (12.1%)	3 (6.3%)	156 (11.6%)	
	Poor	35 (2.4%)		0 (0.0%)	3 (5.2%)	1 (2.1%)	31 (2.3%)	
7.2	**Health now limits your:**	**n=1486**		**n=30**	**n=58**	**n=48**	**n=1350**	**n.s.**
	Moderate activities							
	Yes, limited a lot	134 (9.0%)		4 (13.3%)	9 (15.5%)	3 (6.3%)	118 (8.7%)	
	Yes limited, a little	443 (29.8%)		11 (36.7%)	20 (34.5%)	14 (29.2%)	398 (29.5%)	
	No, not limited at all	909 (61.2%)		15 (50.0%)	29 (50.0%)	31 (64.6%)	834 (61.8%)	
	Climbing flights stairs	**n=1474**		**n=30**	**n=58**	**n=47**	**n=1339**	**n.s.**
	Yes, limited a lot	181 (12.3%)		5 (16.7%)	12 (20.7%)	6 (12.8%)	158 (11.8%)	
	Yes limited, a little	454 (30.8%)		12 (40.0%)	21 (36.2%)	13 (27.7%)	408 (30.5%)	
	No, not limited at all	839 (56.9%)		13 (43.3%)	25 (43.1%)	28 (59.6%)	773 (57.7%)	

Table 21. Health Problems (from the SF-12 Survey)

Quest		All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
		n (%)		n (%)	n (%)	n (%)	n (%)	
7.3	**Physical problems**							
	Accomplished less	**n=1487**		**n=30**	**n=58**	**n=48**	**n=1351**	**n.s.**
	All of the time	76 (5.1%)		2 (6.7%)	7 (12.1%)	0 (0.0%)	67 (5.0%)	
	Most of the time	141 (9.5%)		1 (3.3%)	7 (12.1%)	7 (14.6%)	126 (9.3&)	
	Some of the time	299 (20.1%)		8 (26.7%)	12 (20.7%)	8 (16.7%)	271 (20.1%)	
	A little of the time	396 (26.6%)		8 (27.6%)	15 (25.9%)	14 (29.2%)	359 (26.6%)	
	None of the time	575 (38.7%)		11 (36.7%)	17 (29.3%)	19 (39.6%)	528 (39.1%)	
	Were limited in kind	**n=1487**		**n=30**	**n=58**	**n=48**	**n=1351**	**n.s.**
	All of the time	83 (5.6%)		1 (3.3%)	3 (5.2%)	2 (4.2%)	77 (5.7%)	
	Most of the time	132 (8.9%)		2 (6.7%)	9 (15.5%)	3 (6.3%)	118 (8.9%)	
	Some of the time	274 (18.4%)		6 (20.0%)	12 (20.7%)	13 (27.1%)	243 (18.4%)	
	A little of the time	358 (24.1%)		10 (33.3%)	16 (27.6%)	12 (25.0%)	320 (24.1%)	
	None of the time	640 (43.0%)		11 (36.7%)	18 (31.0%)	18 (37.5%)	593 (43.0%)	
7.4	**Emotional problems**							
	Accomplished less	**n=1485**		**n=30**	**n=58**	**n=48**	**n=1349**	**n.s.**
	All of the time	24 (1.6%)		0 (0.0%)	3 (5.2%)	2 (4.2%)	19 (1.4%)	
	Most of the time	75 (5.1%)		0 (0.0%)	6 (10.3%)	1 (2.1%)	68 (5.0%)	
	Some of the time	204 (13.7%)		2 (6.7%)	10 (17.2%)	5 (10.4%)	187 (13.9%)	
	A little of the time	297 (20.0%)		6 (20.0%)	10 (17.2%)	11 (22.9%)	270 (20.0%)	
	None of the time	885 (59.6%)		22 (73.3%)	29 (50.0%)	29 (60.4%)	805 (59.6%)	
	Less carefully	**n=1478**		**n=29**	**n=58**	**n=48**	**n=1343**	**n.s.**
	All of the time	9 (0.6%)		0 (0.0%)	1 (1.7%)	0 (0.0%)	8 (0.6%)	
	Most of the time	41 (2.8%)		1 (3.4%)	4 (6.9%)	2 (4.2%)	34 (2.5%)	
	Some of the time	156 (10.6%)		0 (0.0%)	10 (17.2%)	4 (8.3%)	142 (10.6%)	
	A little of the time	318 (21.5%)		7 (24.1%)	13 (22.4%)	9 (18.8%)	289 (21.5%)	
	None of the time	954 (64.5%)		21 (72.4%)	30 (51.7%)	33 (68.8%)	870 (64.8%)	
7.5	**Pain interference**	**n=1486**		**n=30**	**n=58**	**n=48**	**n=1350**	**P=.022**
	Not at all	370 (24.9%)		7 (23.3%)	8 (13.8%)	10 (20.8%)	345 (25.6%)	
	A little bit	548 (36.9%)		8 (26.7%)	20 (34.5%)	17 (35.4%)	503 (37.3%)	
	Moderately	294 (19.8%)		11 (36.7%)	10 (17.2%)	11 (22.9%)	262 (19.4%)	
	Quite a bit	202 (13.6%)		1 (3.3%)	14 (24.1%)	9 (18.8%)	178 (13.2%)	
	Extremely	72 (4.8%)		3 (10.0%)	6 (10.3%)	1 (2.1%)	62 (4.6%)	
7.6	**Time during past 4 wks**							
	Calm & peaceful	**n=1484**		**n=30**	**n=58**	**n=48**	**n=1348**	**n.s.**
	All of the time	101 (6.8%)		4 (13.3%)	3 (5.2%)	3 (6.3%)	91 (6.8%)	
	Most of the time	829 (55.9%)		13 (43.3%)	31 (53.4%)	29 (60.4%)	756 (56.1%)	
	Some of the time	298 (20.1%)		7 (23.3%)	14 (24.1%)	8 (16.7%)	269 (20.0%)	
	A little of the time	210 (14.2%)		5 (16.7%)	8 (13.8%)	6 (12.5%)	191 (14.2%)	
	None of the time	46 (3.1%)		1 (3.3%)	2 (3.4%)	2 (4.2%)	41 (3.0%)	

