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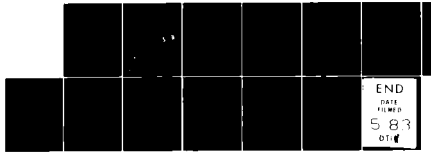

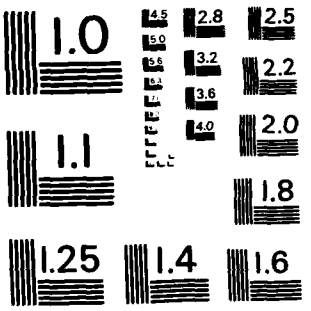

AGE-SPECIFIC MORBIDITY AMONG NAVY PILOTS

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REPORT NO. 82-31

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BETHESDA, MARYLAND

Age-specific Morbidity among Navy Pilots

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Report Number 82-31, supported by Naval Medical Research and Development Command, Department of the Navy, under *Research Work Unit 62758N MF58.528.01A-0001*. The views presented in this paper are those of the authors. No endorsement by the Department of the Navy has been given nor should any be inferred.

SUMMARY

Problem

Given the large monetary and temporal investments involved in pilot training, it is clearly in the best interests of the Navy as well as the individual pilot to take all steps possible to enhance sound mind/body functioning. In order for the Navy's medical department to provide comprehensive medical care, to create intervention and prevention programs, and to develop screening criteria for pilots throughout various career phases, salient health risks need to be identified for each chronological age interval.

Objective

The purpose of this study is to identify all aviation-related disorders and to provide a comprehensive overview of age-specific health effects associated with being a pilot. Specifically, this study compares morbidity (hospitalization) rates by age for male Navy pilots with rates for three male control populations: aircrew officers (nonpilots), unrestricted line officers, and staff officers.

Approach

Pilots (n = 22,417) and nonpilot crew members (n = 9,483) were identified from the Individual Flight Activity Reporting System file which was provided by the Naval Safety Center in Norfolk. Career history records for these two populations and the control groups of unrestricted line officers (n = 55,593) and Staff Corps (n = 46,565) were matched against the medical inpatient historical file to obtain chronological histories for each individual hospitalized from July 1967 through December 1979. The numbers of hospital admissions for each specific diagnosis were tallied by age intervals which spanned three years beginning with age 21 and ending with age 53. After computing populations at risk for each age interval, annual hospitalization rates per 10,000 were computed for each of the four officer groups. Trend analyses were conducted to determine if significant increases in morbidity were observed for each officer group. The χ^2 technique was used to ascertain whether or not differences between officer groups were significant for total hospitalizations and specific diagnoses.

Results

Total hospitalization rates were highest for nonpilot aircrew members (433.1), followed by pilots (392.7), Staff Corps (261.5), and unrestricted line officers (212.2). Aircrew members and pilots also had considerably higher hospitalization rates than other officer groups for most of the major diagnostic categories, especially for Diseases of the Digestive System; Accidents, Poisonings, and Violence; and Diseases of the Musculoskeletal System. The youngest pilot and crew member groups had the highest rates for the first two categories whereas the oldest pilot group had the highest rates for musculoskeletal conditions. Of the digestive diseases, the elevated rates for disorders of tooth development and eruption accounted for a large proportion of the rate differential between aviation and other officers. The highest rates among aviation officers for accidental injuries were attributed primarily to athletic or sports activities.

Comparisons of hospitalizations for aviation-related disorders revealed low rates and small differences across officer groups with the exception of the higher rates among pilots and crew members for cardiac arrhythmia, bone marrow function, and heart effects. Pilots and aircrew members also had the highest rates for all neoplasms and Hodgkin's Disease whereas pilots had at least double the rate of the other groups for cancer of the testis. Other results indicated that pilots had somewhat higher

rates than controls for ischemic heart disease and other circulatory diseases. In comparisons with civilian samples, the four officer populations were considerably healthier.

Conclusions

The incidence of many disorders identified in this study would seem to be readily preventable or certainly reducible through such endeavors as the implementation of life style enhancement programs (e.g., smoking cessation) and improved physical training techniques. To further protect the health of Navy personnel, a health appraisal procedure and intervention and prevention programs should be developed. The Navy's Health and Physical Readiness Program, which is scheduled for implementation in 1983, is a step in the right direction toward enhancing the physical and mental well-being of all personnel.

Age-specific Morbidity among Navy Pilots

Anne Hoiberg and Christopher Blood

Few occupations require as strict an adherence to a sound health surveillance and maintenance program as that of aircraft pilot. In the Navy, the health status of pilots is closely monitored and evaluated to ensure their safe and effective participation in fulfilling the organization's goals. The establishment of a close relationship between the pilot and the aviation medicine practitioner (generally, the flight surgeon) enables the flight surgeon to provide medical care for immediate health problems, to detect the signs and symptoms of disease, and to encourage participation in programs of physical fitness, nutrition, smoking cessation, and stress management. Given the large monetary and temporal investments involved in pilot training, it is clearly in the best interests of the Navy as well as the individual pilot to take all steps possible to enhance sound mind/body functioning.

This association between aviation and medicine, which officially dates back to 1929 with the founding of the aviation medicine specialty, has led to an emergence of research on all aspects of aviation, flight, and the influence of atmospheric conditions (2,10,21). Results of such research have identified more than nine major environmental stressors associated with aviation (e.g., acceleration, heat stress, noise, vibration) and at least 16 related illnesses and injuries that may occur (e.g., pneumothorax, heat fatigue, cardiac arrhythmia, atelectasis, alveolar bone loss).

