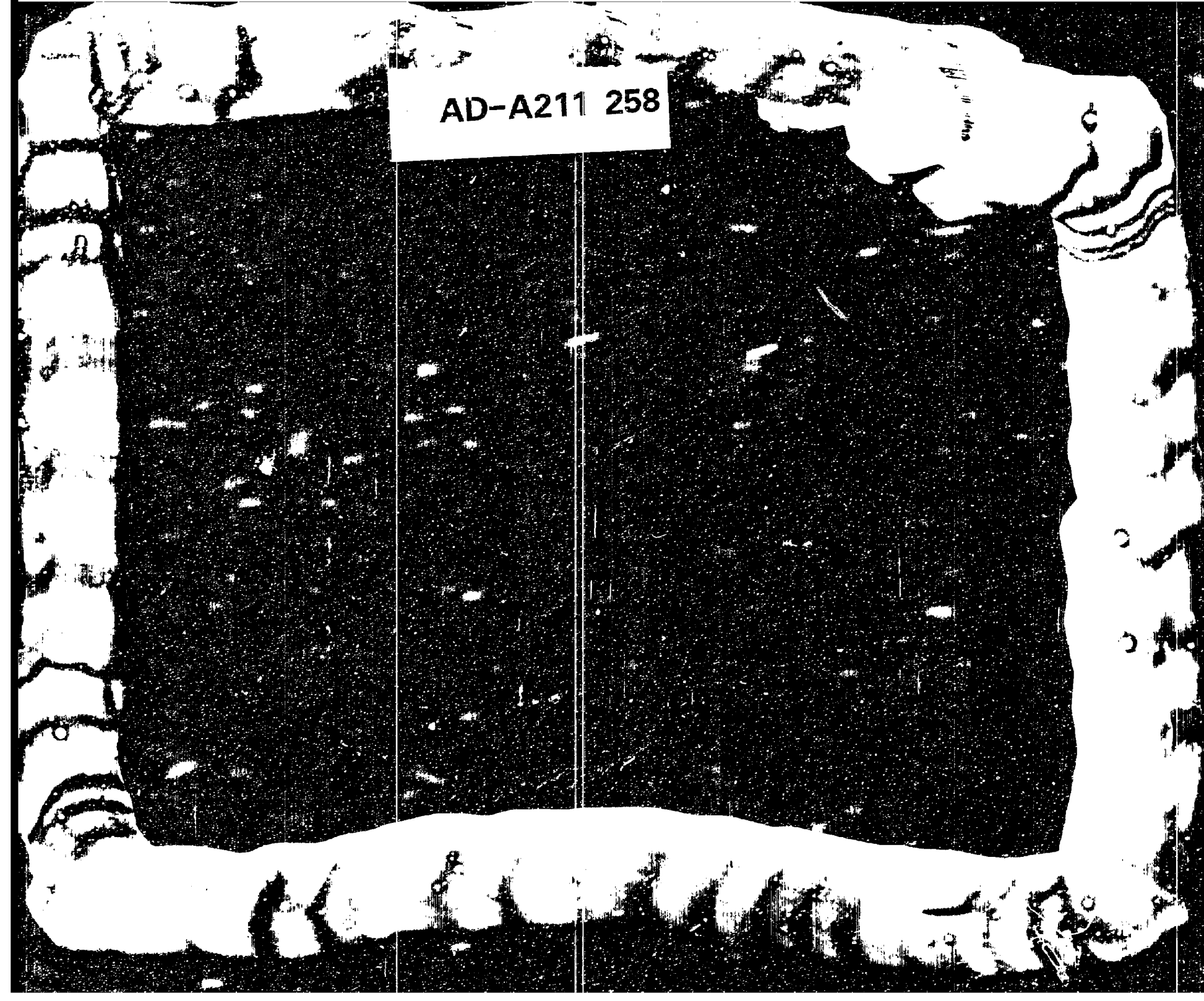

Diseases and Non-Battle Injuries for U.S. Navy Submarine Personnel and Surface-Ship Personnel by Occupational Group

Presented at the Thirty-First Navy Occupational Health
and Preventive Medicine Workshop,
Virginia Beach, Virginia, March, 1989

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Report No. 89-10 was supported by the Naval Medical Research and Development Command, Department of the Navy, under research Work Unit M0095.005-6004. The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

SUMMARY

Problem

Previous Naval Health Research Center studies have found that submarine personnel have lower hospitalization rates than surface-ship personnel. However, because Navy hospitalization admission rates are known to vary by occupation, occupation-specific hospitalization rates for submariners were examined to determine the effects of submarine work environments and health.

Objectives

The objective of this study was to determine the hospitalization rates of submariners within five occupational groups and compare the results with data for surface-ship personnel.

Approach

The Service History file maintained by the Naval Health Research Center in San Diego was searched for all personnel who had served aboard nuclear- and diesel-powered submarines (n=68,475) between 1974-1979. A random sample of enlisted personnel who had served aboard surface ships of similar crew size as submarines was selected as a control group (n=77,541). Age-adjusted hospital admission rates for 16 major diagnostic categories were calculated and compared between submarine and surface-ship personnel for five major occupational groups (administrative/clerical, apprentice, blue collar, electronic/technical, and medical). Relative risks were calculated and 95 percent confidence intervals were computed to determine significant differences in hospitalization rates.

Results

Submarine personnel were found to have lower total hospitalization rates than surface-ship personnel for four of five occupational groups. Blue collar, electronic/technical and medical submarine personnel had at significantly lower total hospitalization rate ($p<.05$); administrative/clerical submarine personnel had a lower total hospitalization rate; however, the difference was not significant. Only apprentice submarine personnel had a significantly higher total hospitalization rate ($p<.05$) than surface-ship apprentice personnel. Among the five occupational groups, submarine

apprentice personnel had the highest total hospitalization rate. The lowest total rate of hospitalization was among submarine electronic/technical personnel.

Conclusions

When comparing hospitalization rates between personnel on submarines and surface-ships for five occupational groups, surface-ship personnel had higher hospitalization rates, except in the apprentice occupational group. This suggests that the lower total hospitalization rates among submarine personnel are due to the screening process for apprentices that removes personnel at risk for illness. Higher hospitalization rates for submarine apprentices may be attributed to the long work hours and stress associated with submarine qualification. Lower submariner hospitalization rates in the other occupations may be a reflection of higher levels of education, difficulty of medical evacuation from a submarine, and submarine selection factors such as the intolerance of disciplinary problems.