	Lots of energy	**n=1485**		**n=30**	**n=58**	**n=48**	**n=1350**	**n.s.**
	All of the time	70 (4.7%)		1 (3.3%)	1 (1.7%)	5 (10.4%)	63 (4.7%)	
	Most of the time	648 (43.6%)		14 (46.7%)	22 (37.9%)	22 (45.8%)	590 (43.7%)	
	Some of the time	455 (30.6%)		12 (40.0%)	20 (34.5%)	10 (20.8%)	413 (30.6%)	
	A little of the time	246 (16.6%)		3 (10.0%)	10 (17.2%)	7 (14.6%)	226 (16.7%)	
	None of the time	67 (4.5%)		0 (0.0%)	5 (8.6%)	4 (8.3%)	58 (4.3%)	
	Downhearted/depressed	**n=1486**		**n=30**	**n=58**	**n=48**	**n=1350**	**n.s.**
	All of the time	22 (1.5%)		1 (3.3%)	1 (1.7%)	1 (2.1%)	19 (1.4%)	
	Most of the time	75 (5.0%)		1 (3.3%)	4 (6.9%)	2 (4.2%)	68 (5.0%)	
	Some of the time	237 (15.9%)		4 (13.3%)	13 (22.4%)	3 (6.3%)	217 (16.1%)	
	A little of the time	474 (31.9%)		9 (30.0%)	15 (25.9%)	11 (22.9%)	439 (32.5%)	
	None of the time	678 (45.6%)		15 (50.0%)	25 (43.1%)	31 (64.6%)	607 (45.0%)	
7.7	**Physical/Emotional**							
	Interfered socially	**n=1484**		**n=30**	**n=58**	**n=48**	**n=1348**	**n.s.**
	All of the time	23 (1.5%)		0 (0.0%)	1 (1.7%)	0 (0.0%)	22 (1.6%)	
	Most of the time	84 (5.7%)		0 (0.0%)	7 (12.1%)	5 (10.4%)	72 (5.3%)	
	Some of the time	230 (15.5%)		7 (23.3%)	12 (20.7%)	3 (6.3%)	208 (15.4%)	
	A little of the time	306 (20.6%)		6 (20.0%)	14 (24.1%)	11 (22.9%)	275 (20.4%)	
	None of the time	841 (56.7%)		17 (56.7%)	24 (41.4%)	29 (60.4%)	771 (57.2%)	

Table 22. Physical and Mental Health (from the SF-12 Survey)

