

AD-A146 032

(2)

**AGE-SPECIFIC MORBIDITY AND MORTALITY RATES AMONG
U.S. NAVY ENLISTED DIVERS AND CONTROLS**

**A. HOIBERG
C. BLOOD**

REPORT NO. 84-25

DTIC
ELECTE
S OCT 1 1984 **D**
NCB



NAVAL HEALTH RESEARCH CENTER

P. O. BOX 85122
SAN DIEGO, CALIFORNIA 92138

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND

DISTRIBUTION STATEMENT A

Approved for public release
Distribution Unlimited

DTIC FILE COPY

84 03 00 027

AGE-SPECIFIC MORBIDITY AND MORTALITY RATES
AMONG U.S. NAVY ENLISTED DIVERS AND CONTROLS

Anne Hoiberg and Christopher Blood
Environmental Medicine Department
Naval Health Research Center, San Diego

Naval Health Research Center
P. O. Box 85122
San Diego, California 92138-9174

DTIC
ELECTE
S OCT 1 1984 D
B

Report No. 84-25, supported by the Naval Medical Research and Development Command, Department of the Navy, under work unit M0099PN01C-0008. The views presented in this paper are those of the authors. No endorsement by the Department of the Navy has been given nor should be inferred.

DISTRIBUTION STATEMENT A

Approved for public release
Distribution Unlimited

SUMMARY

Problem

Given that diving is a hazardous occupation, the health status of U.S. Navy divers should be examined to identify the health effects attributable to diving. Comparisons of divers' hospitalization, disability, and mortality rates with those of a matched control sample should be conducted to determine whether divers are at increased risk of illness and injury.

Objectives

The objectives of this study were 1) to compare age-specific hospitalization rates of U.S. Navy enlisted divers ($n = 11,517$) and 2) to identify similarities and differences between groups in age-specific rates of medical board appearances, physical evaluation board actions, and mortality.

Approach

The U.S. Navy enlisted male diver population consisted of 11,584 men who had at least one dive recorded by the Naval Safety Center in Norfolk from January 1968 through December 1979 and who had a record on the enlisted service history file maintained at the Naval Health Research Center in San Diego. For the control sample, one nondiver enlistee was selected from the enlisted service history file to match each diver's record, as numbers permitted, on the basis of birth year and primary occupational specialty. For both groups, information from the medical inpatient file was extracted on diagnoses, age, and date of all hospitalizations, board actions, and death records. Total and age-specific annual hospitalization rates per 10,000 divers and nondiver controls were computed for six major diagnostic categories and 31 subcategories. Similarly, age-specific mortality rates (number of deaths per 10,000) and medical board and physical evaluation board rates were computed for divers and controls. Ninety-five percent confidence limits were calculated to determine whether or not rate differences between groups were significant for any of these four health indices.

Results

Divers had significantly higher hospitalization rates than controls for the category of environmentally induced disorders (e.g., decompression sickness) and deflected nasal septum as well as for joint disorders at ages 23-28. Controls had significantly higher hospitalization rates for stress-related disorders (e.g., alcohol/drug abuse) and circulatory disease (e.g., cardiovascular disease). Higher rates of medical and physical evaluation board actions for stress-related disorders were observed among controls than divers. Almost all of the significant differences observed were shown to occur prior to the age of 41; the only significant difference noted after the age of 40 was the control group's higher hospitalization rate for diseases of the circulatory system. For both groups, medical board, physical evaluation board, and mortality rates increased with age as did hospitalizations for musculoskeletal diseases, stress-related disorders, and circulatory diseases.

Conclusions

These results pointed up the overall better physical and mental "fitness" of divers in comparison with controls, particularly prior to the age of 41, which probably was a reflection of

an adherence to the relatively stringent selection and retention screening criteria established for divers. Divers' hospitalization rates, moreover, were very low for environmentally induced disorders thereby suggesting that few diving-related disorders or accidents led to a hospitalization. Divers' higher hospitalization rate for deflected nasal septum tended to be associated with the necessity of divers' having an unobstructed nasal passage; treatment for this condition, therefore, would occur with greater frequency among divers than controls.

