Item ID Number	01868
Author	Shepard, Barclay M.
Corporate Author	
Report/Article Title	Critique of West Virginia Mortality Study
Journal/Book Title	
Year	1986
Month/Day	February 4
Color	☐
Number of Images	36
Description Notes	Item inlcudes critique, as well as attached 1) M. L. Neighbors Diversified Maritime Services, Inc. advertisement and 2) Vietnam-Era Veterans Mortality Study, West Virginia Residents 1968-1983, Preliminary Report, January 1986.

Critique of West Virginia Mortality Study

The West Virginia Department of Health has recently completed a mortality study (copy attached) of Vietnam-era veterans based on the recipients of a state bonus. The State offered a differential bonus to all West Virginia residents who served in the military during the Vietnam era with a larger amount going to those who served "in-country". 41,059 in-country (Vietnam veterans) and 41,782 non-in-country (non-Vietnam) veterans received the bonus. The list of bonus recipients was matched against state vital statistic records resulting in 1225 male Vietnam-era veterans who had died between 1968 and 1983. For each deceased male veteran a copy of the Report of Separation From Active Duty (DD 214) was reviewed to determine dates and place of service. The latter was determined by receipt of at least one of the three medals awarded for service in the Southeast Asia theater of operations. In addition, cause of death information was obtained on each deceased veteran. Of the 1225 deceased veterans, 615 were in the group of Vietnam veterans and the remaining 610 were non-Vietnam veterans, i.e., veterans who served elsewhere during the same period of time. When comparing causes of death between all veterans in the group and non-veterans of similar age only those classified as accidents, poisoning, and violence were elevated among the veteran group. Deaths due to cancer were statistically the same in both groups. Other causes of death were lower in the veteran group, a commonly observed phenomenon known as the "healthy veteran effect".

A stated by the authors, the study has a number of limitations which must be kept in mind when interpreting the results:

> "In spite of the intense publicity given to the bonus campaign, it is likely that many veterans or their survivors never applied for the bonus. Thus, those veterans who did qualify for a bonus represent an unknown proportion of the actual number of West Virginia males who served in the military during the Vietnam era. It cannot be assumed that the proportion was similar for both [groups]. Furthermore, because the mortality tape identified only residents of West Virginia who died during the study period, deaths in that period among veterans who no longer resided in West Virginia at the time of their demise would not have been counted among the 1,225 veterans deaths ascertained. ... With respect to a comparison between in-country and era veterans, it cannot be assumed that similar proportions of the respective candidate population qualified for the bonus or that the death rates among in-country veterans who were no longer West Virginia residents were similar to those among era veterans who were no longer residents."

There were 145 cancer deaths of which 71 were in the group of Vietnam veterans and 74 were among the non-Vietnam veterans. In comparing specific types of cancers between these two veteran groups, only Hodgkin's disease, testicular cancer, and soft tissue sarcoma were elevated in the Vietnam veteran group. In each instance, however, the number of actual cases was small, i.e., 5 cases of Hodgkin's disease, 3 testicular cancers and 3 soft tissue sarcomas. As the authors state: "These findings must be interpreted cautiously ... since ... the site- specific cancer deaths were derived from a relatively small number ... and would therefore be subject to ... large random fluctuations".

In addition to the stated limitations of the study, as pointed out by the authors, there has been no systematic review of military personnel records, except for the DD 214 reviews as noted above, to validate the Vietnam service status of the study subjects. Because of the interest and concern over the relationship between soft tissue sarcoma and exposure to the phenoxy herbicides, the authors have now requested a review of the personnel records of the 3 veterans recorded as having this diagnosis. All three of these were reported to have occurred in the in-country veteran group. The first of these is now known to have served in Thailand, not Vietnam, and would not have been exposed to Agent Orange. This is an example of the serious effect of misclassification especially when dealing with small numbers of subjects. In addition, there has been no systematic review of hospital or other clinical records to validate cause of death information or confirm the specific cancer diagnosis. Again, when dealing with relatively small numbers, a few errors in diagnosis can significantly alter the conclusions.

In summary, this study appears to have been well designed and well conducted as far as it goes. As noted by the authors, however, it has inherent limitations and additional data are needed to validate some of the conclusions.