Quest	Component Score	All Divers		Saturation Divers	SAT/EXP Divers	Experimental Divers	Fleet Divers	P
7		**n=1457**		**n=28**	**n=58**	**n=47**	**n=1324**	
	Physical							**P=.040**
	Mean	45.6		43.6	41.9	45.1	45.8	
	Median	47.6		43.5	44.5	46.8	48.0	
	Mode	56		55	Multiple	Multiple	56	
	SD	10.9		13.6	11.6	8.4	10.9	
	Minimum	9		9	19	20	12	
	Maximum	69		66	61	57	69	
	Mental							**n.s.**
	Mean	51.21		53.6	49.3	52.9	51.2	
	Median	54.0		54.2	50.9	56.2	54.0	
	Mode	57		60	Multiple	Multiple	57	
	SD	9.8		10.3	11.8	10.5	9.7	
	Minimum	14		23	19	19	14	
	Maximum	74		74	69	65	72	

Table 23. Correlations (Spearman's rho) between Number of Navy Dives and Both Dive Injuries and Symptoms

Question			# Navy dives		# Non-Navy dives		Total # dives
	Injury						
3.5	Neurological DCS		.216**		.093**		.204**
	Pain-only DCS		.248**		.092**		.240**
	Loss of consciousness		.128**		.009		.110**
	Compression arthralgia		.317**		.039		.264**
4.1	**Symptom**						
	Muscle weakness/tremor		.155**		–.040		.106**
	Impaired hearing		.144**		.031		.134**

Table 24. Correlations (Spearman's rho) between Key Variables and Two Significant Medical Conditions (Muscle Weakness and Impaired Hearing) from Question 4.1

Quest	Variable		Muscle weakness / tremor		Impaired hearing
1.1	Age (estimated)		.045		.142**
1.13	Current smoker		.100**		.056*
1.14	Binge drinking		.038		.056*
2.7	Years diving active duty		.085**		.161**
2.10	Lost-time accident		.229**		.180**
2.12	Worked as welder		.117**		.106**
3.2	Years since first Navy dive		.067*		.175**
3.2	Total years diving		.021		.089**
3.2/3.4	Performed non-Navy diving		–.044		–.031
3.5	Any DCS		.147**		.075*
3.5	Underwater explosion		.158**		.114**
4.2	Head injury		.130**		.151**

* Significant at 0.05 level (two-tailed)
** Significant at 0.01 level (two-tailed)

Table 25. Correlations (Spearman's rho) between Key Variables and Two Significant Medical Conditions from Question 4.2

Question	Variable		Diabetes		Arthritis/other joint disease
1.1	Age (estimated)		.209**		.122**
1.13	Current smoker		–.023		.056*
1.14	Binge drinking		–.020		.030
2.7	Yrs Diving Active Duty		.003		.128**
2.10	Lost time accident		.006		.191**
2.12	Worked as Welder		.067**		.081**
3.2	Yrs since 1st Navy dive		.216**		.126**
3.2	Total Years Diving		–.001		.076**
3.2/3.4	Performed Non-Navy diving		–.048		–.037
3.3	No-decompression dives		–.024		–.051
3.3	Decompression dives		.012		.059*
3.3	Decompression with Sur D O_2		.016		.037
3.3	Saturation diving		.051		.012
3.5	Any DCS		.071**		.103**
3.5	Underwater explosion		.015		.093**
4.2	Head injury		–.001		.161**
Derived from Q 3.3	Dive rank (# of dives performed)				
	Navy		.063*		.091**
	Non-Navy		–.029		.003
	Total		.044		.070*

* Significant at 0.05 level (two-tailed)
** Significant at 0.01 level (two-tailed)

Table 26. Correlations (Spearman's rho) between SF-12 Physical and Mental Component Scores and Key Variables

Question	Variable		Physical (PCS)		Mental (MCS)
1.1	Age (estimated)		–.102**		.168**
1.13	Current smoker		–.117**		.022
1.14	Binge drinking		–.060**		–.072**
2.7	Years Diving Active Duty		–.123**		.058*
2.10	Lost-time accident		–.293**		–.118**
2.12	Worked as welder		–.145**		–.059*
3.2	Years since first Navy dive		–.150**		.133**
3.2	Total years diving		–.014		.070**
3.2/3.4	Performed non-Navy diving		.098**		.043
3.3	No-decompression dives		.013		.011
3.3	Decompression dives		–.110**		.013
3.3	Decompression with Sur D O_2		–.121**		–.039
3.3	Saturation diving		–.066*		.056*
3.5	Any DCS		–.159**		–.004
3.5	Underwater Explosion		–.121**		–.082**
4.2	Head injury		–.191**		–.135**
Derived from Q 3.3	Dive rank (# of dives performed)				
	Navy		–.206**		–.006
	Non-Navy		.034		.002
	Total		–.143**		–.006