Other disorders, as yet undetermined, may be manifested as a result of the cumulative health effects attributable to a prolonged aviation career. Such research findings also could form the basis for resolving in part the persistent controversy that centers on the issue of whether or not chronological age should be the primary consideration in determining a pilot's retirement. For civilian commercial pilots, the calendar age of 60 is the mandatory age of retirement; in the Navy, few pilots remain on active duty beyond the age of 53 and all officers must retire by age 62.

Mohler (18) and Fay (8) have argued vehemently against using age per se as the criterion for involuntary retirement or as a predictor of flying performance. An important basis for their position is that age and experience have repeatedly been shown to correlate negatively with pilots' overall accident rate (3,18) and that pilots tend to be physiologically younger than their chronological age (8). Instead of chronological age, they recommend the use of functional capacity which is established from an assessment of a pilot's longitudinal medical history, results of an exercise electrocardiogram, and the presence or absence of such risk factors as smoking, hypertension, and obesity. Similarly, Gerathewhol (9) describes a pilot's functional age index as consisting of 14 factors associated with pilot performance and proficiency.

In studies of denial rates for licensing, age is often cited as an important positive correlate of medical disqualification in that denial rates increase linearly with age. Dark and Davis (6), for example, report that cardiovascular conditions account for 39.3% of all denials among airline pilots, and the highest rate is observed for the 55- to 59-year age group. Other authors emphasize that the overall incidence of cardiovascular problems is relatively low among military and airline pilots when compared with other U.S. male populations of comparable age levels (4,14-16). Buckendorf, Warren, and Vieweg (5) report that myocardial infarction has been causally implicated in less than 0.5% of military aircraft accidents. Among U.S. commercial pilots of scheduled airlines, there are no records from 1930 to 1980 of accidents attributable to pilot incapacitation from cardiovascular

or other disease (18). In the past 15 years, no scheduled British commercial aircraft has been lost because of a pilot suffering a heart attack (20).

In this brief introduction, an important function of the Navy's medical department was described--that of providing health care and health promotion programs for all naval pilots. Also, research findings were summarized on the numerous disorders unique to the aviation community (e.g., barotitis, atelectasis) and the most important age-specific health problems (i.e., accidental injuries among young pilots and cardiovascular conditions among older pilots). In order for the Navy's medical department to develop intervention and prevention programs as well as screening criteria for pilots throughout various career phases, salient health risks need to be identified for each chronologic age interval. The scope and intent of the present investigation is to identify all aviation-related disorders and to provide a comprehensive overview of age-specific health effects associated with being a pilot. Specifically, this study compares morbidity (hospitalization) rates by age for male Navy pilots with rates for three male control populations: aircrew officers (nonpilots), unrestricted line officers, and staff officers. Comparison of pilots with these control groups should yield some insight into the health problems induced by flight as well as illnesses unique to Navy pilots.

DATA AND METHODS

Pilots and nonpilot crew members were identified from the Individual Flight Activity Reporting System (IFARS) file which was made available to the Naval Health Research Center in San Diego by the Naval Safety Center in Norfolk, Virginia. This file contains information on the flights of all members of the aviation community who served on active duty for any time period since July 1967. The following data were extracted from this file: total flight hours as pilot or aircrew, birthyear, officer designator, pilot or nonpilot status, and initial year of flying. Using these data, the aviation community was divided into (1) pilots who had flown as first pilot or copilot (n = 22,417) and (2) nonpilot officers who had flown only as a member of the crew (n = 9,483).

The two control groups of unrestricted line officers (n = 55,593 which included surface ship, submarine, and special warfare officers) and Staff Corps (n = 46,565 which consisted of physicians, lawyers, chaplains, and so forth) were selected from the career history file of all officers who served on active duty for any time period from July 1967 through 1980. Variables extracted from this file for each of the four officer groups included date and reasons for resignation, separation, or retirement from active duty. Because there were very few women pilots, this study was limited to male personnel.

Records for the four groups were matched against the Navy medical inpatient historical file maintained at the Naval Health Research Center. The data on this file, which contains all hospitalization records from July 1965 through December 1979, are obtained annually from the Naval Medical Data Services Center in Bethesda and compiled into chronological histories for each hospitalized individual. Data selected from this file were diagnosis for each hospitalization (numeric codes were adapted from the Eighth Revision of the International Classification of Diseases Adapted for Use in the United States or ICDA-8) and date of each hospitalization.

In order to determine the age-specific health problems of pilots and the control groups, the numbers of hospitalizations for each diagnosis were tallied by chronological age. The admissions were collapsed into age intervals spanning three years beginning with age 21; because of the few pilots in their mid-50s, the last interval ended with age 53. All hospitalizations recorded from July 1967

through December 1979 were included in the tabulations for each diagnosis which were compiled into the 16 ICDA-8 diagnostic categories and overall total admissions for each age interval within the four groups. To compute hospitalization rates per 10,000 strength, populations at risk were determined by calculating the numbers of individuals on active duty by year and age across the July 1967 through December 1979 time period. With these totals of man-years at risk for each age interval, annual hospitalization rates per 10,000 were computed for each of the four officer groups.

To determine if significant increases in morbidity were observed across age intervals, trend analyses were conducted for each of the four groups. Included in these analyses were the computations of the coefficient of determination and regression coefficients. Using the χ^2 technique, comparisons of hospitalized men in the aviation community with those from other fields ascertained whether or not differences between officer groups were significant for total hospitalizations and specific diagnoses.

RESULTS

Comparisons of Total Hospitalization Rates among Officer Groups

Across the four officer groups, total hospitalization rates were highest for aircrew members (433.1), followed by pilots (392.7), Staff Corps (281.5), and unrestricted line officers (212.2). Results of the χ^2 computations revealed significant differences in hospitalizations ($p < .001$) between pilots and other officers as well as between aviation officers and the two control populations.

