Best
Available
Copy

AD-A282 305

NAVAL HEALTH RESEARCH CENTER

GEOGRAPHIC VARIATION IN HUMAN IMMUNODEFICIENCY VIRUS SEROCONVERSION RATES IN THE U.S. NAVY

F. C. Garland
C. F. Garland
E. D. Gorham
M. R. Miller
S. K. Brodine
A. Fallon
L. L. Balazs

DTIC
ELECTE
JUL 20 1994
S D
G

94 7 14 049

DTIC QUALITY INSPECTED 5

94-22167

Report No. 91-20

Approved for public release: distribution unlimited.

NAVAL HEALTH RESEARCH CENTER
P. O. BOX 85122
SAN DIEGO, CALIFORNIA 92186 – 5122

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATE COVERED
	December 1991	Final Oct 90-Sep 91

4. TITLE AND SUBTITLE
Geographic Variation in Human Immunodeficiency Virus Seroconversion Rates in the U.S. Navy

5. FUNDING NUMBERS
Program Element:
Work Unit Number:
Reimbursable

6. AUTHOR(S) Frank C. Garland, Cedric F. Garland, Edward D. Gorham (et al)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Health Research Center
P. O. Box 85122
San Diego, CA 92186-5122

8. PERFORMING ORGANIZATION Report No. 91-20

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Naval Medical Research and Development Command
National Naval Medical Center
Building 1, Tower 2
Bethesda, MD 20889-5044

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Published in: Journal of Acquired Immune Deficiency Syndromes, 1993, 6:1267-74

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The Navy population is centered around 19 U.S. home ports and several inland duty stations. This is a study of variation in human immunodeficiency virus (HIV) seroconversions in Navy enlisted men by location in the United States, based on 949,570 enzyme-linked immunosorbent assays and 812 seroconversions during 1987-90. Seroconversion rates were higher in personnel in San Francisco ($p=0.0004$), Washington, DC ($p=0.001$), and Orlando, FL ($p=0.04$) than in other areas. They were lower in Charleston, SC, New London, CT, Seattle; and Brunswick, ME ($p<0.05$). Black men had triple the seroconversion rate of all other men ($p<0.0001$). After adjustment for race, age, marital status, and occupation, risk of seroconversion remained high in San Francisco ($p=0.02$) and Orlando ($p=0.03$). The risk of seroconversion in San Francisco was twice that of other areas in a cohort that did not change location ($p=0.01$). In contrast to declining trends overall in the Navy, rates did not decrease in Washington, DC, as a result consistent with previous calculations indicating a delayed second wave of HIV infection in the region.

14. SUBJECT TERMS Geographic Distribution
Human Immunodeficiency Virus (HIV)
Acquired Immunodeficiency Symdroms (AIDS)
Seroconversion Rates

15. NUMBER OF PAGES 8

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

Journal of Acquired Immune Deficiency Syndromes
6:1267–1274 © 1993 Raven Press, Ltd., New York

Geographic Variation in Human Immunodeficiency Virus Seroconversion Rates in the U.S. Navy

*Frank C. Garland, †Cedric F. Garland, *Edward D. Gorham, *Milan R. Miller, *Stephanie K. Brodine, ‡Ann Fallon, and *Louis L. Balazs

**Division of Epidemiology, Department of Health Sciences and Epidemiology, Naval Health Research Center, San Diego, California; †Division of Epidemiology, Department of Family and Preventive Medicine and Cancer Center, School of Medicine, University of California, San Diego, California; and United States Public Health Service and ‡Department of Preventive Medicine, Uniformed Services University of the Health Sciences, Bethesda, Maryland, U.S.A.*

Summary: The Navy population is centered around 19 U.S. home ports and several inland duty stations. This is a study of variation in human immunodeficiency virus (HIV) seroconversions in Navy enlisted men by location in the United States, based on 949,570 enzyme-linked immunosorbent assays and 812 seroconversions during 1987–90. Seroconversion rates were higher in personnel in San Francisco ($p = 0.0004$), Washington, D.C. ($p = 0.001$), and Orlando, FL ($p = 0.04$) than in other areas. They were lower in Charleston, SC, New London, CT, Seattle; and Brunswick, ME ($p < 0.05$). Black men had triple the seroconversion rate of all other men ($p < 0.0001$). After adjustment for race, age, marital status, and occupation, risk of seroconversion remained high in San Francisco ($p = 0.02$) and Orlando ($p = 0.03$). The risk of seroconversion in San Francisco was twice that of other areas in a cohort that did not change location ($p = 0.01$). In contrast to declining trends overall in the Navy, rates did not decrease in Washington, D.C., a result consistent with previous calculations indicating a delayed second wave of HIV infection in the region. **Key Words:** HIV—Seroconversion rates—U.S. Navy.