Recommendations

Although divers were not shown to be at increased risk for disorders other than those specifically associated with diving hazards, a longitudinal study currently is being conducted to identify the long-term health effects related to these conditions and musculoskeletal disorders as well as to diving accidents that did not result in an immediate hospitalization. Results of the present and subsequent research efforts should provide the basis for developing intervention and prevention programs designed to further enhance the health and safety of U.S. Navy divers.



Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

Age-specific Morbidity and Mortality Rates
among U.S. Navy Enlisted Divers and Controls

Diving is considered to be one of the most hazardous of vocations and avocations. Support for this statement is reflected by such research results as those showing mortality rates among U.S. commercial divers in the Gulf of Mexico (2.5 per 1,000 strength) as exceeding rates reported for the high risk jobs of coal mining (2.1) and firefighting (0.9)(1). Studies on divers' mortality and morbidity have focused on identifying risk factors associated with diving. Three classifications of risk factors have been examined, as shown in the following categories along with several selected subcategories and citations: the host factors of age, experience, and previous health status of the diver (1-4); the environmental conditions of dive depth (5-7), temperature (8-9), and equipment performance (3); and the agent factors of drowning (10), decompression sickness (11-13), and dysbaric osteonecrosis (14-15).

Given that diving is a hazardous occupation and that excellent physical fitness and mental health are prerequisites for qualification, the subsequent health of divers should be examined not only to identify the short-term health effects attributable to diving but also the long-term manifestations. For example, Zanini, Adaglia, and Seperati (16) affirmed in their 10-year study that the incidence of hearing loss was significantly higher in their sample of 160 divers than in a nondiver control sample. In their extensive study of the physical examinations and health profiles of 197 physically fit U.S. Navy divers, Dembert and his associates (17) reported readings outside the normal range in the areas of audiometry, pulmonary function tests, and anthropometrics. To be specific, losses were reported in air conduction hearing among divers (mean age of 28.3 years) comparable to declines recorded in the general population at age 50 to 59 years. Divers in that study also were distinguished by larger than expected thoracic dimensions and a higher percentage of body fat than normal. Those investigators recommended that incidence rates and risk factors for chronic disease among divers should be determined. The present authors (2) reported that musculoskeletal disorders accounted for at least 40% of the hospital admissions for six major diagnostic categories recorded from 1969 through 1979. One conclusion of that research was the need to compare divers' hospitalization rates with those of a matched control sample of Navy enlistees to determine whether divers were at greater risk than others of suffering a musculoskeletal disorder as well as other diseases.

The primary purpose of this study was to compare total and age-specific annual hospitalization rates for enlisted divers with a matched sample of nondiver controls. Another objective was to identify similarities and differences between groups in age-specific rates of medical board appearances, physical evaluation board actions, and mortality.

METHOD

Study Population

The U.S. Navy enlisted diver population used in this study was comprised of 11,584 men who had at least one dive recorded by the Naval Safety Center, Norfolk, Virginia, from January 1968 through 1979 and who had a record on the enlisted service history file maintained at the Naval Health Research Center in San Diego, California. The Naval Safety Center's diver file consisted

of more than 700,000 Diving Log-Accident/Injury Reports (OPNAV 9940/1) which were condensed into individual records for the 11,584 divers. Women divers and officers were excluded from this study.

Selecting the control sample for the diver population entailed a three-step process. The first step consisted of extracting a random sample from the enlisted service history file by choosing every other male enlistee with a "5" in the last digit of his Social Security number. Second, this file was matched against the diver population file to eliminate members in the random sample determined to be a diver. For the third phase, each diver was compared with enlistees in the random sample ($n = 90,185$) on the basis of birth year (i.e., < 1935 , 1936-38, 1939-41, 1942-44, 1945-47, 1948-50, 1951-53, 1954-56, 1957-59, > 1960) and occupational specialty. Navy diving is a secondary occupational specialty for enlisted personnel, and the available enlisted diver population was drawn from 87 distinct primary occupational classifications. For each diver who fell into one of the 870 birth year/occupational specialty cells, one member of the random sample was selected, as numbers permitted, for the control sample ($n = 11,517$). This matching procedure was highly successful in obtaining comparable proportions of divers and controls by birth year and occupational specialty; inter-group differences were nonsignificant for both of these controlling variables. Table 1 shows the primary occupations of divers and indicates the proportions of divers and controls in each major occupational category.