As shown in Figure 1, the oldest and youngest age groups of aircrew members had the highest total annual hospitalization rates (985.9 and 873.5 per 10,000, respectively) while pilots' values for these age groups were 793.4 and 871.4. Rates for both aviation groups formed a U-shaped curve with high rates at both ends of the age continuum. The total rate for the oldest aircrew members should be interpreted with caution because of the few hospitalizations (14) recorded during the 12.5 years of the study. The slope for the control groups differed in that rates increased steadily from low values at ages 24 to 26 to the highest for the 51 to 53 age interval. To test the extent of change in morbidity with age, exponential trend analyses were computed for each of the four groups, using the midpoint age from the youngest to oldest age intervals. The slope reflecting increases in rates tended to be minimal, from .01 to .05, and differences in slopes across groups for ages 24 to 50 were nonsignificant.

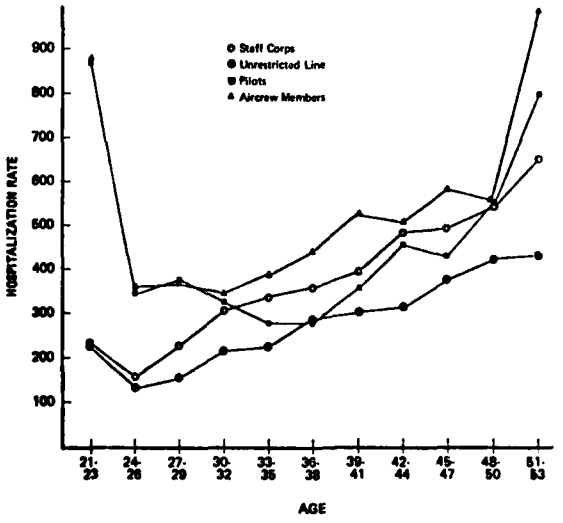

Fig. 1. Total annual hospitalization rates per 10,000 by age for four Navy officer populations, 1967-1979.

TABLE I. Hospitalization Rates for Navy Pilots by Major Disease Categories, Selected Diagnoses, and Age Intervals, 1967-1979

Diagnostic Category (ICDA-8)	Hospitalization Rates by Age Intervals[a]										Overall Rate
	21-23	24-26	27-29	30-32	33-35	36-38	39-41	42-44	45-47	48-50	51-53	
Diseases of the Digestive System	346.4	48.0	52.8	44.5	51.8	51.5	65.7	84.3	93.4	96.8	184.5	80.5
Disorders of tooth development and eruption	256.7	6.7	7.0	1.2	1.5	0	2.5	2.2	2.0	0	0	24.0
Hernia	30.5	15.1	19.8	19.8	25.5	18.4	27.4	49.7	43.7	33.9	92.2	24.5
Accidents, Poisonings, and Violence	172.7	83.7	76.5	57.5	46.0	36.9	40.7	37.8	33.8	38.7	92.2	67.9
Fractures	36.3	23.4	23.8	20.4	23.3	16.1	11.6	17.3	17.9	24.2	55.4	21.8
Strains, sprains, dislocations	65.9	24.2	24.6	14.2	8.8	9.2	14.1	11.9	4.0	9.7	-[b]	20.4
Diseases of the Musculoskeletal System and Connective Tissue	75.4	30.9	36.5	42.6	27.7	28.4	40.7	69.2	41.8	58.1	92.2	41.1
Internal derangement of joint	36.3	9.9	8.8	10.5	5.1	8.4	5.8	6.5	6.0	4.8	-	10.4
Displacement of intervertebral disc	3.8	5.2	8.4	8.6	7.3	9.2	11.6	21.6	19.4	14.5	0	9.0
Diseases of the Respiratory System	68.7	28.6	29.0	28.4	25.5	10.0	16.6	25.9	33.8	33.9	-	28.7
Diseases of the Genitourinary System	31.5	25.8	36.5	35.2	26.3	30.0	25.8	34.6	25.8	48.4	55.4	30.9
Diseases of the Circulatory System	8.6	9.9	19.8	13.6	16.1	23.8	50.7	60.5	61.6	92.0	110.7	25.1
Cardiovascular disease	1.0	2.8	5.7	3.1	8.8	13.8	20.0	29.2	31.8	33.9	73.8	10.3
Cerebrovascular disease	0	2.4	1.8	0.6	0	1.5	5.0	6.5	8.0	4.8	0	2.3
Hemorrhoids	2.9	3.2	5.3	6.2	3.6	7.5	14.1	17.3	15.9	33.9	-	7.4
Infective and Parasitic Diseases	39.1	34.9	29.0	19.2	11.7	10.0	18.3	10.8	13.9	24.2	55.4	23.2
Diseases of the Skin and Subcutaneous Tissue	41.0	17.8	18.5	8.6	7.3	3.8	5.0	8.6	6.0	4.8	-	13.7
Mental Disorders	10.5	7.5	12.3	8.6	15.3	16.1	26.6	29.2	19.9	33.9	0	14.0
Alcoholism	1.0	2.4	3.5	3.7	5.8	9.2	15.8	19.5	17.9	29.0	0	7.1
Neoplasms	18.1	11.9	13.2	11.1	14.6	9.2	16.6	18.4	21.9	53.2	55.4	14.7
Symptoms and Ill-defined Conditions	25.8	21.4	16.3	17.3	4.4	17.7	18.3	21.6	21.9	24.2	-	18.0
Diseases of the Nervous System and Sense Organs	13.4	7.1	11.0	7.4	10.2	14.6	11.6	23.8	21.9	24.2	73.8	12.1
Supplementary Classifications	6.7	7.9	12.3	20.4	17.5	18.4	12.5	10.8	23.9	14.5	0	13.5
Congenital Anomalies	8.6	3.2	8.8	1.2	5.8	4.6	1.7	2.2	2.0	0	0	4.4
Endocrine, Nutritional, and Metabolic Diseases	2.9	3.6	3.1	4.9	2.9	3.8	1.7	10.8	4.0	4.8	0	3.9
Diseases of the Blood and Blood-forming Organs	1.9	1.2	1.3	1.9	1.5	0	0	2.2	0	0	0	1.2
Hospitalization Rate	871.4	343.4	377.0	322.7	278.6	278.8	352.5	450.8	425.4	551.8	793.4	392.7
Numbers of Person-years at Risk	10478	25217	22732	16177	13709	13018	12029	9250	5030	2066	542	130,248