* Significant at 0.05 level (two-tailed)
** Significant at 0.01 level (two-tailed)

Table 27. Correlations (Spearman's rho) between SF-12 Question 7.5 ("During the past four weeks, how much did pain interfere with your normal work?") and Key Variables

Question	Variable		Pain Interference
1.1	Age (estimated)		–.031
1.13	Current smoker		.098**
1.14	Binge drinking		.077**
2.7	Years diving active duty		.133**
2.10	Lost-time accident		.317**
2.12	Worked as welder		.161**
3.2	Years since first Navy dive		.039
3.2	Total years diving		.031
3.2/3.4	Performed non-Navy diving		–.075**
3.3	No-decompression dives		–.001
3.3	Decompression dives		.097**
3.3	Decompression with Sur D O_2		.141**
3.3	Saturation diving		.029
3.5	Any DCS		.135**
3.5	Underwater explosion		.121**
4.2	Head injury		.203**
Derived from Q 3.3	Dive rank (# of dives performed)		
	Navy		.219**
	Non-Navy		–.017
	Combined Total		.161**

* Significant at 0.05 level (two-tailed)
** Significant at 0.01 level (two-tailed)

Appendix C

Pre-survey Predictions and Findings

While the study design did not permit experimental variables to be manipulated, to generate predictions of what the survey would find was useful both in shaping the study's design and in focusing attention on making the comparisons that are of primary interest.

The following predictions (and findings) were made:

- Education: SAT divers have more years of formal education than those in other groups — a prediction based on preliminary data from the neuropsychological assessment database.
  Finding: Inaccurate — the FLT diver group had the most divers (52%) with a bachelor's degree or higher.

- Age: SAT divers will be older than those in the EXP group — a prediction based on the fact that EXP divers constitute a more recently designated (1980s) category.
  Finding: Accurate — on average, SAT divers were three years older than EXP divers.

- Decompression Illness: The incidence of DCI will be greater for SAT/EXP divers than for the other groups — a prediction based on a documented higher incidence of DCI generated by the provocative experimental diving procedures and close medical monitoring of divers at NEDU and NMRI.
  Finding: Accurate — when SAT/EXP divers were compared to FLT and EXP divers; when SAT/EXP diver DCI incidence was compared to that of SAT divers, these two groups of divers showed no difference in DCI.

- Diving Experience: FLT divers dove more than the other groups — a prediction based on surveys of FLT diver records before this study was initiated.
  Finding: Inaccurate — of all the types of Navy diving considered under Question 3.3, FLT divers had highest percentage of those who reported having performed "None."

- Lung Function: The incidence of self-reported lung impairment (e.g., wheezing, breathlessness) will be higher in EXP than in FLT divers — a prediction based on O_2 poisoning associated with the development of O_2 diving and decompression treatment tables.
  Finding: Inaccurate — the responses showed no differences; all groups reported very few cases.

- Complaints: In comparison to EXP and FLT divers, SAT divers will report more complaints of joint and back pain as well as forgetfulness or loss of concentration (a

prediction based on reviews of NEDU saturation dive log reports and on communications via the informal saturation diving "network").

Finding: Inaccurate — SAT divers reported fewer such complaints than those in the SAT/EXP and EXP groups reported.

- Reported Conditions: In comparison with EXP or FLT divers, a higher percentage of SAT divers will report suffering from the following conditions:

  Arthritis

  Finding: Accurate, for the SAT divers versus the FLT group; however, no differences were evident between the SAT and the EXP groups.

  Depression or anxiety

  Finding: No differences were detected.

  Dysbaric bone necrosis

  Finding: No differences were detected; very few cases were reported in all groups.

- Cognitive Complaints: On the mental health section of the survey, SAT divers will respond with an overall higher frequency of complaints than will EXP or FLT divers — a prediction based on the arduous working conditions experienced by pioneer SAT divers lacking adequate protective equipment and procedures.

  Finding: Inaccurate — among the four diving groups, SAT divers reported the fewest problems on the CFQ and had the best mental health score on the SF-12.

Appendix D

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