TABLE 1
COMPARISONS OF PRIMARY OCCUPATIONAL SPECIALTIES AMONG U.S. NAVY
ENLISTED DIVERS AND CONTROLS

Occupational Category	Divers*		Controls	
	No.	%	No.	%
Engineering and Hull	3,310	28.6	3,286	28.5
Ordnance, Electronics,				
Electrical	3,026	26.1	3,014	26.2
Administrative, Communi-				
cations, Service	2,157	18.6	2,151	18.7
Deck, Aviation-related	1,105	9.5	1,082	9.4
Hospital Corps and Dental				
Technician	853	7.4	853	7.4
Apprenticeship	647	5.6	647	5.6
Construction, Aviation				
Mechanical	486	4.2	484	4.2
Total	11,584	100.0	11,517	100.0

$\chi^2 = .171$, $df = 6$, $p = NS$. *Diving is a secondary Navy occupational specialty.

Procedure

Records for both diver and control groups were matched against the medical inpatient file which also is maintained at the Naval Health Research Center. Information extracted from this file included diagnoses for as many as 10 hospitalizations, age at the time of hospitalization, date of admission, and diagnoses for medical board and physical evaluation board actions as well

as death data. The diagnostic nomenclature used in this study was the Eighth Revision of the International Classification of Diseases Adapted for Use in the United States (ICDA-8). Diagnoses selected for examination were those identified in the literature as associated with diving or hypothesized as stress related. These diagnoses were condensed into 31 subcategories which then were classified according to the following six diagnostic categories: Diseases of the Musculoskeletal System, Stress-related Disorders, Diseases of the Respiratory System, Diseases of the Nervous System and Sense Organs, Diseases of the Circulatory System, and Environmentally Induced Disorders.

Using birth year, date of service entry, and date of separation, which were obtained from the service history file, populations at risk during the 1968 to 1979 time period were computed for the diver population and control sample as well as for the within-group age intervals of 17-22, 23-28, 29-34, 35-40, and 41 years and older. These populations at risk were determined by averaging the numbers of personnel on active duty by year and age across the 12-year time period. To calculate total and age-specific annual hospitalization rates per 10,000 strength, the numbers of hospital admissions for the six major diagnostic categories and 31 subcategories were tabulated for each group, divided by the mean population at risk and 12 years surveyed for this study, and multiplied by 10,000. Similarly, age-specific mortality rates (number of deaths per 10,000) and medical board and physical evaluation board rates were computed for divers and controls. Ninety-five percent confidence limits, based on the normal distribution for hospitalizations and medical boards and on the Poisson distribution for physical evaluation boards and deaths (rarely occurring events), were calculated to determine whether or not rate differences between groups were significant for any of these four health indices.

RESULTS

Annual Hospitalization and Medical Board Rates among Divers and Controls

As shown in Table 2, the highest hospitalization and medical board rates for both divers and controls across the six major diagnostic categories were observed for the category of musculoskeletal disorders. Comparisons of 95% confidence limits for hospitalization rates revealed only two significantly higher rates among divers than controls and those were for the category of environmentally induced disorders and the subcategory of deflected nasal septum. Controls had higher rates than divers for the categories of stress-related disorders and circulatory diseases as well as for all six of the stress-related disease subcategories, cardiovascular disease, and cerebrovascular disease. The only significantly higher rates for medical boards were the control group's higher rates for the category of stress-related disorders and the subcategories of bone disease and diabetes mellitus.

Annual Hospitalization Rates of Divers and Controls by Age Interval

As noted above, the highest hospitalization rates for divers were observed for the category of musculoskeletal disorders which showed a linear increase in rates with age (Table 3). In comparing 95% confidence limits of rates between divers and controls, only the rates among 23- to 28-year-olds for joint diseases, respiratory diseases, and deflected nasal septum were significantly higher among divers than controls. As would be expected, divers had higher hospitalization rates

TABLE 2
COMPARISONS OF TOTAL ANNUAL HOSPITALIZATION AND MEDICAL BOARD RATES BETWEEN
U.S. NAVY ENLISTED DIVERS AND CONTROLS BY DIAGNOSTIC CATEGORY, 1968-79