Diseases and Non-Battle Injuries for U.S. Navy Submarine Personnel and Surface-Ship Personnel by Occupational Group

The U.S. Navy shipboard environment for submarine personnel is quite different from that of surface-ship personnel. Extended periods of submergence, smaller living spaces, and a lack of area and facilities for physical activity are some of the environmental stressors the submariner encounters. When Tansey, Wilson, and Schaefer (1979) compared the health of submariners with surface-ship personnel during an 11 year period, 1963 to 1973, they found that surface fleet personnel were at higher risk for respiratory, traumatic, gastrointestinal, skin infections, and miscellaneous illness. In addition, submarine personnel had higher illness rates in genitourinary, systemic, cranial, and neuropsychiatric illness categories.

More recent research, (Burr and Palinkas, 1988; Burr and Palinkas, 1987) comparing submarine and surface-ship personnel during the 1974 to 1979 time period, has shown lower total hospitalization rates among submariners than for surface-ship personnel. In these studies, submarine personnel had significantly fewer hospital admissions for accidents, poisonings, and violence; mental disorders; diseases of the genitourinary system; diseases of the skin and subcutaneous tissue; and diseases of the musculoskeletal system. Among more specific diagnoses, submariners were significantly lower in hospitalizations for viral hepatitis; alcohol abuse; drug abuse; personality disorders; fractures; concussions; contusions; and open wounds.

Even though overall submariner rates of hospitalization are lower than surface-ship personnel, submarine personnel working around nuclear reactors or in the torpedo room may be at higher risk for certain illnesses. This expectation is consistent with the finding that hospital admission rates among naval personnel are affected by occupation (Gunderson and Colcord, 1982). In addition, a study comparing cardiovascular system related hospitalizations of Torpedoman's Mates (TM) potentially exposed to Otto Fuel II to a control group of Fire Control Technicians, found excess morbidity and mortality among TMs (Helmkamp, Forman, McNally, Bone, 1984). Comparison of submarine and surface-ship personnel in the previously mentioned Tansey

study, and in the Burr and Palinkas studies did not examine occupational differences and, therefore, may have failed to detect a specific risk for a particular occupation aboard submarines.

The objective of this study was to compare the hospitalization rates of submariners with surface-ship personnel for five occupational groups. Occupational groups for this study were based on those used in an earlier study conducted at the Naval Health Research Center (Palinkas and Colcord, 1985). The five groups were defined by the similarity of assigned tasks and work environment (see Appendix 1) and included administrative/clerical, blue collar, electronic/technical, medical, and apprentice personnel .

METHOD

The Naval Health Research Center in San Diego, California, maintains computerized Service History and Medical Inpatient files for active duty naval enlisted personnel. The Service History file was searched for all personnel who had served aboard nuclear- and diesel-powered submarines during the period 1974-1979. A control group, consisting of a random sample (approximately 50%) of enlisted personnel who had served aboard surface-ships of approximately the same crew size as submarines during the same period, also was identified from the Service History file. Only white males were selected because of the small number of personnel represented in other groups (e.g., female, black, hispanic) and to control for the potential confounding influence of sex and race on hospital admission rates. Ship types represented in the surface-ship group included Destroyer, Guided Missile Destroyer, Frigate, and Guided Missile Frigate.

Diagnoses were in accordance with the International Classification of Disease Adapted for Use in the United States, Eighth Revision. Sixteen of eighteen major diagnostic categories were included in the study. Complications of pregnancy, childbirth and the puerperium, and certain causes of perinatal morbidity and mortality were eliminated because they were not relevant to the study. Hospitalizations for these samples reflected data for deployed ships as well as ships in port; rates were expressed as the number of hospital admissions per 100,000 person-years.

Age-adjusted hospital admission rates were calculated using the direct method of adjustment (Lilienfeld and Lilienfeld, 1980). The age-adjustment

procedure was used to derive an overall rate which was based on the age distribution of the Navy ship-board population. This was accomplished by using a standard population created by summing the submariner and surface-ship comparison groups and then using occupation-specific rates to compute the expected number of hospitalizations for each group within the standard population. The age-adjusted rates for submariners and surface-ship occupational groups were compared using relative risks. Relative risk was computed by dividing the submariner hospitalization rate for a occupational group by the surface-ship hospitalization rate for that occupational group. This computation gives a measure of the likelihood, relative to the surface ship group, that a member of the submariner group will acquire a certain disease. Ninety-five percent confidence intervals were used to assess statistical significance of observed differences in hospitalization rates by occupational group (Lilienfled and Lilienfeld, 1980). It should be noted, although multiple comparisons are examined, no adjustment to the confidence intervals was made.

RESULTS

The search of the Service History file identified 68,475 submarine personnel and 77,541 surface-ship controls. Table 1 shows the number and percentages of submarine and surface-ship personnel for each of the five occupational groups. Blue collar occupations accounted for nearly one-half of the personnel in both the submarine and in the surface-ship group, percentages of personnel in the other occupational groups were generally comparable between submarines and surface-ships. The number of enlisted white males across all occupational groups for submarine personnel during this period averaged 43,541 per year and the number of enlisted white males for surface-ship personnel averaged 45,151 per year. During the study period, submariners had 16,092 hospital admissions in Navy medical facilities, surface-ship personnel accounted for 23,156 hospital admissions.

Table 2 shows mean age at the time of first hospitalization by occupational group for submarine and surface-ship personnel. Submarine apprentice personnel had the lowest mean age at first hospitalization; surface-ship administrative/clerical personnel had the highest mean age at first hospitalization.

Table 3 shows the hospitalization rates and relative risks for administrative/clerical submarine personnel and the comparison sample of surface-ship administrative/clerical personnel. Statistically, submariners did not have significantly higher hospitalization rates for any diagnostic category nor for any selected diagnoses. Administrative/clerical submarine personnel were significantly lower in hospitalization rates for alcohol abuse; diseases of the nervous system and sense organs; and for contusions.