Accesion For
NTIS CRA&I
DTIC TAB
Unannounced
Justification
By
Distribution /
Availability Codes
Dist | Avail and / or Special
A-1 | 20

The Navy population is primarily centered around 19 U.S. home ports on the Atlantic and Pacific coasts, Hawaii, and Lake Michigan, and several inland duty stations. Rates of human immunodeficiency virus (HIV) seroprevalence and AIDS incidence vary greatly in the civilian population in states with Navy home ports (1–5). The annual incidence rate of AIDS in states with Navy ports ranged from five per 100,000 in Maine to 117 per 100,000 in Washington, D.C. (6).

Considerable geographic diversity in HIV seroprevalence rates has been noted in teenaged applicants for military service (7,8), with seroprevalence in applicants from heavily urbanized areas such as Washington, D.C. reported as more than 20 times that of applicants from less urbanized areas (7). This study assessed HIV seroconversion rates in active-duty Navy enlisted personnel in geographically dispersed home ports and duty stations throughout the U.S. during 1987–90. The population and procedures used have been described (9–11). A previous investigation reported the absence of an association between visits to foreign ports and subsequent risk of HIV infection (11), but no pre-

Address correspondence and reprint requests to Dr. F. C. Garland, Department of Health Sciences and Epidemiology, Naval Health Research Center, P.O. Box 85122, San Diego, CA 92186-5122, U.S.A.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the Navy, Department of Defense, or the U.S. Government. No endorsement by the Department of the Navy has been given.

Manuscript received August 21, 1992; accepted March 10, 1993.

vious study has examined variation in seroconversion rates in the Navy or in any active-duty military population by residence within the United States.

METHODS

Data Sources

The Naval Health Research Center (NHRC) maintains the Navy HIV Central Registry, which contains results of all enzyme-linked immunosorbent assay (ELISA) and Western blot test results for Navy personnel (12), along with individual demographic and career histories obtained from the Naval Military Personnel Command (13). Records of all HIV seropositive personnel are confirmed by the Navy Bureau of Medicine and Surgery and the Naval Health Research Center.

Study Design

The residence for most of the Navy population is a home port or duty station. For this study, each active-duty enlisted person was categorized as residing at one of 19 home ports or duty stations, or at an inland duty station east (Eastern region) or west (Western region) of the Mississippi River. Most duty stations in the Eastern inland region were aviation facilities centered around Memphis, and smaller facilities in Alabama, Georgia, and Mississippi. Most duty stations in the Western inland region were aviation facilities in central and western Texas and Nevada. Smaller stations were grouped with nearby larger facilities. The HIV testing and career histories were linked to determine home port or duty station at the time of testing. For individuals who did not have a designated home port, the home port was designated according to the zip code of the duty station to which the individual was assigned when tested. Individuals for whom no home duty station address or zip code was available in official Navy records or whose home duty stations were outside the United States were included in a residual unspecified/overseas category.

Statistical Procedures

The HIV seroconversion rates were calculated by dividing the annual number of HIV seroconverters at a home port or duty station by the number of individuals tested who had a prior negative ELISA. Rates were age adjusted using the indirect method (14). Statistical significance was assessed using 95% confidence intervals derived from the Poisson distribution (14). For comparisons within racial groups, the seroconversion rate for men of each race in each location was compared to that of all other male Navy personnel of the same race. Temporal trends were examined using chi-squared tests, including tests for trend (15). Statistical significance was tested using chi-squared and Fisher's exact test (15). All p values were two-sided. Similar analyses were performed for a cohort that remained in the same home port for the entire study period. The number of female seroconverters (<20 individuals) was too few for computation of age-adjusted rates by geographic area, so women were not included in this study.

ELISA and Western Blot Confirmation

Navy-wide HIV screening began in the first quarter of 1986 (16). Seroconverters were defined as all male active-duty U.S. Navy personnel who had a negative ELISA blood test for HIV followed after at least 30 days by two positive ELISAs from blood samples drawn on different dates, and at least one positive Western blot or immunofluorescent antibody (IFA) assay. The diagnoses of a total of 99.3% of HIV seroconverters in the Navy were confirmed by a Western blot assay meeting Centers for Disease Control criteria for positivity, consisting of at least two of three bands present at p24, gp41, and both gp120 and 160 (17). The diagnosis was made by a positive IFA assay in the <1% (0.7%) of subjects who had indeterminate Western blots. Seroconversion must have occurred at least 120 days after entry to active-duty service. The average time interval between HIV ELISA tests during this study was 10 months. The study identified individuals who had seroconversion between Jan. 1, 1987, and Dec. 31, 1990. Screening procedures have been described in detail previously (9).

Rosters of individuals tested were completed at 26 medical treatment facilities that collected blood for ELISA and Western blot assays. Names, identification numbers, and dates of birth of persons receiving tests were provided by Biotech, Inc., Rockville, MD, and North American Biologicals, Inc., Miami, FL, which performed the tests. Identifying information was matched against the NHRC Career History File for verification of identity. Race was categorized as white, black, or other, based on official records. The category "white" included individuals of Hispanic origin except those specifically designated as black. The category "other" included Oriental, Asian-American, Pacific Islander (including Philippine, Hawaiian, and Polynesian), American Indian, Eskimo, and Aleut. Further stratification into ethnic groups was not possible.