Diagnostic Category	Rate per 10,000 by Group			
	Hospitalization		Medical Board	
	Divers	Controls	Divers	Controls
Diseases of the Musculoskeletal System	124.6	116.1	34.5	42.3
Diseases of the Joint	43.0	35.6	15.0	18.4
Disorders of the Spinal Column and Back	37.1	35.5	11.3	11.1
Diseases of Connective Tissue and Muscle	22.0	22.0	0.8	2.3
Diseases of the Bone	12.4	13.4	3.1	6.8*
Arthritis/Rheumatism	10.1	9.5	4.2	3.6
Stress-related Disorders	47.8	98.7*	6.4	15.0*
Alcohol/Drug Abuse	23.2	36.2*	-	-
Transient Situational Disturbances	8.2	17.7*	1.2	3.6
Neuroses	6.8	13.6*	1.2	3.8
Psychoses	3.1	10.9*	1.0	2.2
Ulcers	4.9	11.6*	2.0	1.8
Diabetes Mellitus	1.5	8.6*	0.7	3.4*
Diseases of the Respiratory System	34.5	34.7	1.0	0.5
Diseases of the Respiratory Tract	14.7	16.3	-	-
Deflected Nasal Septum	12.4*	7.2	0	0
Sinusitis	3.7	5.0	0	0
Pleurisy/Respiratory Tuberculosis	0.8	2.3	0.4	-
Spontaneous Pneumothorax	1.8	3.4	0	0
Emphysema	1.1	0.5	-	0
Diseases of the Nervous System and Sense Organs	25.4	34.9	4.4	7.7
Diseases of the Nervous System	11.6	15.2	1.9	4.3
Otitis Externa/Other Ear Disorders	7.5	10.5	-	1.4
Deafness	3.3	5.9	1.5	1.4
Neuritis/Neuralgia/Sciatica	2.3	2.7	0.7	-
Facial Paralysis/Cerebral Paralysis	0.7	0.5	0	-
Diseases of the Circulatory System	22.2	35.6*	4.2	6.1
Cardiovascular Disease	7.1	15.6*	1.6	2.9
Hypertension/Other Cerebrovascular Disease	4.8	9.5*	0.7	1.8
Other Diseases of the Circulatory System	5.3	5.7	0.8	0.5
Phlebitis/Thrombophlebitis	3.3	3.6	0.6	0.7
Embolism: Cerebral, Arterial, Venous, etc.	1.8	1.2	0.6	-
Environmentally Induced Diseases	9.3*	1.2	-	-
Decompression Sickness	4.9	0	-	0
Effects Other External Causes/Drowning/ Hypothermia	2.6	0.9	-	-
Effects of Gas	1.8	-	0	0
Barotraumas	0	0	0	0
Mean Population at Risk	6,106	4,652	6,106	4,652

*Rate differs significantly ($p < .05$) between divers and controls as determined by nonoverlapping confidence intervals. Rates are not presented for diagnoses with a frequency of less than 1.

TABLE 3

COMPARISONS OF ANNUAL HOSPITALIZATION RATES BETWEEN U.S. NAVY ENLISTED
DIVERS AND CONTROLS BY AGE AND DIAGNOSTIC CATEGORY, 1968-79