Blue collar personnel from submarines and surface-ships are compared in Table 4. Blue collar submarine personnel were not significantly higher in hospitalization rate for any diagnostic category or selected diagnoses. However, this group did exhibit significantly lower hospitalization rates for the diagnostic categories of infective and parasitic diseases; mental disorders; diseases of the nervous system and sense organs; diseases of the respiratory system; diseases of the digestive system; diseases of the genitourinary system; diseases of the skin and subcutaneous tissue; diseases of the musculoskeletal system; symptoms and unspecified conditions; accidents, poisonings and violence. Submarine blue collar personnel were also significantly lower for the specific diseases viral hepatitis; venereal diseases; alcohol abuse; drug abuse; pneumonia; hernia; cellulitis; fractures; strains and sprains; contusions; open wounds; and burns, as well as for total hospital admissions, relative to their occupational counterparts aboard surface-ships.

Table 5 compares hospitalization rates for electrical/technical personnel from submarine and surface-ships. Again, submarine personnel were not significantly higher in hospitalization rate for any diagnostic category or selected diagnoses. Submarine electronic/technical personnel were significantly lower in hospitalization rate for the diagnostic categories of infective and parasitic diseases; mental disorders; diseases of the nervous system and sense organs; diseases of the digestive system; diseases of the skin and subcutaneous tissue; congenital anomalies; and accidents, poisonings and violence. Also, submarine electronic/technical personnel had significantly lower hospital admissions for several specific diagnoses including alcohol abuse; pneumonia; cellulitis; fractures; open wounds; and for total hospital admissions.

The comparison of hospitalization rates between submariners and surface-ship personnel in the fourth occupational group, medical personnel, is shown in Table 6. As in the previous occupations, submarine personnel were not statistically significantly higher in hospitalization rate for any diagnostic category or selected diagnoses. Submarine medical personnel had significantly lower hospitalization rates than surface-ship medical personnel for infective and parasitic diseases; mental disorders; alcohol abuse; diseases of the nervous system and sense organs; diseases of the respiratory system; diseases of the skin and subcutaneous tissue; supplementary exams; and for total hospital admissions.

Apprentices were the only occupational group in which submarine personnel had significantly higher hospitalization rates than surface-ship personnel. Table 7 shows hospitalization rates for submariner and surface-ship apprentice personnel. Submariner apprentice personnel had significantly higher hospitalization rates for infective and parasitic diseases; diseases of the nervous system and sense organs; diseases of the circulatory system; and for total hospital admissions. Apprentice submariners were also significantly higher for the specific diagnoses of diarrheal disease; personality disorders; and acute upper respiratory infection. On the other hand, apprentice submariners had significantly lower hospitalization rates than surface-ship apprentice personnel for diseases of the blood and blood-forming tissue; mental disorders; alcohol abuse; diseases of the respiratory system; hernia; diseases of the genitourinary system; diseases of the skin and subcutaneous tissue; diseases of the musculoskeletal system; and for open wounds.

DISCUSSION

Submarine personnel were found to have lower total hospitalization rates than surface-ship personnel for four of five occupational groups. Blue collar, electronic/technical and medical submarine personnel had a significantly lower total hospitalization rate; administrative/clerical submarine personnel also had a lower total hospitalization rate, although, the difference was not statistically significant. Only apprentice submarine personnel had a significantly higher total hospitalization rate than surface-ship apprentice personnel.

Among the five occupational groups, submarine apprentice personnel had the highest total hospitalization rate. The demands placed upon the submarine apprentice are great. Not only are they expected to qualify for submarine service by learning the submarine from bow to stern, but they also must perform their regular job tasks. It is not unusual for submarine apprentices to work 18 to 20 hour days. An examination of the diagnostic categories and diagnoses for which submarine apprentices were significantly higher in hospitalization rate than surface-ship apprentice personnel shows that each has been frequently referred to as potentially stress related (ie. infective diseases, diseases of the nervous system and of the circulatory system, diarrheal disease, personality disorders, and acute upper respiratory infection). The finding that apprentice submariners have higher hospitalization rates than apprentice surface-ship personnel, but, that all other submarine occupations have lower rates than their surface-ship counterparts suggests that the screening process (submarine qualification) is removing personnel at risk for illness from the submarine service.

The lowest total rate of hospitalization was among submarine electronic/technical personnel. Gunderson and Colcord (1982) also found naval personnel in electronic occupations to be among the lowest in hospitalization rates. Among naval personnel there is a negative linear relationship between education and the incidence of disease and illness (Gunderson, Rahe and Arthur, 1970), and electronic/technical personnel are in the highest group for years of education.

Another noteworthy result was the finding that submarine personnel were statistically significantly lower for alcohol abuse in all five occupational groups. The hospitalization rate for alcohol abuse across all occupational groups for submariners was less than one-half the rate for surface-ship personnel (RR=.40, $p<.05$). Schuckit and Gunderson (1974) have suggested that the association between alcoholism and naval job type could be a result of selection factors rather than a function of the job. Jobs that tolerate a higher level of disciplinary problems before separating a man from the service could be expected to have higher rates of alcoholism. Due to the nature of its mission and the potential hazards associated with performance decrement in this environment, the submarine service does not tolerate disciplinary problems, and, therefore has lower rates of alcohol related

hospitalizations. Further, hospitalization for alcohol abuse usually results in the transfer of personnel to surface-ships upon return to duty; therefore, repeat offenders could only occur among surface-ship personnel and not submarine personnel.

The present study has some limitations. The data were collected from the Service History and Medical Inpatient files for general epidemiological purposes and not as part of a designed study on occupational factors in illness; therefore, conclusions about causal factors must be made with caution. Also, outpatient data were not available and hospital admission data may not completely reflect health status, particularly among submarine personnel where long periods of deployment may preclude hospital admission for relatively minor conditions. A study by Nice (1984) found that the rates of medical evacuations from submarines are among the lowest of all naval ships, suggesting that medical events are treated by available medical personnel.

In summary, when comparing hospitalization rates between personnel on submarines and surface-ships for five occupational groups, surface-ship personnel had higher hospitalization rates, except in the apprentice occupation. The higher hospitalization rates for submarine apprentices may be a result of the long work hours and stress associated with submarine qualification. The lower submariner hospitalization rates in the other occupations appears to be associated with higher levels of education, submarine selection factors such as the intolerance of disciplinary problems, and may be a consequence of medical practices associated with long periods at sea and the difficulty of medical evacuation from a submarine.

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Table 1. Number and Percent of Submarine Personnel and Surface-Ship Personnel by Occupational Group.