[a]Hospitalization rates are numbers of admissions per 10,000 population per year.

[b]Rates were not computed for diagnoses with a frequency of less than 3.

TABLE II. Hospitalization Rates for Navy Aircrew Officers by Major Disease Categories, Selected Diagnoses, and Age Intervals, 1967-1979

Diagnostic Category (ICDA-8)	Hospitalization Rates by Age Intervals[a]											Overall Rate
	21-23	24-26	27-29	30-32	33-35	36-38	39-41	42-44	45-47	48-50	51-53	
Diseases of the Digestive System	257.6	50.4	49.2	66.8	67.2	89.3	117.1	55.6	117.8	61.5	-[b]	81.1
Disorders of tooth development and eruption	168.6	3.7	1.9	1.2	0	0	0	0	0	0	-	15.8
Hernia	28.1	19.3	18.9	35.2	25.8	49.3	55.1	16.7	58.9	30.8	-	28.8
Accidents, Poisonings, and Violence	194.4	77.0	79.4	49.8	70.6	40.0	82.7	44.5	58.9	0	-	77.5
Fractures	49.2	28.4	28.4	23.1	27.6	14.1	17.2	16.7	35.3	0	-	27.0
Strains, sprains, dislocations	67.9	19.3	19.9	8.5	25.8	7.1	27.6	11.1	23.6	0	-	21.6
Diseases of the Musculoskeletal System and Connective Tissue	60.9	36.7	43.5	29.2	49.9	70.5	75.8	27.8	23.6	61.5	-	45.2
Internal derangement of joint	25.8	11.0	13.2	6.1	1.7	7.1	10.3	5.6	0	0	-	10.0
Displacement of intervertebral disc	2.3	8.2	8.5	7.3	18.9	37.6	34.4	5.6	0	30.8	-	12.8
Diseases of the Respiratory System	112.4	40.4	29.3	35.2	39.6	25.8	37.9	55.6	23.6	0	-	42.0
Diseases of the Genitourinary System	37.5	34.8	34.0	24.3	20.7	28.2	37.9	44.5	47.1	61.5	-	32.0
Diseases of the Circulatory System	18.7	9.2	15.1	13.4	6.9	11.8	10.3	55.6	35.3	61.5	-	14.8
Cardiovascular disease	2.3	0.9	2.8	2.4	1.7	4.7	3.4	22.2	23.6	30.8	-	3.8
Cerebrovascular disease	0	0	3.8	1.2	1.7	0	0	5.6	0	0	-	1.6
Hemorrhoids	4.7	2.8	6.6	2.4	3.4	2.4	3.4	11.1	11.8	0	-	4.2
Infective and Parasitic Diseases	39.8	34.8	27.4	26.7	22.4	16.5	13.8	5.6	0	30.8	-	26.4
Diseases of the Skin and Subcutaneous Tissue	51.5	21.1	20.8	19.4	17.2	4.7	10.3	5.6	11.8	0	-	20.0
Mental Disorders	9.4	11.9	14.2	15.8	18.9	47.0	34.4	77.9	82.4	184.6	352.1	23.6
Alcoholism	4.7	1.8	2.8	8.5	3.4	28.2	27.6	61.2	58.9	184.6	-	12.0
Neoplasms	4.7	10.1	15.1	12.2	13.8	28.2	24.1	16.7	35.3	30.8	-	14.6
Symptoms and Ill-defined Conditions	32.8	12.8	16.1	15.8	22.4	42.3	37.9	16.7	70.7	0	-	21.2
Diseases of the Nervous System and Sense Organs	25.8	2.8	5.7	9.7	12.1	11.8	10.3	66.8	35.3	30.8	211.3	12.4
Supplementary Classifications	7.0	5.5	6.6	21.9	18.9	18.8	17.2	11.1	11.8	0	-	12.2
Congenital Anomalies	11.7	1.8	3.8	3.6	5.2	2.4	3.4	16.7	0	0	-	4.0
Endocrine, Nutritional, and Metabolic Diseases	0	4.6	3.8	4.9	5.2	2.4	10.3	16.7	23.6	30.8	-	4.8
Diseases of the Blood and Blood-forming Organs	9.4	0.9	2.8	0	18.9	0	0	0	0	0	-	1.6
Hospitalization Rate	873.5	354.9	366.9	345.2	387.4	439.3	523.6	506.4	577.2	553.8	985.9	433.1
Number of Person-years at Risk	4270	10905	10574	8227	5808	4257	2903	1797	849	325	142	50,057

[a]Hospitalization rates are numbers of admissions per 10,000 population per year.

[b]Rates were not computed for diagnoses with a frequency of less than 3.