BARCLAY M. SHEPARD, M.D.
Director, Agent Orange Projects Office

M. L. Neighbors

Diversified Maritime Services, Inc.

1 January 1986

ANNOUNCEMENT

M. L. NEIGHBORS, DIVERSIFIED MARITIME SERVICES, INC., announces that it is now able to offer part time consultative service or representation in the Washington, DC area to additional firms or persons that are engaged or have an interest in maritime related business ventures or business involving the disposal of chemical waste. Such work may also be arranged for in locations other than the Washington DC area as mutually agreed, and on either a prime or sub-contract basis.

Among services offered are:

A. Maintaining continuous contact with federal agencies having jurisdiction or control over maritime or chemical waste disposal ventures, and submittal of reports on matters of client interest. Rapid "feed-back" on specific information of more urgent interest can also be provided.

B. Projection of U.S. chemical waste disposal requirements, in general or with specificity.

C. Assisting in the initiation of either a maritime project or a project involving chemical waste disposal (except services involving the disposal of chemical waste by incineration at sea cannot be provided until after 30 November, 1986).

CORPORATE EXPERIENCE INCLUDES:

Nineteen years involvement with Department of Defense vessel charters and military cargo movement contracts.

Thirteen years involvement with various offices of the Environmental Protection Agency that are responsible for regulating chemical waste disposal. This work included interaction with other federal agencies and with commercial firms offering alternative types of chemical waste disposal service.

Written inquiries should be addressed to M. L. Neighbors, DMS Inc., 777 Fourteenth St., Suite 747, Washington, DC, 20005. Further information may also be obtained from Mr. Neighbors at phone number 564 1568 (area code 301 if calling from outside metro area).

WEST VIRGINIA VIETNAM-ERA VETERANS MORTALITY STUDY

WEST VIRGINIA HEALTH DEPARTMENT

VIETNAM-ERA VETERANS MORTALITY STUDY

WEST VIRGINIA RESIDENTS

1968 - 1983

Preliminary Report

January 1986

Arch A. Moore, Jr.
Governor

David K. Heydinger, M.D.
Director, Department of Health

Alan P. Holmes, B.S.E.E., M.B.A.
Principal Investigator

WEST VIRGINIA DEPARTMENT OF HEALTH
VIETNAM-ERA VETERANS MORTALITY STUDY COMMITTEE

Charles Bailey
Assistant Director, Health Statistics Center
Roy C. Baron, M.D., M.P.H.
Medical Epidemiologist
Edward Bosanac, Ph.D.
Research Consultant
John Brough, Dr. P.H.
Director, Preventive Health Services
Charles Conroy, M.A.
Agent Orange Program Coordinator
Acting Director, Community Health Services
Loretta Haddy, M.A., M.S.
State Epidemiologist
Alan P. Holmes, M.B.A.
Director, Health Statistics Center

ACKNOWLEDGEMENTS

Sandra Y. Pope, Administrative Assistant, Agent Orange Program
Eugenia Thoenen, Publications Coordinator, Health Statistics Center
Thomas N. Leonard, Programmer/Analyst, Health Statistics Center
Betty Jo Berry, Secretary, Health Statistics Center

We would also like to thank Col. John W. Moon and the staff of the West Virginia Department of Veterans' Affairs for their invaluable assistance in providing data used in this study.

For further information, contact
Charles Conroy, Agent Orange Program Coordinator
1800 Washington Street, East
Charleston, WV 25305
Telephone: (304) 348-3210

Vietnam-Era Veterans Mortality Study
West Virginia Residents 1968-1983

The Agent Orange Assistance Program, established in 1982 by the West Virginia legislature, requested the Health Statistics Center of the Department of Health to conduct a study of the causes of death among state Vietnam veterans from 1968 through 1983.* The purpose of the study was to compare the mortality pattern among veterans with that of nonveterans in order to generate hypotheses regarding any differences in the causes of death among the former. A comparison of the causes of death among veterans who served in Vietnam with those among veterans who did not serve in Vietnam was also undertaken in order to speculate whether the Vietnam experience might be associated with a distinct mortality pattern.