Adjustment for Covariates

Adjustment for covariates was performed using Poisson regression (18,19). Individuals were combined into unique groups based on home port or duty station, age in years (17–19, 20–29, or 30+), race (white, black, or other), marital status (ever married, never married), and occupation (medium or low HIV seroprevalence, high HIV seroprevalence). An individual was considered to be in an occupation with high seroprevalence if the occupation was ranked in the top 20% of all Navy occupations in seroprevalence rates (not shown). Poisson regression was performed using the LOGISTIC procedure in SAS. For events with small probabilities of occurrence, such as HIV seroconversion in this population, this procedure closely approximates the Poisson regression method (20). Poisson regression analyses were also performed for the cohort of men who remained in the same home port or duty station throughout the study period. Odds ratios obtained from regression were used as the estimates of relative risk of seroconversion, with p values derived from the Wald chi-squared test (20). Norfolk, the home port with the greatest number of person-years at risk, was used as the reference port for regression analyses.

RESULTS

There were 812 seroconverters in 949,570 persons tested with a previous negative ELISA (Table

1). Seroconverters included 455 white men, 310 black men, and 47 men of other races.

Geographic Variation

Overall age-adjusted HIV seroconversion rates in San Francisco, ($p = 0.0004$), Washington, D.C. ($p = 0.001$), and Orlando, FL ($p = 0.04$) were higher than in all other areas (Table 1). Areas with significantly low rates included Charleston, SC; New London, CT; Seattle; and Brunswick, ME ($p < 0.05$).

Trends

There was an overall downward trend in HIV seroconversion rates ($p < 0.001$) (Table 2). Rates declined between 1987–8, with apparent stabilizing in most areas during 1989–90. There were some exceptions to the declining trend, such as an increasing trend of borderline significance ($p = 0.10$) in Washington, D.C., which experienced its highest seroconversion rate during 1990.

White Men

There was considerable geographic variation in HIV seroconversion rates in white men during the early part of the study period (Fig. 1). The rate in Orlando during 1987 ($p = 0.0001$) and 1989 ($p = 0.0001$) was statistically significantly higher than that of all white men in the Navy. An apparently high seroconversion rate in white men in the Western inland region in 1990 was of borderline significance ($p = 0.06$) (Fig. 1).

Black Men

The seroconversion rate in black men overall was approximately triple that of all male Navy person-

TABLE 1. *Age-adjusted human immunodeficiency virus seroconversion rate per 1,000 tested by home port or duty station, active-duty U.S. Navy enlisted personnel, men, 1987–90*

Home port or duty station	No. of seroconverters	No. in population tested with previous negative test	Age-adjusted seroconversion rate per 1,000	95% confidence interval on age-adjusted rate	
				Lower	Upper
West					
San Francisco	98	81,030	1.2[a]	1.0	1.5
San Diego	161	153,646	1.0	0.9	1.2
Pearl Harbor, HI	36	44,557	0.8	0.6	1.1
Long Beach, CA	43	50,830	0.8	0.6	1.1
Seattle	17	43,289	0.4[b]	0.2	0.6
Mid-Atlantic					
Washington, D.C.	28	17,345	1.6[a]	1.1	2.3
Philadelphia	28	21,493	1.3	0.9	1.9
Norfolk, VA	169	172,977	1.0	0.8	1.1
New York	2	6,199	0.3	0.0	1.2
New England					
Newport, RI	6	8,220	0.7	0.3	1.6
Boston	2	4,265	0.5	0.1	1.7
New London, CT	12	29,370	0.4[b]	0.2	0.7
Brunswick, ME	0	5,653	0.0[b]	0.0	0.5
Great Lakes					
Chicago	17	29,058	0.6	0.4	1.0
Southeast					
Miami	7	4,324	1.6	0.6	3.3
Orlando, FL	15	9,926	1.7[c]	1.0	2.8
New Orleans	39	36,757	1.1	0.8	1.6
Jacksonville, FL	44	57,822	0.8	0.6	1.0
Charleston, SC	34	61,866	0.5[b]	0.4	0.7
Other					
Western inland	2	3,386	0.6	0.1	2.2
Eastern inland	2	10,666	0.2	0.0	0.8
Unspecified/overseas	50	96,891	0.6[b]	0.4	0.7
Total	812	949,570	0.9	0.8	0.9

[a] Statistically significantly high, $p < 0.001$.
[b] Statistically significantly low, $p < 0.05$.
[c] Statistically significantly high, $p < 0.05$.