Occupational Group	Submarine		Surface-Ship	
	N	Percent	N	Percent
Blue Collar	31,759	46.4	33,140	42.7
Electronic/ Technical	24,368	35.6	23,110	29.8
Administrative/ Clerical	6,516	9.5	8,259	10.6
Apprentice	3,758	5.5	10,047	13.0
Medical	1,075	1.6	997	1.3
Other	999	1.4	1,988	2.6
Total	68,475	100.0	77,541	100.0

Table 2. Mean Age at First Hospitalization of Submarine Personnel and Surface-Ship Personnel by Occupational Group.

	Submarine			Surface-Ship		
Occupational Group	N	Mean Age	Std Dev	N	Mean Age	Std Dev
Blue Collar	5,479	25.6	5.9	7,500	25.3	6.1
Electronic/ Technical	3,726	26.0	6.1	4,109	25.5	6.0
Administrative/ Clerical	1,213	26.6	7.1	1,692	27.1	6.8
Apprentice	3,994	19.5	2.2	7,335	19.9	2.6
Medical	384	27.4	7.2	514	26.0	6.6
Total	14,796	24.2	6.1	21,150	23.6	5.9

Table 3. Total Age-Adjusted Hospitalization Rates per 100,000 Person-Years and Relative Risks Among Administrative/Clerical Submarine Personnel and a Comparison Sample of Surface-Ship Administrative/Clerical Personnel, White Male Enlisted Personnel, 1974-1979

Diagnostic Category and selected diagnoses	Submarine Personnel (22,322 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel (29,426 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Relative Risk[1]
INFECTIVE AND PARASITIC DISEASES	84	395.0	310.5	479.5	96	342.4	273.9	410.9	1.15
Diarrheal disease	16	74.0	37.7	110.3	15	45.3	22.4	68.2	1.63
Viral Hepatitis	14	65.8	31.3	100.3	21	79.6	45.6	113.6	0.83
Venereal Diseases	9	45.1	15.6	74.6	16	60.6	30.9	90.3	0.74
NEOPLASMS	28	108.8	68.5	149.1	27	76.1	47.4	104.8	1.43
ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES	7	26.1	6.8	45.4	20	62.4	35.1	89.7	0.42
DISEASES OF BLOOD AND BLOOD-FORMING TISSUE	4	18.3	0.4	36.2	13	38.7	17.7	59.7	0.47
MENTAL DISORDERS	228	1005.3	874.8	1135.8	360	1120.9	1005.1	1236.7	0.90
Alcohol Abuse	89	377.4	299.0	455.8	212	614.3	531.6	697.0	0.61*
Drug Abuse	11	56.0	22.9	89.1	17	69.0	36.2	101.8	0.81
Personality Disorders	28	143.3	90.2	196.4	30	105.2	67.6	142.8	1.36
DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	29	117.7	74.9	160.5	74	218.2	168.5	267.9	0.54*
DISEASES OF THE CIRCULATORY SYSTEM	71	248.7	190.9	306.5	86	227.0	179.0	275.0	1.10
DISEASES OF THE RESPIRATORY SYSTEM	119	539.9	442.9	636.9	149	533.8	448.1	619.5	1.01
Acute Upper Respiratory Infection	2	9.6	0	22.9	3	12.8	0	27.3	0.75
Pneumonia	16	73.0	37.2	108.8	20	72.2	40.6	103.8	1.01
DISEASES OF THE DIGESTIVE SYSTEM	172	712.7	606.2	819.2	241	775.9	677.9	873.9	0.92
Hernia	61	251.7	188.5	314.9	87	270.5	213.7	327.3	0.93
DISEASES OF THE GENITO-URINARY SYSTEM	63	261.4	196.9	325.9	107	354.6	287.4	421.8	0.74
DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	90	422.7	335.4	510.0	111	406.4	330.8	482.0	1.04
Cellulitis	34	153.8	102.1	205.5	42	142.5	99.4	185.6	1.08

Table 3. (continued)

Diagnostic Category and selected diagnoses	Submarine Personnel N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel N	Rate	95% Confidence Limits Lower	Upper	Relative Risk
DISEASES OF THE MUSCULO-SKELETAL SYSTEM	136	579.7	482.3	677.1	174	560.5	477.2	643.8	1.03
CONGENITAL ANOMALIES	18	89.7	48.3	131.1	29	97.3	61.9	132.7	0.92
SYMPTOMS AND UNSPECIFIED CONDITIONS	61	259.2	194.2	324.2	69	218.1	166.6	269.6	1.19
ACCIDENTS, POISONINGS AND VIOLENCE	229	1040.4	905.6	1175.2	338	1169.5	1044.8	1294.2	0.89
Fractures	70	321.0	245.8	396.2	116	395.5	323.5	467.5	0.81
Strains and Sprains	39	181.6	124.6	238.6	46	151.8	107.9	195.7	1.20
Contusions	4	18.9	0	37.4	23	88.9	52.6	125.2	0.21*
Open Wounds	25	115.9	70.5	161.3	29	101.7	64.7	138.7	1.14
Burns	6	25.1	5.0	45.2	10	31.5	12.0	51.0	0.80
SUPPLEMENTARY EXAMS	17	77.5	40.7	114.3	32	103.5	67.6	139.4	0.75
TOTAL HOSPITAL ADMISSIONS	1358	5912.8	5598.3	6227.3	1926	6305.1	6023.5	6586.7	0.94

[1] Relative risk is the risk of the submarine administrative/clerical personnel relative to the surface-ship administrative/clerical personnel.