METHODS

Identification of West Virginia Veterans

West Virginia residents who served in the military during the years of the Vietnam Conflict were identified from the list

---

*The Vietnam era is generally defined as extending from 1964 until 1973. For the purposes of this study, however, only those deaths from 1968 were considered because of the small number of deaths occurring before that year, in addition to difficulties imposed by cause-of-death coding changes over the longer interval.

of applicants for a military service bonus offered by the state Department of Veterans' Affairs in 1974. To qualify for a bonus, veterans had to meet the following criteria:

1) they must have rendered active service in the armed forces at some time between August 1, 1964, and March 28, 1973, inclusive, or have been recipients of the Vietnam armed forces expeditionary medal if they saw active service prior to August 1;

2) they must have been residents of West Virginia for at least six months prior to entry into active service;

3) they must have actively served for a period of at least ninety days unless discharged because of a service-related disability, and

4) they must have been honorably discharged.

Efforts to notify eligible veterans or their survivors about the bonus program included one national public awareness campaign conducted in November 1975 and one conducted in July 1976. Public service announcements were issued over the television networks, and notices were posted in every major newspaper in the country and on service networks overseas. Veterans' organizations advertised the bonus legislation in their publications, and some offered assistance in filing for the bonus as a promotional device in their membership campaigns.

Three different bonuses were offered. Veterans who did not serve in Vietnam ("out-of-country" or era veterans) were to receive up to $300 (Type 3 bonus); Vietnam veterans ("in-country" veterans) were to receive up to $400 (Type 4 bonus), and surviving relatives of veterans who died while in the service during the period designated by the legislature were to receive

$500 (Type 5 bonus).

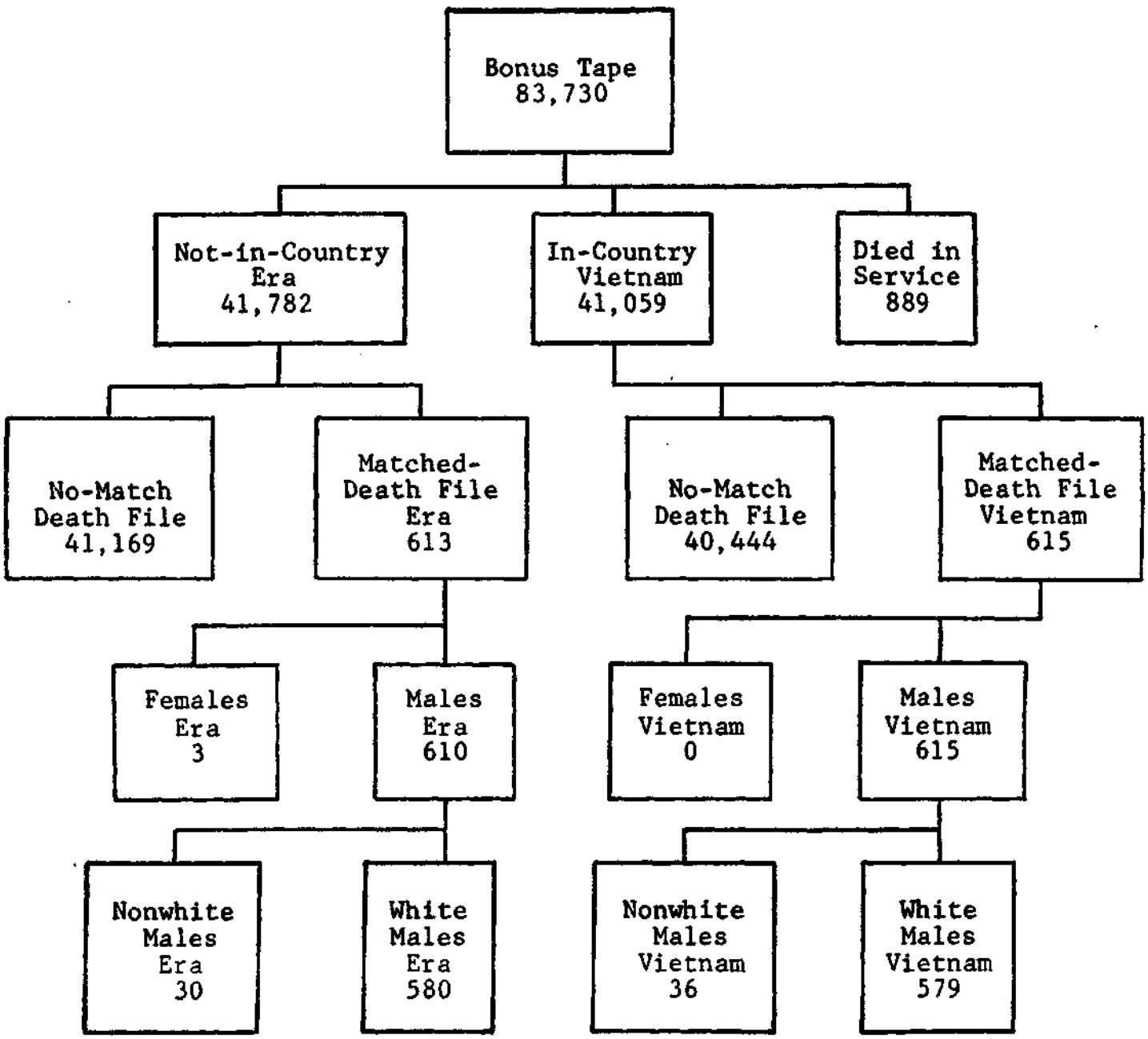
In West Virginia, the Department of Veterans' Affairs reported a total of 86,247 initial applicants. Of those who applied for the bonus, 83,730 veterans or survivors (97%) were eligible (Figure 1). Of these, 41,782 qualified for the Type 3 (Vietnam-era) bonus, 41,059 qualified for the Type 4 (Vietnam) bonus, and 889 qualified for the Type 5 bonus. Since this was to be a study of mortality following discharge from the service, the Type 5 bonus recipients were excluded from subsequent analyses. Names of the Type 3 and Type 4 qualifiers were entered onto a computer tape, referred to as the "bonus tape."