TABLE 2. *Age-adjusted human immunodeficiency virus seroconversion rate per 1,000 tested, by home port or duty station, race, and year, active-duty U.S. Navy enlisted personnel, men, 1987–90*

Home port or duty station	White				Black				Total			
	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990
West												
San Francisco	2.8	1.0	0.5	0.5	7.5	4.2	2.1	2.3	3.6	1.5[a]	0.7	0.7
San Diego	1.8	1.1	0.7	0.7	6.2	2.0	1.1	1.5	2.6	1.3	0.7	0.8
Pearl Harbor, HI	1.5	0.5	0.8	0.4	3.5	2.5	0.6	1.8	2.0	0.8	0.8	0.6
Long Beach, CA	1.0	0.9	0.7	0.5	1.7	1.6	2.0	1.1	1.0	0.9	0.9	0.7
Seattle	0.4	0.2	0.2	0.3	4.1	2.5	1.0	0.7	0.6	0.4	0.3	0.4
Mid-Atlantic												
Washington, D.C.	2.4	0.6	0.7	1.0	0.0	3.1	4.3	8.5[b]	1.8	1.0	1.3	2.8[b]
Philadelphia	1.9	0.9	0.2	0.5	6.2	4.3	1.4	1.3	4.1	1.7	0.6	0.8
Norfolk, VA	1.5	0.5	0.3	0.5	7.6	2.9	2.2	2.1	2.8	1.0	0.7	0.9
New York	5.1	0.0	0.0	0.7	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.7
New England												
Newport, RI	0.0	0.0	1.0	0.6	0.0	0.0	3.5	7.4	0.0	0.0	1.3	1.6
Boston	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
New London, CT	0.0	0.8	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.7	0.2	0.3
Brunswick, ME	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Great Lakes												
Chicago	0.9	0.6	0.3	0.4	10.1	1.9	0.7	0.8	2.1	0.8	0.4	0.5
Southeast												
Miami	3.1	2.5	0.0	1.2	0.0	3.8	0.0	0.0	2.6	2.5	0.0	1.0
Orlando, FL	13.9[b]	0.0	4.3[b]	0.5	0.0	0.0	0.0	4.8	13.3[b]	0.0	3.5[a]	1.3
New Orleans	1.3	0.8	0.5	0.6	9.7	3.5	2.0	1.1	2.8	1.2	0.9	0.7
Jacksonville, FL	0.8	0.6	0.6	0.4	5.4	1.4	1.4	0.9	1.8	0.8	0.7	0.5
Charleston, SC	0.5	0.6	0.4	0.4	2.4	1.1	0.6	0.8	0.8	0.6	0.4	0.5
Other												
Western inland	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Eastern inland	0.0	0.0	0.0	0.0	0.0	1.8	3.8	0.0	0.0	0.2	0.7	0.0
Unspecified/overseas	1.6	0.5	0.3	0.3	8.4	1.0	0.8	0.9	2.5	0.5	0.3	0.4
Total	1.7	0.7	0.5	0.5	5.7	2.3	1.5	1.6	2.3	0.9	0.6	0.7

[a] Statistically significantly high, $p < 0.01$.
[b] Statistically significant high, $p < 0.0001$.

nel ($p < 0.001$). For the entire period, black men in Washington, D.C., had an age-adjusted seroconversion rate more than twice that of all black men in the Navy ($p = 0.001$), a rate in San Francisco 1.7 times that of all black men ($p = 0.002$), and a rate in Norfolk 1.3 times that of all black men ($p = 0.004$). Unlike most duty stations, rates in black men in Washington D.C., did not decrease during the study period, although an apparent increase (Fig. 2) was not statistically significant ($p = 0.32$). The seroconversion rate was statistically significantly higher for black men in Washington, D.C., in 1990, however, than that of all black men in the Navy ($p < 0.0001$). Apparently increasing time trends in seroconversion rates in black men were not significant in Newport, RI ($p = 0.26$) and Orlando ($p = 0.24$). The rate in Newport in 1990 was higher than that of all black men, although the difference was of borderline significance ($p = 0.11$), while the rate in Orlando in 1990 did not differ significantly from that of all black men ($p = 0.35$). Tables providing further detail on trends by race and location are available from F.C.G.

Adjustment for Covariates

Geographic Variation

After adjustment for race, age, and other covariates by regression, using Norfolk as the reference home port, personnel in San Francisco ($p = 0.02$) and Orlando ($p = 0.03$) had statistically significantly high relative risks of seroconversion during the entire study (Table 3). After adjustment for covariates, Orlando had the highest multiple adjusted relative risk of seroconversion in 1987 and 1989, while Miami had the highest in 1988. In 1990, only personnel in Washington, D.C. had a significantly high adjusted relative risk of seroconversion ($p = 0.0003$). Relative risks were low in Charleston, New London, and Seattle during 1987–1990 ($p < 0.05$).