* $p < .05$

Table 4. Total Age-Adjusted Hospitalization Rates per 100,000 Person-Years and Relative Risks Among Blue Collar Submarine Personnel and a Comparison Sample of Surface-Ship Blue Collar, White Male Enlisted Personnel, 1974-1979

Diagnostic Category and selected diagnoses	Submarine Personnel (112,243 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel (105,472 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Relative Risk[1]
INFECTIVE AND PARASITIC DISEASES	271	238.5	210.1	266.9	375	356.0	320.0	392.0	0.67*
Diarrheal disease	51	45.2	32.8	57.6	59	56.6	42.2	71.0	0.80
Viral Hepatitis	33	28.7	18.9	38.5	70	66.8	51.2	82.4	0.43*
Venereal Diseases	16	14.0	7.1	20.9	44	41.4	29.2	53.6	0.34*
NEOPLASMS	156	141.5	119.3	163.7	187	181.4	155.4	207.4	0.78
ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES	59	53.4	39.8	67.0	60	58.2	43.5	72.9	0.92
DISEASES OF BLOOD AND BLOOD-FORMING TISSUE	15	13.2	6.5	19.9	21	20.4	11.7	29.1	0.65
MENTAL DISORDERS	725	640.2	593.6	686.8	1288	1245.0	1177.0	1313.0	0.51*
Alcohol Abuse	252	235.4	206.3	264.5	707	690.5	639.6	741.4	0.34*
Drug Abuse	26	21.2	13.1	29.3	50	45.4	32.8	58.0	0.47*
Personality Disorders	129	109.1	90.3	127.9	154	146.2	123.1	169.3	0.75
DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	201	179.9	155.0	204.8	312	302.6	269.0	336.2	0.59*
DISEASES OF THE CIRCULATORY SYSTEM	246	229.5	200.8	258.2	296	286.6	253.9	319.3	0.80
DISEASES OF THE RESPIRATORY SYSTEM	506	440.0	401.7	478.3	614	589.1	542.5	635.7	0.75*
Acute Upper Respiratory Infection	8	6.7	2.1	11.3	11	10.6	4.3	16.9	0.63
Pneumonia	41	36.5	25.3	47.7	67	64.6	49.1	80.1	0.57*
DISEASES OF THE DIGESTIVE SYSTEM	709	640.9	593.7	688.1	868	835.2	779.6	890.8	0.77*
Hernia	246	224.4	196.4	252.4	369	354.1	318.0	390.2	0.63*
DISEASES OF THE GENITO-URINARY SYSTEM	259	228.9	201.0	256.8	351	339.8	304.3	375.3	0.67*
DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	292	256.9	227.4	286.4	461	441.2	400.9	481.5	0.58*
Cellulitis	86	76.8	60.6	93.0	168	160.1	135.9	184.3	0.48*

Table 4. (continued)

Diagnostic Category and selected diagnoses	Submarine Personnel N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel N	Rate	95% Confidence Limits Lower	Upper	Relative Risk
DISEASES OF THE MUSCULO-SKELETAL SYSTEM	744	658.9	611.6	706.2	916	882.7	825.5	939.9	0.75*
CONGENITAL ANOMALIES	71	64.0	49.1	78.9	90	85.6	67.9	103.3	0.75
SYMPTOMS AND UNSPECIFIED CONDITIONS	278	246.3	217.3	275.3	352	338.5	303.1	373.9	0.73*
ACCIDENTS, POISONINGS AND VIOLENCE	1344	1173.8	1111.0	1236.6	1988	1885.4	1802.5	1968.3	0.62*
Fractures	452	394.1	357.8	430.4	639	606.2	559.2	653.2	0.65*
Strains and Sprains	164	142.8	120.9	164.7	220	210.3	182.5	238.1	0.68*
Contusions	53	46.0	33.6	58.4	127	120.2	99.3	141.1	0.38*
Open Wounds	89	78.8	62.4	95.2	187	177.4	152.0	202.8	0.44*
Burns	37	32.7	22.2	43.2	65	61.2	46.3	76.1	0.53*
SUPPLEMENTARY EXAMS	127	115.5	95.4	135.6	148	142.9	119.9	165.9	0.81
TOTAL HOSPITAL ADMISSIONS	6004	5322.3	5187.7	5456.9	8327	7990.4	7818.8	8162.0	0.67*

[1] Relative risk is the risk of the submarine blue collar personnel relative to the surface-ship blue collar personnel.

* $p < .05$

Table 5. Total Age-Adjusted Hospitalization Rates per 100,000 Person-Years and Relative Risks Among Electronic/Technical Submarine Personnel and a Comparison Sample of Surface-Ship Electronic/Technical Personnel, White Male Enlisted Personnel, 1974-1979

Diagnostic Category and selected diagnoses	Submarine Personnel (86,365 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel (76,008 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Relative Risk[1]
INFECTIVE AND PARASITIC DISEASES	206	238.6	206.0	271.2	262	349.4	307.1	391.7	0.68*
Diarrheal disease	43	49.2	34.5	63.9	43	57.2	40.1	74.3	0.86
Viral Hepatitis	36	41.8	28.1	55.5	46	61.0	43.4	78.6	0.69
Venereal Diseases	20	23.1	13.0	33.2	21	27.8	15.9	39.7	0.83
NEOPLASMS	95	106.1	84.8	127.4	71	93.4	71.7	115.1	1.14
ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES	44	48.1	33.9	62.3	34	45.4	30.1	60.7	1.06
DISEASES OF BLOOD AND BLOOD-FORMING TISSUE	14	15.2	7.2	23.2	14	18.4	8.8	28.0	0.83
MENTAL DISORDERS	528	600.5	549.3	651.7	641	837.5	772.7	902.3	0.72*
Alcohol Abuse	181	199.8	170.7	228.9	297	384.5	340.8	428.2	0.52*
Drug Abuse	23	27.5	16.3	38.7	24	32.7	19.6	45.8	0.84
Personality Disorders	84	99.6	78.3	120.9	99	132.7	106.6	158.8	0.75
DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	129	144.9	119.9	169.9	165	217.3	184.1	250.5	0.67*
DISEASES OF THE CIRCULATORY SYSTEM	170	188.6	160.2	217.0	154	199.4	167.9	230.9	0.95
DISEASES OF THE RESPIRATORY SYSTEM	339	388.0	346.7	429.3	339	443.3	396.1	490.5	0.88
Acute Upper Respiratory Infection	4	4.3	0.1	8.5	4	5.2	0.1	10.3	0.83
Pneumonia	32	36.5	23.9	49.1	53	69.5	50.8	88.2	0.53*
DISEASES OF THE DIGESTIVE SYSTEM	526	594.0	543.2	644.8	551	724.8	664.3	785.3	0.82*
Hernia	188	213.0	182.6	243.4	212	279.3	241.7	316.9	0.76
DISEASES OF THE GENITO-URINARY SYSTEM	181	204.9	175.0	234.8	233	300.0	261.5	338.5	0.68*
DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	197	223.3	192.1	254.5	281	368.5	325.4	411.6	0.61*
Cellulitis	59	67.0	49.9	84.1	102	134.2	108.2	160.2	0.50*

Table 5. (continued)