TABLE III. Hospitalization Rates for Navy Staff Corps Officers by Major Disease Categories, Selected Diagnoses, and Age Intervals, 1967-1979

Diagnostic Category (ICDA-8)	Hospitalization Rates by Age Intervals[a]											Overall Rate
	21-23	24-26	27-29	30-32	33-35	36-38	39-41	42-44	45-47	48-50	51-53	
Diseases of the Digestive System	39.9	21.3	34.4	45.3	50.8	62.6	61.3	81.4	86.8	112.8	121.7	44.9
Disorders of tooth development and eruption	13.4	2.8	1.5	1.9	1.6	0.6	0.6	0	0	0	-[b]	2.8
Hernia	6.9	6.2	8.3	13.2	15.0	26.5	24.6	41.0	44.5	66.7	71.4	15.7
Accidents, Poisonings, and Violence	39.5	22.2	31.0	40.0	30.5	37.2	34.8	42.6	39.2	25.4	34.4	32.4
Fractures	10.9	5.9	8.4	14.9	7.7	11.3	12.0	15.2	12.7	11.1	13.2	9.9
Strains, sprains, dislocations	10.1	7.0	10.9	14.9	10.6	12.4	13.3	14.4	14.8	9.5	10.6	11.0
Diseases of the Musculoskeletal System and Connective Tissue	19.2	13.5	22.7	37.4	42.3	45.7	43.6	60.1	45.5	52.4	52.9	30.2
Internal derangement of joint	5.8	3.7	5.8	6.2	8.9	7.9	5.0	6.8	2.1	6.4	-	5.7
Displacement of intervertebral disc	2.5	1.9	4.0	8.6	13.0	16.9	15.2	19.0	13.8	14.3	21.2	7.7
Diseases of the Respiratory System	40.2	21.6	24.6	33.1	32.5	28.8	32.2	41.8	24.3	36.5	26.4	29.0
Diseases of the Genitourinary System	12.3	12.0	19.8	24.2	32.9	26.5	27.8	39.5	33.9	50.8	55.5	22.4
Diseases of the Circulatory System	6.5	6.7	11.8	10.8	28.4	22.0	35.4	45.6	77.3	82.6	124.3	20.0
Cardiovascular disease	0.7	1.9	1.4	1.9	8.5	11.3	17.1	23.6	43.4	47.7	79.3	8.0
Cerebrovascular disease	1.1	0.5	2.0	1.4	3.2	2.2	1.9	3.8	13.8	23.8	29.1	2.9
Hemorrhoids	1.4	1.9	2.8	3.1	8.5	5.1	8.2	12.9	10.6	7.9	7.9	4.3
Infective and Parasitic Diseases	24.6	20.4	25.0	34.3	24.4	19.7	25.9	11.4	15.9	11.1	15.9	23.5
Diseases of the Skin and Subcutaneous Tissue	14.9	8.2	9.7	6.5	11.4	10.7	8.8	10.6	2.1	4.8	21.2	9.4
Mental Disorders	10.1	7.2	11.5	22.1	22.4	37.2	37.9	48.6	41.3	58.8	60.8	20.2
Alcoholism	0.4	1.1	1.2	7.7	11.0	22.0	25.9	34.2	25.4	38.1	34.4	9.0
Neoplasms	2.2	3.6	7.1	8.4	9.4	11.3	14.5	20.5	23.3	33.4	31.7	8.9
Symptoms and Ill-defined Conditions	12.3	7.8	9.7	15.1	15.8	29.3	24.0	28.9	34.9	36.5	37.0	15.4
Diseases of the Nervous System and Sense Organs	6.9	4.8	6.3	11.7	12.2	12.4	25.9	29.6	34.9	23.8	31.7	11.4
Supplementary Classifications	3.6	3.6	5.4	9.1	6.5	7.9	9.5	8.4	13.8	9.5	21.2	6.5
Congenital Anomalies	2.5	1.7	1.8	3.8	6.9	4.5	4.4	5.3	3.2	4.8	23.8	3.2
Endocrine, Nutritional, and Metabolic Diseases	1.1	1.4	1.8	2.2	6.1	4.5	6.3	5.3	4.2	3.2	10.6	2.9
Diseases of the Blood and Blood-forming Organs	1.1	0.6	0.9	1.0	1.6	1.1	1.9	0	2.1	1.6	0	1.0
Hospitalization Rate	237.0	156.7	223.4	305.0	334.2	361.4	394.5	479.8	482.7	548.2	640.0	281.5
Number of Person-years at Risk	27589	64252	65165	41703	24596	17736	15816	13152	9446	6293	3781	289,529

[a] Hospitalization rates are numbers of admissions per 10,000 population per year.

[b] Rates were not computed for diagnoses with a frequency of less than 3.

TABLE IV. Hospitalization Rates for Navy Unrestricted Line Officers by Major Disease Categories, Selected Diagnoses, and Age Intervals, 1967-1979