Diagnostic Category	Hospitalization Rate per 10,000 by Age and Group									
	17-22 Years		23-28 Years		29-34 Years		35-40 Years		≥ 41 Years	
	Divers	Controls	Divers	Controls	Divers	Controls	Divers	Controls	Divers	Controls
Diseases of the Musculoskeletal System										
Diseases of the Joint	87.3	97.2	116.9	94.0	187.2	170.6	201.7	201.2	262.8	197.7
Disorders of the Spinal Column and Gack	38.4	38.7	46.9*	26.9	52.4	37.0	34.8	42.8	42.6	39.5
Diseases of Connective Tissue and Muscle	17.5	22.6	31.2	28.9	64.4	64.0	88.7	83.5	142.1	69.2
Diseases of the Bone	15.6	17.6	21.0	19.7	36.1	28.4	29.6	45.0	35.5	29.7
Arthritis/Rheumatism	8.1	12.6	11.6	11.2	19.8	19.9	24.3	15.0	21.3	-
	7.8	5.7	6.2	7.2	14.6	21.3	24.3	15.0	21.3	39.5
Stress-related Disorders										
Alcohol/Drug Abuse	30.6	71.4*	45.1	79.5*	67.9	187.7*	99.1	164.8*	106.6	217.5
Transient Situational Disturbances	10.0	21.2*	17.4	26.9	41.2	76.8*	71.3	54.2	71.0	39.5
Neuroses	5.9	17.6*	12.9	14.5	6.0	29.9*	7.0	12.8	0	-
Psychoses	7.2	13.3	4.5	9.9	11.2	22.8	7.0	17.1	0	-
Ulcers	3.1	12.6	5.8	11.8	0	7.1	-	-	0	-
Diabetes Mellitus	3.4	5.7	3.1	12.5*	8.6	21.3	10.4	21.4	-	49.4
	0.9	1.1	1.3	3.9	-	29.9	-	15.0	21.3	108.7
Diseases of the Respiratory System										
Diseases of the Respiratory Tract	27.8	28.3	46.9*	28.3	30.9	37.0	26.1	89.9*	63.9	39.5
Deflected Nasal Septum	12.5	11.1	17.4	10.5	12.9	19.9	12.2	57.8*	49.7	29.7
Sinusitis	9.0	6.8	19.6*	7.9	12.0	7.1	7.0	8.6	0	0
Pleurisy/Respiratory Tuberculosis	3.1	5.7	4.9	5.3	2.6	-	-	-	0	0
Spontaneous Pneumothorax	-	1.1	1.3	2.0	-	-	-	12.8	0	0
Zephysema	1.6	3.6	2.7	2.0	-	5.7	0	-	0	0
	1.2	0	-	-	-	0	0	-	-	-
Diseases of the Nervous System and Sense Organs										
Diseases of the Nervous System	25.6	24.4	20.1	40.7*	35.2	49.8	27.8	53.5*	35.5	49.4
Otitis Externa/Other Ear Disorders	11.2	11.1	9.4	14.5	18.9	18.5	15.6	32.1	0	39.5
Deafness	10.6	9.3	5.4	11.8	4.3	15.6	-	8.6	-	0
Neuritis/Neuralgia/Sciatica	3.1	2.2	3.1	8.5	3.4	11.4	-	10.7	-	-
Facial Paralysis/Cerebral Paralysis	0	1.1	1.3	5.3	6.9	4.3	7.0	0	0	0
Diseases of the Circulatory System										
Cardiovascular Disease	15.6	18.6	18.3	21.0	24.9	51.2*	38.3	96.3*	120.8	336.1*
Hypertension/Other Cerebrovascular Disease	4.4	4.7	4.0	9.9	6.9	24.2*	17.4	51.4*	78.2	177.9
Other Diseases of the Circulatory System	1.6	3.2	3.6	3.3	7.7	15.6	15.6	36.4	-	108.7
Phlebitis/Thrombophlebitis	4.7	6.8	4.5	3.3	6.9	5.7	-	6.4	21.3	-
Embolism: Cerebral, Arterial, Venous, etc.	3.7	2.9	3.6	3.9	2.6	4.3	0	0	0	29.7
	1.2	1.1	2.7	-	-	-	-	-	-	-
Environmentally Induced Disorders										
Decompression Sickness	8.7*	1.4	12.9	-	4.3	-	8.7	0	-	0
Effects Other External Causes/Drowning/ Hypothermia	4.0	0	7.6	0	2.6	0	5.2	0	0	0
Effects of Gas	3.1	-	2.7	-	-	-	-	0	-	0
Barotraumas	1.6	-	2.7	0	-	0	-	0	0	0
	0	0	0	0	0	0	0	0	0	0
Mean Population at Risk	2,672	2,324	1,867	1,268	970	586	479	389	117	84

*Rate differs significantly ($P < .05$) between divers and controls as determined by nonoverlapping confidence intervals. Rates are not presented for diagnoses with a frequency of less than 3.

than controls for the category of environmentally induced disorders but, because of the few admissions recorded for controls, only the confidence limits for the 17-22 year interval were compared, and the rate difference was found to be significant.