Identification of Veteran and Nonveteran Deaths

A complete listing of West Virginia resident deaths from 1968 through 1983 was prepared from records maintained by the Health Statistics Center and entered onto a "mortality tape." The names on this list were then compared with those on the bonus tape in order to identify veterans who died during this period. For deaths from 1968 through 1978, the information had to be matched by name since social security numbers were not included on the mortality tape for these years. Any possible match generated in this manner was searched by hand and confirmed by comparing the social security number on the death certificate with that on the veteran application. From 1979 through 1983, it was possible to match by social security number.

FIGURE 1

WV VIETNAM VETERAN MORTALITY STUDY
SELECTION OF STUDY POPULATION
1968-83



There were 1,234 initial matches between the bonus tape and the mortality tape, 614 Vietnam-era (Type 3) veterans and 620 in-country (Type 4) veterans. The veterans' discharge forms (DD-214s) were then manually checked to verify their in-country status.* This review resulted in the deletion and/or reclassification of several records, leaving 1,228 deceased veterans who qualified, 613 for the Type 3 bonus and 615 for the Type 4 bonus. Three of the deceased veterans, all Type 3 bonus recipients, were female. They were excluded from the final tape; the subsequent analyses included only deceased male veterans.

Of the 1,225 male veterans who died (Table 1), 1,159 were white and 66 were nonwhite (65 black and 1 Hawaiian). Thirty nonwhite veterans were Type 3 (5%) and 36 were Type 4 (6%). Because nonwhite veterans constituted a small percentage of those who died, the study combined the mortality patterns of white and nonwhite veterans.

For nonveteran males, deaths were identified from the mortality tape by deleting the records of all remaining female deaths and those of the 1,225 male veteran deaths. There were thus four groups defined for analysis: (1) all male veterans who died; (2) male Vietnam-era-only (Type 3) veterans who died;

---

*In-country status was determined by the receipt by the veteran of one of three service medals (the Vietnam service medal, the Vietnam campaign medal, or the Vietnam expeditionary medal) as noted on the DD-214. These medals were awarded to military personnel who served in the Southeast Asia theater of operations.