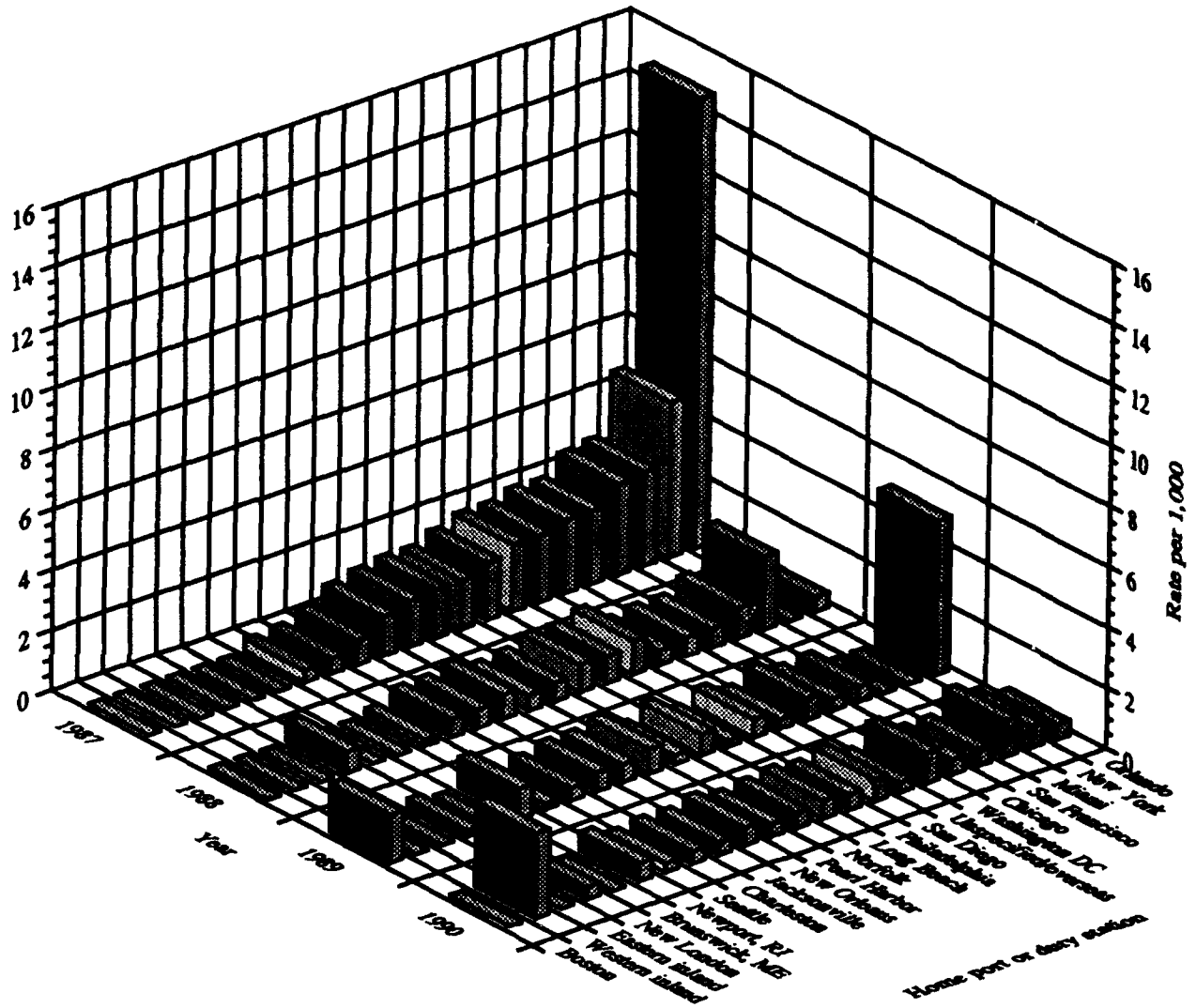

FIG. 1. Age-adjusted seroconversion rate per 1,000 tested, by home port or duty station and year, U.S. Navy enlisted personnel, white men, 1987–90.

Age and Race

The black–white differential in seroconversion rates remained virtually unchanged after adjustment for all covariates ($p < 0.001$ in all years) (Table 3). Men 20 years and older tended to have higher rates than younger men.

Cohort Remaining in the Same Home Port

For the cohort who remained in the same home port or duty station for the entire study period (181,189 men, with 195 seroconverters), the relative risk of seroconversion in San Francisco was approximately twice that of the entire Navy ($p < 0.01$) (Table 3).

DISCUSSION

Individuals in San Francisco, Washington, D.C., and Orlando had higher seroconversion rates than those in all other areas, a difference that persisted in San Francisco and Orlando after adjustment by regression for race and other covariates. Apparent fluctuations in seroconversion rates in Orlando (Figs. 1 and 2) were within the range of random variation, since they were based on fewer events than in larger duty stations. The risk of seroconver-