Controls, on the other hand, differed from divers in that musculoskeletal disorders did not account for their largest proportion of all hospitalizations; hospital admissions for the control sample reflected a comparability in rates for both stress-related disorders and musculoskeletal conditions and a preponderance of circulatory diseases among its oldest members. Their hospitalization rates were significantly higher than divers' for the major diagnostic categories of stress-related disorders (from ages 17-40), respiratory diseases (35-40), nervous system disorders (ages 23-28 and 35-40), and circulatory diseases (29 years of age and older) as well as at various ages for the subcategories of alcohol/drug abuse, transient situational disturbances, ulcers, respiratory tract disorders, and cardiovascular disease. Hospitalization rates for hypertension and cerebrovascular disease also were substantially higher among controls than divers.

Overall, the significant illness differences observed between divers and controls reflected the influence of age by occupation interaction on hospitalization rates. That is, younger divers had much lower hospitalization rates than their control counterparts for stress-related disorders and circulatory diseases and higher rates for all environmentally induced disorders. After the age of 40, the only significant difference was the control group's higher hospitalization rate than divers for circulatory diseases.

Annual Physical Evaluation Board and Mortality Rates among Divers and Controls

Because of the relatively low number of physical evaluation board appearances for both divers and controls, rates were only computed for the six major diagnostic categories. The highest rates for both groups were noted for diseases of the musculoskeletal system. In comparing 95% confidence limits, the control group differed significantly from divers for rates of stress-related disorders (4.0 per 10,000 for divers vs. 12.2 for controls); none of the other five diagnostic category comparisons of confidence limits was significant.

During the 12 years surveyed for this study, a total of 71 divers and 67 controls died; the annual mortality rates per 10,000 were 9.7 and 12.0, respectively. The underlying causes of death were similar in that accidental injuries accounted for the highest mortality rates for both divers (7.0) and controls (9.0), followed by cardiovascular disease (0.8 and 1.4, respectively). Of the accidental injury rates, on-duty death rates were 2.5 for divers and 2.2 for controls.

Annual Board and Mortality Rates of Divers and Controls by Age Interval

Table 4 is a presentation of medical board, physical evaluation board, and mortality rates for divers and controls by age interval. The intervals were condensed from five to three levels because of the few cases at various ages. Significant age differences in medical board and physical evaluation board actions were observed in that controls had higher rates than divers for the age intervals of 17-28 and 29-40. Differences in rates between groups were nonsignificant for the age interval of 41 years and older. Nonsignificant differences in mortality rates between groups were observed for each of the three age intervals.

DISCUSSION

Results of this study identified few disorders with hospitalization rates significantly higher among divers than controls: environmentally induced disorders, deflected nasal septum, and

TABLE 4
COMPARISONS OF ANNUAL MEDICAL BOARD, PHYSICAL EVALUATION BOARD,
AND MORTALITY RATES BETWEEN U.S. NAVY ENLISTED DIVERS AND
CONTROLS BY AGE, 1968-79

Age Interval (in years)	Rate per 10,000 by Group					
	Medical Board		Physical Evaluation Board		Mortality	
	Divers	Controls	Divers	Controls	Divers	Controls
17 - 28	85.4	119.5*	31.9	54.3*	9.6	9.0
29 - 40	154.1	222.2*	50.0	82.7*	8.6	17.1
≥ 41	177.6	296.4	120.7	196.6	28.4	79.0

*Rate differs significantly ($p < .05$) between divers and controls as determined by nonoverlapping confidence intervals.

joint diseases. Controls had higher rates than divers for stress-related disorders, circulatory diseases, nervous system disorders, and respiratory diseases.

Explanations for these differences include the following general factors. First, the major reason suggested for these findings is that divers must be in excellent physical and mental condition to be accepted into the diver training program. Selection of applicants is based on results of five screening tests: physical examination, recompression chamber pressure test, oxygen tolerance test, a test dive with a qualified officer, and an interview by a qualified diving officer to ascertain, insofar as possible, the attitude and motivation of the applicant. Second, to continue in this secondary occupational classification, the diver must meet the screening criteria specified in the annual physical examination. Third, another explanation concerns the possibility that divers do indeed live up to their image, which reflects a relatively high level of toughness and hardiness--and a high pain threshold. Kindwall (9) has noted that there are many phlegmatic individuals in the diving and compressed air industry who, for example, "elect to 'walk off' symptoms of decompression sickness or treat them at home with the classic remedy of aspirin and a few stiff shots of whiskey." Fourth, the final consideration pertains to the composition of the control sample in that the matching procedure was successful in extracting records of enlistees who performed the same primary duties as divers and who were born during the same time frame. Comparisons of age-specific hospitalization rates between divers and controls were expected to yield the unique health hazards of diving; any significantly higher rates among divers than controls would have a relatively high probability of being attributable to diving and not to the primary occupational specialty or the aging process.