Diagnostic Category and selected diagnoses	Submarine Personnel N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel N	Rate	95% Confidence Limits Lower	Upper	Relative Risk
DISEASES OF THE MUSCULO-SKELETAL SYSTEM	500	560.9	511.7	610.1	464	607.8	552.5	663.1	0.92
CONGENITAL ANOMALIES	32	37.9	24.8	51.0	57	73.9	54.7	93.1	0.51*
SYMPTOMS AND UNSPECIFIED CONDITIONS	181	204.6	174.8	234.4	183	240.6	205.7	275.5	0.85
ACCIDENTS, POISONINGS AND VIOLENCE	865	991.0	925.0	1057.0	998	1316.2	1234.5	1397.9	0.75*
Fractures	339	388.3	347.0	429.6	364	480.6	431.2	530.0	0.81*
Strains and Sprains	109	125.3	101.8	148.8	123	161.8	133.2	190.4	0.77
Contusions	38	44.4	30.3	58.5	48	64.0	45.9	82.1	0.69
Open Wounds	51	58.1	42.2	74.0	82	107.9	84.5	131.3	0.54*
Burns	12	13.2	5.7	20.7	19	25.3	13.9	36.7	0.52
SUPPLEMENTARY EXAMS	65	73.3	55.5	91.1	60	77.8	58.1	97.5	0.94
TOTAL HOSPITAL ADMISSIONS	4073	4620.8	4478.9	4762.7	4508	5915.1	5742.4	6087.8	0.78*

[1] Relative risk is the risk of the submarine electronic/technical personnel relative to the surface-ship electronic/technical personnel.

* $p < .05$

Table 6. Total Age-Adjusted Hospitalization Rates per 100,000 Person-Years and Relative Risks Among Medical Submarine Personnel and a Comparison Sample of Surface-Ship Medical, White Male Enlisted Personnel, 1974-1979

Diagnostic Category and selected diagnoses	Submarine Personnel (4,242 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel (3,999 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Relative Risk[1]
INFECTIVE AND PARASITIC DISEASES	27	801.9	499.4	1104.4	60	2099.7	1568.4	2631.0	0.38*
Diarrheal disease	10	288.6	109.7	467.5	20	726.6	408.2	1045.0	0.40
Viral Hepatitis	5	124.5	15.4	233.6	8	210.6	64.7	356.5	0.59
Venereal Diseases	-	-	-	-	3	127.7	0	272.2	-
NEOPLASMS	7	111.2	28.8	193.6	11	276.3	113.0	439.6	0.40
ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES	3	49.2	0	104.9	2	30.7	0	73.2	1.60
DISEASES OF BLOOD AND BLOOD-FORMING TISSUE	-	-	-	-	3	89.8	0	191.4	-
MENTAL DISORDERS	62	1303.0	978.7	1627.3	83	2163.1	1697.7	2628.5	0.60*
Alcohol Abuse	24	395.1	237.0	553.2	45	1142.8	808.9	1476.7	0.35*
Drug Abuse	2	64.8	0	154.6	-	-	-	-	-
Personality Disorders	6	146.4	29.3	263.5	11	359.8	147.2	572.4	0.41
DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	12	206.7	89.7	323.7	24	619.1	371.4	866.8	0.33*
DISEASES OF THE CIRCULATORY SYSTEM	21	439.3	251.4	627.2	15	282.1	139.3	424.9	1.56
DISEASES OF THE RESPIRATORY SYSTEM	41	1193.4	828.1	1558.7	77	2243.3	1742.2	2744.4	0.53*
Acute Upper Respiratory Infection	2	64.8	0	154.6	3	108.3	0	230.9	0.60
Pneumonia	5	126.5	15.6	237.4	9	238.6	82.7	394.5	0.53
DISEASES OF THE DIGESTIVE SYSTEM	60	1385.6	1035.0	1736.2	59	1395.8	1039.6	1752.0	0.99
Hernia	21	337.6	193.2	482.0	17	390.2	204.7	575.7	0.87
DISEASES OF THE GENITO-URINARY SYSTEM	22	416.2	242.3	590.1	20	527.7	296.4	759.0	0.79
DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	14	299.7	142.7	456.7	25	786.6	478.3	1094.9	0.38*
Cellulitis	4	61.6	1.2	122.0	10	320.3	121.8	518.8	0.19

Table 6. (continued)

Diagnostic Category and selected diagnoses	Submarine Personnel N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel N	Rate	95% Confidence Limits Lower	Upper	Relative Risk
DISEASES OF THE MUSCULO-SKELETAL SYSTEM	54	1207.7	885.6	1529.8	63	1643.8	1237.9	2049.7	0.73
CONGENITAL ANOMALIES	5	128.1	15.8	240.4	5	214.7	26.5	402.9	0.60
SYMPTOMS AND UNSPECIFIED CONDITIONS	28	534.1	336.3	731.9	21	516.2	295.4	737.0	1.03
ACCIDENTS, POISONINGS AND VIOLENCE	69	2207.1	1686.3	2727.9	85	2709.5	2133.5	3285.5	0.81
Fractures	14	316.1	150.5	481.7	20	517.9	290.9	744.9	0.61
Strains and Sprains	16	455.9	232.5	679.3	13	431.5	196.9	666.1	1.06
Contusions	1	32.4	0	95.9	3	89.8	0	191.4	0.36
Open Wounds	7	347.1	90.0	604.2	6	234.8	46.9	422.7	1.48
Burns	3	48.2	0	102.7	1	17.6	0	52.1	2.74
SUPPLEMENTARY EXAMS	4	79.6	1.6	157.6	20	603.8	339.2	868.4	0.13*
TOTAL HOSPITAL ADMISSIONS	429	10362.6	9382.0	11343.2	573	16202.2	14875.6	17528.8	0.64*

[1] Relative risk is the risk of the submarine medical personnel relative to the surface-ship medical personnel.