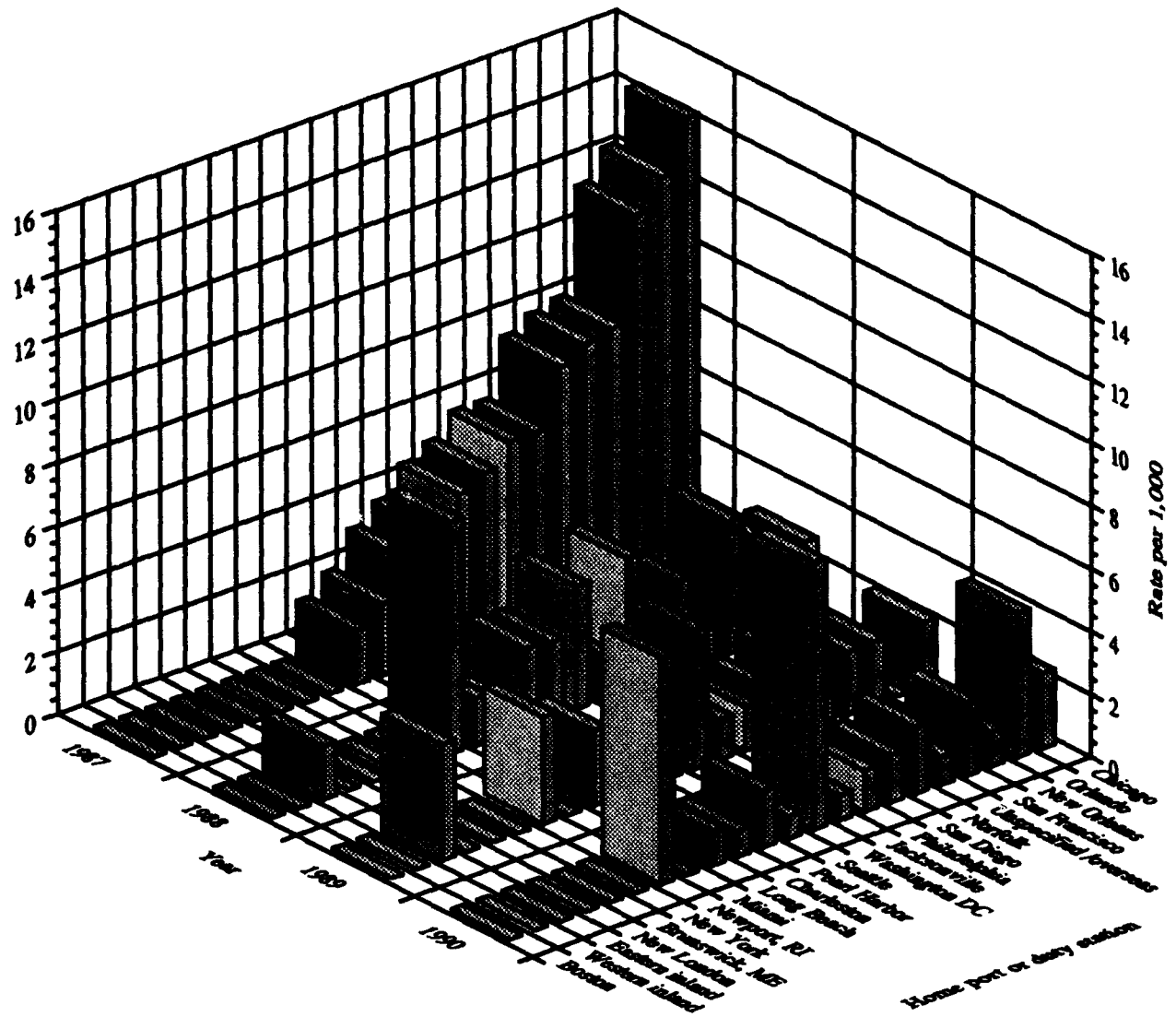

FIG. 2. Age-adjusted seroconversion rate per 1,000 tested, by home port or duty station and year, U.S. Navy enlisted personnel, black men, 1987–90.

sion in the cohort that remained in San Francisco during 1987–90 was twice that of other locations.

Adjustment for covariates was done using Poisson regression, which is well suited to analysis of seroconversion rates in large populations where the outcome is relatively uncommon (18), and has been used previously in studies of HIV seroconversion (21,22). Only men who remained in the Navy long enough to have at least two ELISAs were included in this study, since at least two tests were required to define the occurrence of seroconversion. It is possible that some individuals could have suspected an undetected HIV infection and might have left the Navy after a single negative ELISA. If so, differences among home ports in early separation due to such suspicion could account for some portion of the results. This appears unlikely, though, as military personnel cannot voluntarily terminate service without serious consequences, such as loss of health care and other benefits. The increased risks of seroconversion in black men, in those 20 years and older, and in never-married men in this study are consistent with findings in the Army (22,23).

The geographic variation in HIV seroconversion rates in this study was also consistent with previously reported variation in seroprevalence rates in the civilian population (21,24), military recruits (7,8,25), and Job Corps participants (26). The high-

TABLE 3. *Relative risk adjusted by multiple regression for home port or duty station, age, race, marital status, and occupation[a], by year, U.S. Navy active-duty enlisted personnel, men, 1987–90*