Adherence to these selection and retention screening criteria also was reflected in the results of the disease by age comparisons. Prior to the age of 41, divers had significantly lower hospitalization rates than controls for stress-related disorders and circulatory diseases. Similarly, rates for medical board and physical evaluation board actions among enlistees younger than 41 years of age were significantly lower for divers than controls. After the age of 40, differences between the two groups were nonsignificant except for the control group's significantly higher hospitalization rate for diseases of the circulatory system. These results pointed up the overall better physical and mental "fitness" among divers than controls throughout the most active years of a diving career, the years prior to the age of 41. The findings of divers' lower hospitalization rates for stress-related disorders contrasted with research reported ten years ago which identified divers as having a higher psychiatric hospitalization rate than controls (18).

Other results specific to ages less than 41 identified divers' significantly higher hospitalization rates than controls for the category of environmentally induced disorders, which included decompression sickness and effects of gas and other external causes. After the age of 40, few hospitalizations were recorded for these reasons among both divers and controls. Divers' hospitalization rates, moreover, were very low thereby suggesting that few diving-related disorders or accidents led to a hospitalization. Acute health problems experienced at the diving site probably were treated by an attending Hospital Corpsman or possibly at a medical outpatient facility. Support for this statement was provided from other research in which divers reported complete relief after a diving accident for 80.7% of all mishaps and substantial relief for 17.7% (19).

The age interval of 23-28 also was implicated as being of increased risk among divers for joint diseases. While their hospitalization rate distinguished divers from controls, it did not differ significantly from any of the four other age intervals within the diver population (2). The age-specific finding for joint diseases, therefore, should be interpreted as emphasizing the very low rate among controls rather than an elevated risk for divers ages 23-28.

Another significant difference was that divers had higher hospitalization rates than controls for the subcategory of deflected nasal septum which probably was associated with the necessity of divers' having an unobstructed nasal passage for underwater nose breathing. It seemed likely, therefore, that treatment for this condition would occur with greater frequency among divers than controls.

By way of contrast, several diving-related disorders were not shown to have significantly higher hospitalization rates for divers than controls. For example, divers' rates for otitis externa/other ear disorders and deafness were quite low and failed to differentiate the two groups. These comparable rates differed from research cited at the outset which reported a significantly higher incidence of hearing loss among divers than nondiver controls (16). Those findings, however, were based on audiographic readings rather than hospital admissions. To determine the extent of hearing and ear problems among all Navy divers, data should be collected from sources in addition to the medical inpatient file, such as medical outpatient facilities and audiographic readings which routinely should be taken and examined on a regular basis.

To conclude, divers were not shown to be at increased risk for disorders other than those specifically associated with diving hazards. A longitudinal study currently is being conducted to identify the long-term health effects related to those conditions and musculoskeletal disorders as well as to diving accidents that did not result in an immediate hospitalization. Results of these research efforts should provide the basis for developing intervention and prevention programs designed to further enhance the health and safety of U.S. Navy divers.