* $p < .05$

Table 7. Total Age-Adjusted Hospitalization Rates per 100,000 Person-Years and Relative Risks Among Apprentice Submarine Personnel and a Comparison Sample of Surface-Ship Apprentice Personnel, White Male Enlisted Personnel, 1974-1979

Diagnostic Category and selected diagnoses	Submarine Personnel (6,212 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel (17,364 Person-years) N	Rate	95% Confidence Limits Lower	Upper	Relative Risk[1]
INFECTIVE AND PARASITIC DISEASES	661	6591.9	6089.4	7094.4	921	4007.4	3748.6	4266.2	1.64*
Diarrheal disease	53	615.9	450.1	781.7	77	342.5	266.0	419.0	1.80*
Viral Hepatitis	37	420.9	285.3	556.5	73	408.0	314.4	501.6	1.03
Venereal Diseases	7	278.1	72.1	484.1	35	173.7	116.2	231.2	1.60
NEOPLASMS	29	942.3	599.3	1285.3	70	536.6	410.9	662.3	1.76
ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES	3	36.2	0	77.2	12	128.7	55.9	201.5	0.28
DISEASES OF BLOOD AND BLOOD-FORMING TISSUE	7	49.3	12.8	85.8	21	185.7	106.3	265.1	0.27*
MENTAL DISORDERS	335	7479.2	6678.3	8280.1	1016	16488.7	15474.8	17502.6	0.45*
Alcohol Abuse	79	2631.7	2051.4	3212.0	374	11487.2	10323.0	12651.4	0.23*
Drug Abuse	41	538.8	373.9	703.7	123	642.8	529.2	756.4	0.84
Personality Disorders	105	2166.7	1752.3	2581.1	248	1556.4	1362.7	1750.1	1.39*
DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS	59	1389.3	1034.8	1743.8	148	853.2	715.7	990.7	1.63*
DISEASES OF THE CIRCULATORY SYSTEM	27	1574.4	908.5	2168.3	83	674.0	529.0	819.0	2.34*
DISEASES OF THE RESPIRATORY SYSTEM	918	10990.9	10279.9	11701.9	1287	12582.8	11895.3	13270.3	0.87*
Acute Upper Respiratory Infection	287	2977.7	2633.2	3322.2	345	1213.0	1085.0	1341.0	2.45*
Pneumonia	327	3427.9	3056.4	3799.4	456	8823.4	8013.5	9633.3	0.39*
DISEASES OF THE DIGESTIVE SYSTEM	292	4703.2	4163.7	5242.7	527	6763.2	6185.8	7340.6	0.70*
Hernia	117	1862.4	1524.9	2199.9	206	4581.5	3955.9	5207.1	0.41*
DISEASES OF THE GENITO-URINARY SYSTEM	65	761.9	576.7	947.1	214	1460.6	1264.9	1656.3	0.52*
DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE	393	6206.4	5592.8	6820.0	669	10294.2	9514.1	11074.3	0.60*
Cellulitis	312	5154.3	4582.4	5726.2	495	5711.0	5207.9	6214.1	0.90

Table 7. (continued)

Diagnostic Category and selected diagnoses	Submarine Personnel N	Rate	95% Confidence Limits Lower	Upper	Surface-Ship Personnel N	Rate	95% Confidence Limits Lower	Upper	Relative Risk
DISEASES OF THE MUSCULO-SKELETAL SYSTEM	145	3090.8	2587.7	3593.9	441	6239.1	5656.8	6821.4	0.50*
CONGENITAL ANOMALIES	46	614.5	436.9	792.1	88	444.4	351.5	537.3	1.38
SYMPTOMS AND UNSPECIFIED CONDITIONS	122	1919.5	1578.9	2260.1	261	1598.6	1404.7	1792.5	1.20
ACCIDENTS, POISONINGS AND VIOLENCE	593	7745.8	7122.4	8369.2	1505	8556.5	8124.2	8988.8	0.91
Fractures	186	2528.1	2164.8	2891.4	419	2545.1	2301.4	2788.8	0.99
Strains and Sprains	85	1342.6	1057.2	1628.0	209	1347.9	1165.2	1530.6	1.00
Contusions	31	481.4	311.9	650.9	108	654.2	530.8	777.6	0.75
Open Wounds	33	359.9	237.1	482.7	140	670.3	559.3	781.3	0.54*
Burns	12	106.5	46.2	166.8	43	180.7	126.7	234.7	0.59
SUPPLEMENTARY EXAMS	437	5949.2	5391.4	6507.0	440	5751.9	5214.4	6289.4	1.03
TOTAL HOSPITAL ADMISSIONS	4132	60044.8	58214.0	61875.6	7702	51800.2	50643.3	52957.1	1.16*

[1] Relative risk is the risk of the submarine apprentice personnel relative to the surface-ship apprentice personnel.

* $p < .05$

APPENDIX 1

Naval Enlisted Personnel Rates in each Occupational Group

Numerical Code	Alpha Abbreviation	Available Pay-grades	Occupation (Rate)
Administrative/Clerical			
1400	NC	E5-E9	Navy Counselor
1700	YN	E1-E9	Yeoman
1750	LN	E5-E9	Legalman
1800	PN	E1-E9	Personnelman
1900	DP	E1-E9	Data Processing Technician
2000	SK	E1-E9	Storekeeper
2100	DK	E1-E9	Disbursing Clerk
2200	MS	E1-E9	Mess Management Specialist
2300	IS	E1-E9	Intelligence Specialist
2490	SH	E1-E9	Ship's Serviceman
2600	JO	E1-E9	Journalist
2700	PC	E1-E9	Postal Clerk
Blue Collar			
0100	BM	E1-E9	Boatswain's Mate
0450	OT	E9	Ocean Systems Technician
0500	TM	E1-E9	Torpedoman's Mate (Sub/Surf)
0600	GM	E8-E9	Gunner's Mate
0601	GMM	E1-E7	Gunner's Mate-Missiles
0602	GMT	E1-E9	Gunner's Mate-Technician
0604	GMG	E1-E7	Gunner's Mate-Guns
0810	MT	E1-E7	Missile Technician
0900	MN	E1-E9	Mineman
3700	MM	E1-E9	Machinist's Mate
3800	EN	E1-E9	Engineman
3900	MR	E1-E9	Machinery Repairman
4000	BT	E1-E9	Boiler Technician-at E6 may opt for BR
4020	BR	E6-E9	Boilermaker
4100	EM	E1-E9	Electrician's Mate
4200	IC	E1-E8	Interior Communications Electrician
4300	HT	E1-E9	Hull Maintenance Technician
4400	GS	E8-E9	Gas Turbine System Technician
4600	PM	E1-E7	Patternmaker
4700	ML	E1-E9	Molder
5100	EA	E1-E8	Engineering Aid
5300	CE	E1-E8	Construction Electrician
5410	EO	E1-E8	Equipment Operator
5500	CM	E1-E8	Construction Mechanic
5600	BU	E1-E8	Builder
5700	SW	E1-E8	Steelworker
5800	UT	E1-E9	Utilitiesman