Home port or duty station	Relative risk					
	1987	1988	1989	1990	1987–90	1987–90 cohort[b]
West						
San Francisco	1.32	1.56[c]	0.98	1.00	1.34[c]	1.97[d]
San Diego	0.90	1.28	1.02	0.96	1.10	1.17
Pearl Harbor, HI	0.79	0.89	1.20	0.90	0.94	2.14
Long Beach, CA	0.36	0.92	1.29	0.82	0.89	0.15
Seattle	0.28	0.49	0.45	0.63	0.50[f]	0.00
Mid-Atlantic						
Washington, D.C.	0.55	0.83	1.51	3.03[e]	1.47	0.63
Philadelphia	1.29	1.57	0.81	0.93	1.26	0.00
Norfolk, VA	1.00	1.00	1.00	1.00	1.00	1.00
New York	1.42	0.00	0.00	1.06	0.46	0.00
New England						
Newport, RI	0.00	0.00	1.88	1.99	0.80	0.74
Boston	0.00	0.00	2.59	0.00	0.59	0.00
New London, CT	0.00	0.88	0.38	0.51	0.53[f]	0.00
Brunswick, ME	0.00	0.00	0.00	0.00	0.00	0.00
Great Lakes						
Chicago	0.80	0.97	0.80	0.63	0.80	1.70
Southeast						
Miami	1.12	2.92[c]	0.00	1.66	2.02	3.95
Orlando, FL	4.93[e]	0.00	4.36[d]	1.35	1.80[c]	2.14
New Orleans	1.15	1.24	1.48	0.84	1.23	1.33
Jacksonville, FL	0.69	0.83	1.04	0.66	0.84	0.78
Charleston, SC	0.29[f]	0.63	0.60[f]	0.58	0.55[f]	0.43
Other						
Western inland	0.00	0.00	0.00	3.40	0.68	0.00
Eastern inland	0.00	0.29	0.89	0.00	0.25	1.55
Unspecified/overseas	0.89	0.51[f]	0.47[f]	0.45[f]	0.52[f]	1.19
Age, yr						
17–19	1.00	1.00	1.00	1.00	1.00	1.00
20–29	1.92[c]	4.98[e]	2.27[c]	1.51	2.37[e]	0.49[f]
35+	1.95	5.40[e]	3.26[d]	1.13	2.45[e]	0.33[f]
Race						
White	1.00	1.00	1.00	1.00	1.00	1.00
Black	3.40[e]	2.94[e]	2.66[e]	2.95[e]	2.93[e]	4.37[e]
Other	1.79	0.81	0.89	0.94	1.02	0.86
Marital status						
Ever married	1.00	1.00	1.00	1.00	1.00	1.00
Never married	2.27[e]	3.28[e]	3.54[e]	1.96[e]	2.73[e]	1.86[e]

[a] Human immunodeficiency virus seroprevalence data on men in the Navy. As expected based on this definition, the effect of occupation was significant ($p < 0.001$) in each year and for the total of all years, with relative risks ranging from 2.1–3.6.
[b] Based on the cohort of 181,386 men who did not change home port or duty station area during the period Jan. 1, 1987, through June 30, 1990, which included 195 seroconverters.
[c] Statistically significantly high, $p < 0.05$.
[d] Statistically significantly high, $p < 0.01$.
[e] Statistically significantly high, $p < 0.001$.
[f] Statistically significantly low, $p < 0.05$.

est AIDS incidence rates in the civilian population in states with Navy home ports were in Washington, D.C., New York, Florida, and California (6). Generally, personnel in Navy home ports or duty stations in states with low incidence rates of AIDS (6) and low seroprevalence rates of HIV (7,8) had low seroconversion rates, with the exception of New York, which had high seroprevalence rates in the civilian population (7,8) but paradoxically low rates in Navy personnel.

Unlike seroconversion rates in most areas, those in Washington, D.C. increased during the study period. This was partly due to an apparent upward trend in seroconversion rates for black men, although the trend was not statistically significant ($p = 0.32$). According to back calculation of HIV infection rates using AIDS incidence rates, there were two waves of HIV infection in the civilian population of Washington, D.C. (27), with the first wave peaking in 1982–3 and the second beginning to

rise in the mid-1980s. The results of this study are consistent with the effects of the second wave of infection deduced from back calculation.

Information on behavioral risk factors in individual Navy men was not available, but the parallels between these data and patterns of incidence of AIDS in the civilian population suggest that geographic differences in sexual behavior, i.v. drug abuse, and socioeconomic factors in the surrounding civilian population (28) account for much of the geographic variation in HIV seroconversion rates in the Navy. This study specifically provides support for previous back calculations of HIV seroconversion rates, including the existence of a second wave of infection in the Washington, D.C., area, and provides a basis for targeting control efforts to the areas with highest seroconversion rates.

Acknowledgment: This study was supported by the Naval Medical Research and Development Command, under a reimbursable work unit from funds provided by the Army. Special thanks are due Mr. M. McNally; Ms. Yeng Wu; Hospital Corpsman, First Class, Janice Moore; and CDR D. C. Edman for their diligent work in maintaining records of HIV-tested personnel; and to Ms. Edith Smith, who provided contract management and quality control. Ms. Tamara Clark and Mrs. Laura Schaffroth assisted with statistical analyses. Dr. E. K. Eric Gunderson brought together many of the data bases that provided the demographic information for this report.