TABLE 1

TYPE 3 AND TYPE 4
MATCHES BETWEEN BONUS TAPE AND MORTALITY TAPE
BY YEAR
1968-83

YEAR	VIETNAM-ERA (Type 3)	IN-COUNTRY (Type 4)	TOTAL
1968	4	13	17
1969	14	16	30
1970	17	22	39
1971	16	33	49
1972	26	31	57
1973	33	22	55
1974	25	29	54
1975	50	47	97
1976	47	46	93
1977	50	40	90
1978	54	35	89
1979	53	44	97
1980	58	51	109
1981	53	70	123
1982	55	59	114
1983	56	56	112
TOTAL	610	615	1,225

(3) male in-country (Type 4) Vietnam veterans who died, and (4) all other West Virginia males (nonveterans) who died from 1968-83.

DEMOGRAPHIC PROFILE OF DECEASED VETERANS

Age Distribution

The average age at death was 35.3 for all veterans, 35.1 for era veterans and 35.4 for in-country veterans. Table 2 shows that the distribution of deaths by age for Type 3 and Type 4 veterans was similar.

Tables 3 and 4 present the distributions of age at death by race for Vietnam-era and Vietnam veterans, respectively. Among white Type 3 veterans, the average age at death was 35.3, among nonwhites 31.3. For Type 4 veterans, the mean age at death for whites was 35.5, with 33.5 that for nonwhites.

TABLE 2

ALL VIETNAM-ERA VETERANS
Age Distribution by Type of Service

AGE GROUP	VIETNAM-ERA (Type 3)		IN-COUNTRY (Type 4)		TOTAL	
	#	%	#	%	#	%
15-19	4	0.7	1	0.2	5	0.4
20-24	82	13.4	92	14.9	174	14.2
25-29	139	22.8	125	20.3	264	21.5
30-34	137	22.4	143	23.2	280	22.9
35-39	83	13.6	61	9.9	144	11.7
40-44	42	6.9	53	8.6	95	7.7
45-49	36	5.9	60	9.8	96	7.8
50-54	40	6.6	33	5.4	73	6.0
55-59	24	3.9	32	5.2	56	4.6
60-64	12	2.0	12	2.0	24	2.0
65-69	9	1.5	3	0.5	12	1.0
70-74	2	0.3	0	0.0	2	0.2
TOTAL	610	100.0	615	100.0	1,225	100.0
Average Age at Death	35.1		35.4		35.3	

TABLE 3

VIETNAM-ERA VETERANS (TYPE 3)
Age Distribution by Race

AGE GROUPS	WHITE		NONWHITE		TOTAL	
	#	%	#	%	#	%
19	4	0.7	0	0.0	4	0.7
20-24	77	13.3	5	16.7	82	13.4
25-29	131	22.6	8	26.7	139	22.8
30-34	127	21.9	10	33.3	137	22.4
35-39	79	13.6	4	13.3	83	13.6
40-44	42	7.2	0	0.0	42	6.9
45-49	33	5.7	3	10.0	36	5.9
50-54	40	6.8	0	0.0	40	6.6
55-59	24	4.2	0	0.0	24	3.9
60-64	12	2.1	0	0.0	12	2.0
65-69	9	1.6	0	0.0	9	1.5
70-74	2	0.3	0	0.0	2	0.3
TOTAL	580	100.0	30	100.0	610	100.0
Average Age at Death	35.3		31.3		35.1	

TABLE 4

IN-COUNTRY VIETNAM VETERANS (TYPE 4)
Age Distribution by Race

AGE GROUPS	WHITE		NONWHITE		TOTAL	
	#	%	#	%	#	%
19	0	0.0	1	2.8	1	0.2
20-24	87	15.0	5	13.8	92	14.9
25-29	114	19.7	11	30.5	125	20.3
30-34	135	23.3	8	22.2	143	23.2
35-39	59	10.2	2	5.6	61	9.9
40-44	51	8.8	2	5.6	53	8.6
45-49	59	10.2	1	2.8	60	9.8
50-54	29	5.0	4	11.1	33	5.4
55-59	30	5.2	2	5.6	32	5.2
60-64	12	2.1	0	0.0	12	2.0
65-69	3	0.5	0	0.0	3	0.5
70-74	0	0.0	0	0.0	0	0.0
TOTAL	579	100.0	36	100.0	615	100.0
Average Age at Death	35.5		33.5		35.4	