Diagnostic Category (ICDA-8)	Hospitalization Rates by Age Intervals[a]											Overall Rate
	21-23	24-26	27-29	30-32	33-35	36-38	39-41	42-44	45-47	48-50	51-53	
Diseases of the Digestive System	82.6	20.2	27.6	35.1	38.4	47.8	57.3	70.3	63.6	92.1	78.4	44.0
Disorders of tooth development and eruption	57.4	2.4	2.6	1.6	0.5	1.1	0	0	0	0	0	10.7
Hernia	7.0	6.0	11.9	15.2	13.3	17.6	23.9	26.6	47.7	46.8	46.4	14.0
Accidents, Poisonings, and Violence	43.1	24.9	25.0	25.0	29.8	35.3	23.9	25.9	25.4	25.6	-[b]	29.0
Fractures	12.0	6.6	8.2	9.0	13.8	13.7	9.0	11.8	13.8	4.5	-	9.4
Strains, sprains, dislocations	17.1	7.0	9.3	6.6	6.7	8.5	6.0	6.6	4.2	9.0	0	8.9
Diseases of the Musculoskeletal System and Connective Tissue	15.6	12.7	18.9	23.0	23.0	31.3	27.1	39.9	28.6	51.3	43.5	20.7
Internal derangement of joint	5.5	3.6	5.2	5.8	0.5	2.8	1.8	4.4	3.2	4.5	-	4.0
Displacement of Intervertebral disc	1.3	0.8	3.0	7.0	10.8	14.8	10.8	14.0	8.5	16.6	14.5	5.3
Diseases of the Respiratory System	21.1	13.7	14.5	19.1	17.9	18.8	18.1	18.5	25.4	30.2	29.0	17.5
Diseases of the Genitourinary System	10.3	11.0	7.8	19.9	15.9	19.4	21.1	20.0	32.8	22.6	37.7	14.3
Diseases of the Circulatory System	3.4	6.2	5.4	9.4	16.9	23.9	33.2	42.2	65.7	70.9	75.4	15.2
Cardiovascular disease	0.8	1.5	2.2	1.6	5.1	9.7	15.7	24.4	40.2	43.8	40.6	13.6
Cerebrovascular disease	0.2	0.9	0	2.3	1.5	2.3	2.4	3.0	5.3	9.0	26.1	3.4
Hemorrhoids	0.6	1.1	1.5	2.7	8.2	6.8	9.0	8.1	13.8	10.6	-	3.5
Infective and Parasitic Diseases	17.7	11.0	9.9	12.1	10.2	8.5	7.8	7.4	7.4	12.1	11.6	11.4
Diseases of the Skin and Subcutaneous Tissue	9.7	8.1	11.1	10.2	10.2	11.4	6.6	5.2	9.5	7.5	-	9.1
Mental Disorders	8.0	6.5	8.0	11.7	13.8	22.8	30.1	20.7	28.6	19.6	11.6	12.0
Alcoholism	0.4	0.5	1.1	3.1	4.1	9.1	18.1	11.8	22.2	18.1	8.7	4.3
Neoplasms	6.1	5.2	3.2	11.3	13.3	20.5	15.7	20.7	19.1	25.7	31.9	9.6
Symptoms and Ill-defined Conditions	8.0	7.7	6.9	14.0	9.2	10.2	22.9	15.5	21.2	18.1	29.0	10.6
Diseases of the Nervous System and Sense Organs	3.2	4.3	5.4	7.4	7.7	10.8	12.7	10.4	20.1	16.6	34.8	7.1
Supplementary Classifications	2.5	1.9	4.3	10.5	8.7	12.5	14.5	7.4	10.5	12.1	20.3	6.0
Congenital Anomalies	1.7	1.3	0.9	2.3	4.6	2.8	2.4	1.5	5.3	4.5	-	2.0
Endocrine, Nutritional, and Metabolic	0.8	2.6	2.3	2.0	3.1	4.0	4.8	5.2	5.3	7.5	8.7	2.9
Diseases of the Blood and Blood-forming Organs	0.4	0.4	1.3	0.8	1.0	0.6	0	1.5	0	3.0	-	0.7
Hospitalization Rate	234.4	137.6	154.6	214.4	224.0	280.7	300.0	312.2	368.8	421.1	429.5	212.2
Number of Person-years at Risk	47364	84466	46058	25605	19533	17565	16587	13517	9437	6626	3446	290,204

[a]Hospitalization rates are numbers of admissions per 10,000 population per year.

[b]Rates were not computed for diagnoses with a frequency of less than 3.

Comparisons of Hospitalization Rates for Specific Categories and Diagnoses

Major Diagnostic Categories: Comparisons of hospitalization rates for the 16 major diagnostic categories revealed considerably higher rates among the youngest pilots and aircrew members (Tables I and II) than their control group counterparts (Tables III and IV) for nearly all diagnoses, but especially for the three highest-ranked categories of Diseases of the Digestive System; Accidents, Poisonings, and Violence; and Diseases of the Musculoskeletal System and Connective Tissue. The youngest aviation officers accounted for the highest rates for the first two categories whereas the oldest pilot group had the highest rates for musculoskeletal conditions. With increasing age, differences in rates for most categories narrowed substantially across groups although rates for accidental injuries among pilots and aircrew members remained consistently higher through age 35 than the rates for other officers. In explaining the higher injury rates, it should be noted that only 10.2% of all pilots' injury-related hospitalizations occurred during an on-duty aviation mission and only 7.7% of all aircrew members' injury hospitalizations were aviation related. More pilots were injured in athletic/sports mishaps (38.4%), falls/miscellaneous accidents (30.0%), and land/water vechicle accidents (11.2%) than was the case for on-duty, aviation-related mishaps. In other comparisons, older pilots and staff officers had the highest rates for Diseases of the Circulatory System; the earliest and most critical age interval for a substantial increase in such rates occurred for 39- to 41-year-old pilots. The highest rates for Mental Disorders were observed among older aircrew members and officers in the Staff Corps.