REFERENCES

1. Centers for Disease Control. The sentinel HIV seroprevalence surveys. *Public Health Rep* 1990;105:113–71.
2. Centers for Disease Control. Update: acquired immunodeficiency syndrome—United States, 1989. *MMWR* 1990;39: 81–6.
3. Gardner LI, Brundage JF, Burke DS, McNeil JG, Visintine R, Miller RN. Evidence for spread of the human immunodeficiency virus epidemic into low prevalence areas of the United States. *J Acquir Immune Defic Syndr* 1989;2:521–32.
4. Shannon GW, Pyle GF, Bashshur R. *The geography of AIDS: origins and course of an epidemic*. New York: Guilford Press, 1991;111–35.
5. Selik RM, Castro KG, Pappaioanou M. Racial/ethnic differences in the risk of AIDS in the United States. *Am J Public Health* 1988;78:1539–45.
6. Centers for Disease Control. *HIV/AIDS surveillance: U.S. AIDS cases reported through October 1991*. Atlanta: CDC, 1991;3.
7. Burke DS, Brundage JF, Goldenbaum M, et al. Human immunodeficiency virus infections in teenagers: seroprevalence among applicants for US military service. *JAMA* 1990; 263:2074–7.
8. Burke DS, Brundage JF, Herbold JR, et al. Human immunodeficiency virus infections among civilian applicants for United States military service, October 1985 to March 1986. *N Engl J Med* 1987;317:131–6.
9. Garland FC, Mayers DL, Hickey TM, et al. Incidence of human immunodeficiency virus seroconversion in U.S. Navy and Marine Corps personnel, 1986 through 1988. *JAMA* 1989;262:3161–5.
10. Garland FC, Gorham ED, Cunnion SO, et al. Decline in human immunodeficiency virus seropositivity and seroconversion in US Navy enlisted personnel: 1986 to 1989. *Am J Public Health* 1992;82:581–4.
11. Garland FC, Garland CF, Gorham ED, et al. Risk of human immunodeficiency virus (HIV) seroconversion in U.S. Navy personnel following visits to foreign ports. San Diego: Naval Health Research Center Report No. 91-10, 1991.
12. Garland FC, Miller MR, McNally MS, et al. The Navy Human Immunodeficiency Virus Central Registry: data collection and operating procedures. San Diego: Naval Health Research Center, Report No. 91-8, 1991.
13. Garland FC, Helmkamp JC, Gunderson EKE, et al. A guide to the computerized medical data resources of the Naval Health Research Center. San Diego: Naval Health Research Center, Report No. 87-13, 1987.
14. Lilienfeld AM, Lilienfeld DE. *Foundations of epidemiology*. 2nd ed. New York: Oxford, 1980:78–80, 336–8.
15. Armitage P, Berry G. *Statistical methods in medical research*. 2nd ed. Oxford: Blackwell, 1987:125–32, 372–3.
16. Mayer W. What we are doing about AIDS. *Defense* 1986 January/February:30–2.
17. Hausler Jr W, Joseph J, DiSalvo A, et al. Interpretation and use of the Western blot assay for serodiagnosis of human immunodeficiency virus type I infection. *MMWR* 1989;38: 1–7.
18. Frome EL. The analysis of rates using Poisson regression models. *Biometrics* 1983;39:665–74.
19. Kleinbaum DG, Kupper LL, Muller KE. *Applied regression analysis and other multivariable methods*. Boston: PWS-Kent, 1988:497–512.
20. SAS Institute Inc. *SAS/STAT user's guide*. Version 6, 4th ed. Cary NC: SAS Institute, 1989:1071–126.
21. Kingsley LA, Zhou SY, Bacellar H, et al. Temporal trends in human immunodeficiency virus type 1 seroconversion 1984–1989: a report from the multicenter AIDS cohort study (MACS). *Am J Epidemiol* 1991;134:331–9.
22. McNeil JG, Brundage JF, Wann ZF, et al. Direct measurement of human immunodeficiency virus seroconversions in a serially tested population of young adults in the United States Army, October 1985 to October 1987. *N Engl J Med* 1989;320:1581–5.
23. McNeil JG, Brundage JF, Gardner LI, et al. Trends of HIV seroconversion among young adults in the U.S. Army, 1985 to 1989. *JAMA* 1991;265:1709–14.
24. Centers for Disease Control. *National HIV seroprevalence surveys: summary of results*. 2nd ed. Atlanta: CDC, 1990:7–20.
25. Brundage JF, Burke PS, Gardner LI, et al. Tracking the spread of the HIV infection epidemic among young adults in the United States: results of the first four years of screening among civilian applicants for military service. *J Acquir Immune Defic Syndr* 1990;3:1168–80.
26. St Louis ME, Conway GA, Hayman CR, Miller C, Petersen LR, Dondero TJ. Human immunodeficiency virus infection in disadvantaged adolescents. Findings from the U.S. Job Corps. *JAMA* 1991;266:2387–91.
27. Rosenberg PS, Levy ME, Brundage JF, et al. Population-based monitoring of an urban HIV/AIDS epidemic: magnitude and trends in the District of Columbia. *JAMA* 1992;268: 495–503.
28. Rosenberg PS, Gail MH, Schrager LK, et al. National AIDS incidence trends and the extent of zidovudine therapy in selected demographic and transmission groups. *J Acquir Immune Defic Syndr* 1991;4:392–401.