Branch of Service

Review of the DD-214 forms showed that 718 (59%) of the deceased veterans had served in the army, 210 (17%) had served in the air force, 167* (14%) had served in the navy, and 120 (10%) had served in the marines (Table 5). Seventy-five percent of the in-country veterans who died had been in either the army or the marines, in contrast to 62% of the era veterans. Twenty-five percent of in-country veterans had served in either the air force or the navy, in contrast to 37% of the era veterans. For 10 veterans, the branch of service was not recorded on the discharge forms.

---

*Includes 3 coast guard veterans.

TABLE 5

ALL VIETNAM-ERA VETERANS
Branch of Service by Type of Service

BRANCH OF SERVICE	VIETNAM-ERA (Type 3)		IN-COUNTRY (Type 4)		TOTAL	
	#	%	#	%	#	%
Army	340	55.7	378	61.5	718	58.6
Air Force	127	20.8	83	13.5	210	17.2
Navy	98*	16.1	69	11.2	167	13.6
Marines	39	6.4	81	13.2	120	9.8
Unknown	6	1.0	4	0.6	10	0.8
TOTAL	610	100.0	615	100.0	1,225	100.0

*Includes 3 coast guard veterans

ANALYTIC METHODS

In spite of the intense publicity given to the bonus campaign, it is likely that many veterans or their survivors never applied for the bonus. Thus, those veterans who did qualify for a bonus represent an unknown proportion of the actual number of West Virginia males who served in the military during the Vietnam era. It cannot be assumed that the proportion was similar for both Type 3 (era) and Type 4 (in-country) qualifiers. Furthermore, because the mortality tape identified only residents of West Virginia who died during the study period, deaths in that period among veterans who no longer resided in West Virginia at the time of their demise would not have been counted among the 1,225 veteran deaths ascertained.

Because of these limitations, the records provide neither complete information about the total candidate population nor a comprehensive estimate of the force of mortality among the veterans who did qualify. With respect to a comparison between the veteran and the nonveteran groups, the data would underestimate the relative force of mortality among the veterans, if such a comparison were made. With respect to a comparison between in-country and era veterans, it cannot be assumed that similar proportions of the respective candidate population qualified for the bonus or that the death rates among in-country veterans who were no longer West Virginia residents were similar to those among era veterans who were no longer residents.

The method of choice for a study of mortality when there is incomplete data on the population at risk is a proportionate mortality analysis. In this type of study the proportion of all deaths due to the disease(s) of interest in the study population is compared with the proportion of all deaths due to the disease(s) of interest in the comparison (referent) population. Such proportional rates do not express the risk of dying from a disease since the incidence is not measured against a population base. They simply suggest that there may be a difference worth investigating further. The validity of such a study rests on the assumption that there is no association between the study factor, i.e., veteran status, and the occurrence of other diseases. Since we cannot make this assumption, such an analysis is used to generate hypotheses or to conduct preliminary tests of etiologic hypotheses without collecting much additional data.

The relationship between the proportion of deaths due to a specified cause in a study population and the proportion derived from the referent population is expressed as a proportionate mortality ratio (PMR). The PMRs in this study are standardized to adjust for selected confounding variables. When the veteran group and its subgroups were compared with the nonveteran group, adjustments were made by stratifying on age at death by 5-year intervals (15-19, 20-24, . . . etc.) and on year of death by 2-year intervals (1968-69, 1970-71, . . . 1982-83). For each stratum, expected deaths were calculated by determining the percentage the cause of death of interest contributed to all

causes in the referent population and multiplying this result by the total deaths from all causes in the study population. The standardized PMR statistic (sPMR) is the ratio of the number of deaths of interest observed in the study population summed over all strata, multiplied by 100, and then divided by the expected values summed over all strata. Stratification by age only and not by year of death was done when the in-country (study) group of veterans was compared to the era (referent) group. This was done in order to avoid losing data from the study group when respective strata in the referent group had no deaths. An sPMR greater than 100 indicates that the cause of interest contributes a greater percentage of all deaths in the study population than in the referent population; an sPMR less than 100 indicates that the cause contributes a smaller percentage of all deaths in the study population than in the referent population, and an sPMR of 100 indicates that the cause of interest contributes the same percentage of all deaths in both groups. The observed and expected frequencies for each cause of interest were tested against the null hypothesis, i.e., each group has the same proportionate mortality structure, by calculating a 95% confidence interval around each sPMR and also a one-tailed p-value expressing the exact probability of finding the difference between the observed and expected frequencies.