Appendix 1 (Continued)

Blue Collar

6080	AF	E9	Aircraft Maintenance Technician
6180	AV	E9	Avionics Technician
6200	AD	E1-E8	Aviation Machinist's Mate
6206	ADJ	E1-E7	Aviation Machinist's Mate-Jet Engines
6500	AO	E1-E9	Aviation ordnanceman
6520	AQ	E1-E8	Aviation Fire Control Technician
6700	AB	E8-E9	Aviation Boatswain's Mate
6800	AE	E1-E8	Aviation Electrician's Mate
6900	AM	E8	Aviation Structural Mechanic
7000	PR	E1-E9	Aircrew Survival Equipmentman
7300	AK	E1-E9	Aviation Storekeeper
7400	AZ	E1-E9	Aviation Maintenance Administrationman
7500	AS	E6-E9	Aviation Support Equipment Technician

Electronic/Technical

0150	MA	E5-E9	Master-at-Arms
0200	QM	E1-E9	Quartermaster
0250	SM	E1-E9	Signalman
0300	OS	E1-E9	Operations Specialist
0350	EW	E1-E9	Electronics Warfare Technician
0400	ST	E9	Sonar Technician
0401	STG	E1-E8	Sonar Technician-Surface
0404	STS	E1-E8	Sonar Technician-Submarine
0800	FT	E8-E9	Fire Control Technician
0801	FTG	E2-E7	Fire Control Technician-Gun
0802	FTM	E1-E7	Fire Control Technician-Surface Missile
0803	FTB	E1-E7	Fire Control Technician-Ballistic Miss.
1000	ET	E1-E9	Electronics Technician
1001	ETN	E1-E5	Electronics Technician-Communications
1002	ETR	E1-E5	Electronics Technician-Radar
1010	DS	E1-E9	Data Systems Technician
1100	IM	E1-E8	Instrumentman
1200	OM	E1-E8	Opticalman
1500	RM	E1-E9	Radioman
1666	CTI	E1-E9	Cryptologic Technician-Interpretive
6300	AT	E1-E8	Aviation electronics Technician
6310	AX	E1-E8	Antisubmarine Warfare Technician
6400	AW	E1-E9	Aviation ASW Operator (Acoustic/Non-acoustic)
6600	AC	E1-E9	Air Controlman
7100	AG	E1-E9	Aerographer's Mate
7200	TD	E1-E9	Tradesman
7600	PH	E1-E9	Photographer's Mate

Medical

8000	HM	E4-E9	Hospital Corpsman
8300	DT	E4-E9	Dental Technician

Appendix 1 (Continued)

Apprentice

3600	SR,SA,SN	E1-E3	Seaman recruit, Apprentice, Seaman
5000	FR,FA,FN	E1-E3	Fireman Recruit, FN Apprentice, Fireman
6000	CR,CA,CN	E1-E3	Construction Recruit, Const. Apprentice, Constructionman
7800	AR,AA,AN	E1-E3	Airman Recruit, AN Apprentice, Airman

Other

0000			Not Reported
3100	LI	E2-E9	Lithographer
3200	DM	E1-E9	Illustrator-Draftsman
3300	MU	E2-E9	Musician

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NHRC Report No. 89-10	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Health Research Center 6b. OFFICE SYMBOL (*If applicable*) Code 20	7a. NAME OF MONITORING ORGANIZATION Commander, Naval Medical Command
6c. ADDRESS (*City, State, and ZIP Code*) P. O. Box 85122 San Diego, CA 92138-9174	7b. ADDRESS (*City, State, and ZIP Code*) Dept. of the Navy Washington, DC 20372-5120
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Naval Medical Research & Development Command 8b. OFFICE SYMBOL (*If applicable*)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (*City, State, and ZIP Code*) Naval Medical Command, National Capital Region Bethesda, MD 20814-5044	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 62706N; PROJECT NO. M0095.; TASK NO 005; WORK UNIT ACCESSION NO. 6004

11. TITLE (*Include Security Classification*)
DISEASES AND NON-BATTLE INJURIES FOR U.S. NAVY SUBMARINE PERSONNEL AND SURFACE-SHIP PERSONNEL BY OCCUPATIONAL GROUP

12. PERSONAL AUTHOR(S)
BURR, Ralph, G.; PALINKAS, Lawrence A.; PINEDA, Anthony S.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (*Year, Month, Day*)	15. PAGE COUNT
Final	FROM _____ TO _____	89 March 27	

16. SUPPLEMENTARY NOTATION
Presented at the 31st Navy Occupational Health and Preventive Medicine Workshop, Virginia Beach, VA March 1989.

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (*Continue on reverse if necessary and identify by block number*)
Non-battle injuries Submarine work environments
USN Submariners
Surface-ship personnel

19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

This study evaluated health risks associated with U.S. Navy submarine duty by comparing hospitalization rates of submariners with surface-ship personnel for five occupational groups. Occupational groups included administrative/clerical, apprentice, blue collar, electronic/technical, and medical personnel. Occupational groups were compared between ship type using age-adjusted hospitalization rates for 16 major diagnostic categories and several specific diagnoses within these categories. Submarine personnel had significantly lower total hospitalization rates than surface-ship personnel in blue collar, electronic/technical, and medical occupations. The only occupational group in which submariners had significantly higher hospital admission rates was among apprentice personnel. Submarine apprentices were higher than surface-ship apprentice personnel for infective and parasitic diseases, diarrheal disease, personality disorders, diseases of the nervous system and sense organs, diseases of the circulatory system, acute upper respiratory infection, and for total hospital admissions.

(Continued on reverse side)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Ralph G. Burr	22b. TELEPHONE (*Include Area Code*) (619) 553-9967 22c. OFFICE SYMBOL Code 20

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete

(II) SECURITY CLASSIFICATION OF THIS PAGE

U.S. Government Printing Office: 1985-607-047

UNCLASSIFIED

(Continued from front side, Block 19)

The results show that of the five occupational categories, the submarine environment has the greatest health effects on apprentice personnel. Age and job-related stress in the submarine environment are discussed as contributing factors.