Specific Diagnoses: For specific disorders, pilots and aircrew members had significantly higher hospitalization rates than the two control groups for several diagnoses in the digestive disease category, such as appendicitis and disorders of tooth development and eruption (with rates for the latter condition as much as 20 times greater for pilots than Staff Corps officers). For specific injuries, the highest rates were noted for strains, sprains, and dislocations ($p < .001$) among young pilots and aircrew members. The rates for musculoskeletal system conditions among pilots and aircrew members also were as much as double those for the nonaviation groups, especially for total rates across the diagnoses of internal derangement of the joint, displacement of intervertebral disc, vertebrogenic pain syndrome, and other diseases of the joint ($p < .001$). Of the circulatory diseases, pilots had the highest rates for hemorrhoids ($p < .001$) and ischemic heart disease ($p < .05$). Their rates for melanoma, Hodgkin's Disease, and cancer of the testis (in the category of Neoplasms) also were higher than the other groups although of the three comparisons, only those for Hodgkin's Disease and cancer of the testis reached the level of statistical significance ($p < .05$ and $p < .01$, respectively). Aircrew members and officers of the Staff Corps were observed to have the highest rates for alcoholism with rates that increased gradually across age intervals. Pilots ranked third in hospitalization rates for alcoholism among the four groups. The lowest rates for almost all of these specific diagnoses were observed for unrestricted line officers.

Aviation-related Disorders: Hospitalization rates for 16 specific disorders reported as associated with the stressors of aviation were compared to determine whether Navy pilots had significantly higher admission rates than the other officer groups. The disorders included: noise-induced deafness, errors of refraction, cataracts, cardiac arrhythmia, cerebral edema, pneumothorax, atelectasis, pulmonary edema, alveolitis, bone rarefaction, vertigo, heat effects and fatigue, toxic effects, the barotraumas, decompression sickness, and air sickness. All of the rates across the four groups were very low with the highest rate observed for cardiac arrhythmia (2.7 per 10,000) among pilots which

contrasted with rates of less than 1.8 for each of the other three groups. Pilots also had the highest rate, a value twice that of the other groups, for bone rarefaction (0.8 per 10,000). The rates for effects of heat, including heat exhaustion, were higher among aircrew members and pilots than for other officers. The difference between pilots and the nonaviation groups reached the level of statistical significance ($p < .05$) for these three aviation-related disorders, whereas the differences between pilots and crew members were nonsignificant.

DISCUSSION

At first glance, results of the present research seem to differ from other studies in which military pilots are shown to have disproportionately low illness rates when compared with various control samples. Moreover, MacIntyre et al.(16) conclude that the characteristics of Navy pilots typify those known to positively predict longevity and physical and mental well-being: intelligence, socioeconomic status, health and fitness orientation, and parental longevity (particularly the mother). In this study, aircrew members and pilots have the highest hospitalization rates of the four officer groups for both total admissions and for most of the major diagnostic categories, which suggests that members of the aviation community might not be as physically and mentally fit as reported elsewhere. Comparisons of hospitalization rates in the aviation community with those for a civilian sample, however, reveal considerably higher rates within the nonmilitary community, as much as eight times greater, than is observed for each of the four officer populations (19). Civilian total rates per 10,000 are 928 among men less than 45 years of age and 1,779 for those 45 to 54 years old. With rates that range from the lowest of 212 per 10,000 for unrestricted line officers to 433 for aircrew officers, it can be concluded that Navy officers in general have a significantly better health status than the nonmilitary U.S. male population. Hospitalization rates also have been reported as being considerably higher for Navy male enlisted personnel than those observed for their officer counterparts in this study (11,17).

Differences in rates among the four officer groups are the greatest for Diseases of the Digestive System; Accidents, Poisonings, and Violence; and Diseases of the Musculoskeletal System and Connective Tissue; aircrew members and pilots have the highest rates for these categories. For the digestive diseases, the elevated rates for disorders of tooth development and eruption account for a large proportion of the rate differential between aviation and other officers. One explanation for these marked differences is that all dental problems, such as the possibility of an impacted wisdom tooth (or, for that matter, any other potentially distracting or incapacitating disorder) must be corrected in order to ensure the pilot's and aircrew member's total concentration during flight.

The higher rates among aviation officers for accidental injuries are attributed primarily to athletic and sports activities. Being oriented toward health and physical fitness, as noted by MacIntyre et al. (16), probably contributes to pilots' and crew members' higher rates for the accidental injuries category. Another consideration, reported in Interceptor (24), is the keen desire among pilots to excel in sports and in endeavors that involve a high degree of risk taking. Such personality characteristics probably contribute to hospitalization rates for accidental injuries. Their lower rate for land vehicular accidental injuries, on the other hand, supports findings reported elsewhere in which automobile accident rates are shown to be remarkably low for pilots and for all officers as well (16).

Pilots and aircrew members also have higher rates than nonaviation officers for Diseases of the Musculoskeletal System and Connective Tissue, specifically, disorders associated with the back and joints. The most logical explanation for these higher rates is the aforementioned athletic activities as well as the effects of aircraft vibration although researchers have reported no serious health problems attributed to aircraft vibration. While results of this study do point toward an increased tendency among pilots and aircrew members to suffer back and joint disorders, it should be noted that their rates for these disorders are considerably lower than those reported in a civilian sample (19).

Comparisons of hospitalizations for aviation-related disorders reveal low rates and small differences across officer groups with the exception of higher rates among pilots and crew members for cardiac arrhythmia, bone rarefaction, and heat effects. Similarly, although the incidence is very low for neoplasms among officer groups, pilots and aircrew members have the highest rates for all neoplasms and Hodgkin's Disease whereas pilots have at least double the rate of other groups for cancer of the testis. Another study currently underway is designed to examine the types of aircraft flown and the extent of atmospheric exposure to determine if there is a relationship between these environmental or occupational variables and the incidence of cancer or aviation-related disorders. One important comparison, for example, will identify any adverse effects, such as cardiac arrhythmia, that might be attributed to high performance aircraft models.