RESULTS

In the period 1968 through 1983, there were 1,225 deaths among males who had served in the military during the Vietnam

Conflict. Six hundred fifteen of the men served at least a portion of their duty in Vietnam (in-country, Type 4 veterans) and 610 had no experience in Vietnam (era, Type 3 veterans). For both groups combined, 716 deaths (58%) were from external causes (injury from accidents, poisoning, or violence), 237 (19%) were from cardiovascular disease, 145 (12%) were from malignant neoplasms, 48 (4%) were from nonmalignant diseases of the gastrointestinal system, 24 (2%) were from nonmalignant diseases of the respiratory system, 5 (<1%) were from allergic, metabolic, and endocrine disorders, and 50 (4%) were from all other causes.

With nonveteran West Virginia male deaths from 1968 through 1983 as a reference, Table 6 demonstrates the number of observed and expected deaths in each cause-of-death category for all veterans together and for in-country and era veterans separately. For all veterans, the observed distribution of deaths over these categories was significantly different from the expected (Chi square Goodness of Fit = 50.2 with 6 degrees of freedom, $p < 10^{-8}$).

Accidents, poisoning, and violence accounted for a significantly greater proportion of all veteran deaths than expected (sPMR excess), while deaths from allergic, metabolic, and endocrine conditions and from all other causes accounted for significantly smaller-than-expected proportions of all veteran deaths (sPMR deficits). For cardiovascular, digestive, and

TABLE 6

ALL CAUSES OF MORTALITY
Vietnam Veterans vs. Nonveterans
West Virginia, 1968-83

ALL CAUSES	ALL VETERANS vs. NONVETERANS			IN-COUNTRY VETERANS vs. NONVETERANS			ERA VETERANS vs. NONVETERANS		
	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)
Accidents, Poisoning, and Violence (E800-E999)	$716/626.74$	114**	(106-123)	$362/308.6$	117**	(106-130)	$354/318.1$	111*	(100-124)
Cardiovascular Disease (390-459)	$237/251.5$	94	(83-107)	$114/129.1$	88	(73-106)	$123/122.4$	100	(84-120)
Malignant Neoplasms (140-209)	$145/142.4$	102	(86-120)	$71/73.6$	96	(75-122)	$74/68.8$	108	(85-136)
Diseases of the Digestive System (520-577)	$48/56.7$	85	(62-112)	$29/29.0$	100	(67-144)	$19/27.8$	68	(41-107)
Diseases of the Respiratory System (460-519)	$24/32.9$	73	(47-108)	$12/16.7$	72	(37-125)	$12/16.2$	74	(38-129)
Allergic, Metabolic, and Endocrine Diseases (240-279)	$5/21.9$	23**	(7-53)	$1/11.2$	9**	(=1-47)	$4/10.6$	38*	(10-96)
All Other Causes (Residual)	$50/92.9$	54**	(40-71)	$26/46.8$	56**	(36-81)	$24/46.1$	52**	(33-77)
	Goodness of Fit $X^2_{6df}=50.2$ $p=10^{-8}$								

*poisson p value $<.05$
**poisson p value $\leq.001$

respiratory diseases, the standardized proportionate mortality ratios were less than unity when all veterans were compared with nonveterans, but the observed numbers of deaths in these categories were not significantly lower than the expected. The proportion of veteran deaths due to malignant neoplasms was similar to that of nonveterans.

The pattern of death for in-country and era veterans evaluated separately relative to the nonveteran population was similar in both instances to the pattern observed for the groups combined. In a separate contrast with era veteran deaths as the standard (not shown), no difference was observed in the overall mortality pattern between in-country and era veterans (Chi square Goodness of Fit = 7.0 with 5 degrees of freedom, p = .22).