REFERENCES

1. Bradley ME. An epidemiological study of fatal diving accidents in two commercial diving populations. In: Bachrach AJ, Matzen MM, eds. Underwater physiology VII. Proceedings of the seventh symposium on underwater physiology. Bethesda: Undersea Medical Society, 1981: 869-75.
2. Hoiberg AL, Blood CG. Effects of age and exposure on the health status of U.S. Navy divers. San Diego, CA: Naval Health Research Center, Report No. 84-3, 1984.
3. Berghage TE, Rohrbach PA, Bachrach AJ, Armstrong FW. Navy diving: who's doing it and under what conditions. Bethesda: Naval Medical Research Institute Report MPN10.03.2040DAC9, 1975.
4. Bachrach AJ. The human in extreme environments. In: Baum A, Singer JE, eds. Advances in environmental physiology: Volume 4 environment and health. Hillsdale, NJ: Lawrence Erlbaum Associates, 1982:223-36.
5. Biersner RJ. Factors in 171 Navy diving decompression accidents occurring between 1960-1969. Aviat Space Environ Med 1975;46:1069-73.
6. Leitch DR. A study of unusual incidents in a well-documented series of dives. Aviat Space Environ Med 1981;52:618-24.
7. Biersner RJ, Dembert ML, Browning MD. Comparisons of performance effectiveness among divers. Aviat Space Environ Med 1980;51:1193-6.
8. Parker JW. The incidence of diving accidents as related to water and air temperatures and type of dive [Abstract]. Undersea Biomed Res 1981;8:63.
9. Kindwall EP. Medical aspects of commercial diving and compressed air work. In: Zenz C, ed. Occupational medicine: principles and practical applications. Chicago: Year Book Medical Publishers 1975:393-4.
10. Miles S, Mackay DE. Underwater Medicine. Philadelphia: JB Lippincott Company 1976:182-94.
11. Kidd DJ, Elliot DH. Decompression disorders in divers. In: Bennett PB, Elliot DH, eds. The physiology and medicine of diving and compressed air work. Baltimore: Williams and Wilkins, 1975:471-95.
12. Schilling CW, Werts MF, Schandelmeier NR. The underwater handbook. New York: Plenum Press, 1976:485-93.

13. Strauss RH. Decompression sickness. In: Strauss RH, ed. Diving medicine. New York: Grune and Stratton, 1976:63-80.
14. McCallum RI. Dysbaric osteonecrosis: aseptic necrosis of bone. In: Bennett PB, Elliot DH, eds. The physiology and medicine of diving and compressed air work. Baltimore: Williams and Wilkins, 1975:504-21.
15. Hunter WL Jr, Biersner RJ, Sphar RL, Harvey CA. Aseptic bone necrosis among U.S. Navy divers: survey of 934 nonrandomly selected personnel. Undersea Biomed Res 1978;5:25-36.
16. Zannini D, Adaglia G, Sperati G. Auditory changes in professional divers. In: Lambertsen CJ, ed. Underwater physiology V. Proceedings of the fifth symposium on underwater physiology. Bethesda: Undersea Medical Society, 1976:675-684.
17. Dembert ML, Mooney LW, Ostfeld AM, Lacroix PG. Multiphasic health profiles of Navy divers. Undersea Biomed Res 1983;10:45-61.
18. Biersner RJ, Ryman DH. Psychiatric incidence among military divers. Milit Med 1974;139:633-35.
19. Blood C, Holberg A. Diving accidents: Analyses of underlying variables. San Diego, CA: Naval Health Research Center, Report No. 84-14, 1984.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 84-25	2. GOVT ACCESSION NO. AD-A146032	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Age-specific Morbidity and Mortality Rates among U.S. Navy Enlisted Divers and Controls		5. TYPE OF REPORT & PERIOD COVERED Interim
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Anne Hoiberg and Christopher Blood		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Health Research Center P.O. Box 85122 San Diego, CA 92138		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS M0099PN01C-0008
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Medical Research & Development Command Naval Medical Command, National Capital Region Bethesda, MD 20814		12. REPORT DATE July 1984
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Commander, Naval Medical Command Department of the Navy Washington, DC 20372		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Approved for public release; distribution unlimited.		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) U.S. Navy enlisted divers and controls Environmentally induced disorders Hospitalization rates Stress-related disorders Age-specific disability and mortality rates Musculoskeletal disorders		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The purpose of this study was to compare age-specific hospitalization, disability, and mortality rates for diving-related and stress-induced disorders between U.S. Navy enlisted divers ($n = 11,584$) and a matched sample of non-diver enlistees ($n = 11,517$). Divers had significantly higher hospitalization rates than controls for the category of environmentally induced disorders (e.g., decompression sickness) and deflected nasal septum as well as for joint diseases at ages 23-28. Controls had significantly higher hospital-		

7 ization rates for stress-related disorders (e.g., alcohol/drug abuse and transient situational disturbances) and circulatory diseases (e.g., cardiovascular disease). Higher rates of medical and physical evaluation board actions for stress-related disorders were observed among controls than divers. For both groups, medical board, physical evaluation board, and mortality rates increased with age as did hospitalizations for musculoskeletal disorders, stress-related disorders, and circulatory diseases. Subsequent research will examine the long-term health effects associated with divers' hospitalizations for musculoskeletal conditions and job-related accidents.