Other results indicate that pilots have somewhat higher rates than controls for ischemic heart disease and other circulatory diseases. The extensive monitoring of pilots' health status may contribute to these higher rates in that any irregularities detected by the flight surgeon could result in the pilot's immediate hospitalization. The health status of nonaviator officers, by way of contrast, is less closely scrutinized and the prescribed treatment may more often be delivered at an outpatient medical facility or with somewhat less urgency primarily because of the less hazardous nature of their jobs. Overall rates for circulatory disease among pilots, however, are substantially lower than those reported for civilians (7,19). Rates for hypertension and other cerebrovascular disease are fairly comparable across the officer groups and approximately 20 times lower than those reported in the Framingham study (1).

Results of this study also identify the ages of 21 to 23 among aviation officers as the interval of greatest risk for digestive disorders (primarily disorders of tooth development and eruption) and accidental injuries. These diagnoses alone account for 60% of pilots' hospitalizations for this young age group. Also noted is the finding that the ages of 39 to 41 represent an age span of increased risk among pilots for circulatory disorders and problems with alcohol abuse. The increase in alcohol-related hospitalizations emphasizes not only the actual incidence of alcoholism but also the fact that being hospitalized for this behaviorally related condition probably signifies the culmination of many years of excessive drinking. Voge (22), moreover, implicates the hangover as a probable contributing influence in two of 11 causal factors of aviation mishaps.

The incidence of many disorders would seem to be readily preventable or certainly reducible. Improvements in physical training programs and warm-up exercises would lead to a lower rate of sports-related hospitalizations. Changes in an individual's life style and personal habits as well as adverse occupational influences would prove beneficial in lowering hospitalization rates for stress-related disorders and chronic disease (8,13,18).

As a first step in this reduction of morbidity, however, a health appraisal procedure should be developed to identify those individuals at risk not only for these conditions but also for all other stress-related diseases. At the time of the annual physical examination, flight surgeons could institute an assessment, similar to the USAF Coronary Artery Risk Evaluation (CARE) Package which, after obtaining measures of an individual's fasting blood sugars, blood pressure, weight, total cholesterol, HDL Cholesterol, and amount of smoking, can be used to determine the individual's relative risk for CHD by sex and age (23). On the basis of these objective results, the medical practitioner decides whether or not the individual qualifies for enrollment in an intervention program.

A procedure developed by researchers at the Institute of Medicine recommends that pilots who are at moderate risk should be counseled on techniques to reduce or eliminate risk factors, to be followed up in a year by a reassessment of their risk profiles (12). High risk individuals would require not only consultation in risk reduction but also completion of a treadmill stress ECG and a reappraisal of their risk profiles at the end of a six-week follow-up. Other tests recommended for those who remain at high risk include a thallium exercise test and a coronary angiograph.

At present, the Navy is developing several programs, such as an expanded medical screening procedure and a life style enhancement program, which should be operational as early as 1983. With implementation of these programs and an increased sense of responsibility on the pilot's part for adhering to these programs as well as a wholesome life style, hospitalization rates, although quite low at present, no doubt would decrease in the future. Participation in these programs and the acceptance of the challenge to remain physically and mentally fit throughout a career are as beneficial to the pilot as to the organization they serve.

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1. REPORT NUMBER 82-31	2. GOVT ACCESSION NO. AD-A127 749	3. RECIPIENT'S CATALOG NUMBER
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		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, California 92138-9174		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62758N MF58.528.01A-0001
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Medical Research and Development Command National Naval Medical Center Bethesda, Maryland 20814		12. REPORT DATE January 1983 13. NUMBER OF PAGES 8
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)* Bureau of Medicine and Surgery Department of the Navy Washington, D.C. 20370		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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This study compares the morbidity (hospitalization) rates by age of male Navy pilots (n = 22,417) with rates for three male control populations: nonpilot aircrew officers (n = 9,483), unrestricted line officers (n = 55,593), and staff officers (n = 46,565). Aircrew members and pilots have the highest hospitalization rates of the four officer groups for both total admissions and for most of the 16 major diagnostic categories. Younger pilots have the highest rates for disorders of tooth development and eruption and accidental injuries

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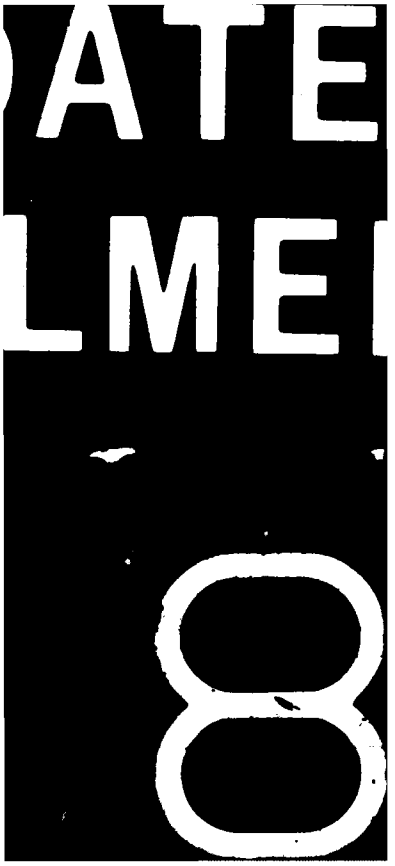
(primarily sports related) while one of the highest rates for older pilots is observed for circulatory diseases. In comparisons with civilian samples, the four officer populations are considerably healthier. To further protect the health of Navy personnel, a health risk profile should be developed, implemented, and used as the initial step in reducing and eliminating health risk factors.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