In order to evaluate more specific causes of death within the leading categories, the contrasts were repeated to obtain standardized proportionate category-specific mortality ratios for external causes (injury), cardiovascular diseases, and malignant neoplasms separately. Table 7 shows the distribution of injury deaths for veterans contrasted with nonveterans over five causes: motor vehicle accidents, non-motor-vehicle accidents, suicide, homicide, and all other external causes. Homicide accounted for a significantly smaller-than-expected proportion of the injury deaths among veterans. The standardized proportionate injury mortality ratio for motor-vehicle-related deaths among veterans was greater than 100 but was not a statistically significant

TABLE 7

INJURY MORTALITY
Vietnam Veterans vs. Nonveterans
West Virginia, 1968-83

ACCIDENTS, POISONING, AND VIOLENCE (E800-999)	ALL VETERANS vs. NONVETERANS			IN-COUNTRY VETERANS vs. NONVETERANS			ERA VETERANS vs. NONVETERANS		
	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)
Motor Vehicle (E810-E825)	315/290.6	108	(97-121)	161/150.1	107	(91-125)	154/140.5	110	(93-128)
Non-Motor Vehicle (E800-E809, E826-E949)	201/209.3	96	(83-110)	100/105.1	95	(77-116)	101/104.2	97	(79-118)
Suicide (E950-E959)	111/107.2	104	(85-125)	59/53.0	111	(85-144)	52/54.2	96	(72-126)
Homicide (E960-E969)	63/81.5	77*	(59-99)	28/40.2	70*	(46-101)	35/41.4	85	(59-118)
All Other Causes (E970-E999)	26/27.4	95	(62-139)	14/13.6	103	(56-173)	12/13.8	87	(45-152)
	Goodness of Fit X^2_{4df}=6.78 p=.15			Goodness of Fit X^2_{4df}=5.43 p=.25			Goodness of Fit X^2_{4df}=2.71 p=.61		

*poisson p value <.05

excess. For non-motor-vehicle fatalities, suicide, and all other causes, the expected numbers were similar to the observed. The overall pattern for veterans was not significantly different from nonveterans (Chi square Goodness of Fit = 6.78 with 4 degrees of freedom, $p = .15$). Separate comparisons of the in-country and era veteran populations with nonveterans similarly reflected no overall difference in the distribution of injury deaths; the ratios in each of these contrasts were similar to those observed for the combined veteran group.

Among the cardiovascular causes of mortality (Table 8), there were no veteran deaths from either hypertension or rheumatic heart disease ($p < .005$), fewer-than-expected veteran deaths from cerebrovascular disease (difference not significant), and more-than-expected veteran deaths due to ischemic heart disease (difference not significant). The individual standardized proportionate cardiovascular disease mortality ratios for in-country and era veterans were similar to the corresponding mortality ratios derived for the combined group.

Proportionate cancer mortality ratios comparing veterans to nonveterans are shown in Table 9. In the comparison between all veterans and the nonveteran population, neoplasms of the respiratory system accounted for a significantly greater proportion of veteran cancer deaths than expected. The excess contributed by in-country veterans was virtually identical to that contributed by era veterans. Melanoma of

TABLE 8

CARDIOVASCULAR DISEASE MORTALITY
Vietnam Veterans vs. Nonveterans
West Virginia, 1968-83

CARDIOVASCULAR DISEASES (390-459)	ALL VETERANS vs. NONVETERANS			IN-COUNTRY VETERANS vs. NONVETERANS			ERA VETERANS vs. NONVETERANS		
	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)
Ischemic Heart Disease (410-414)	158/141.5	112	(95-131)	75/67.7	111	(87-139)	83/74.0	112	(89-139)
Cerebrovascular Disease (430-438)	18/25.0	72	(43-114)	8/10.9	73	(32-144)	10/14.0	71	(34-131)
Hypertension (400-405)	0/6.5	0**	-	0/3.4	0*	-	0/3.0	0*	-
Rheumatic Heart Disease (390-398)	0/5.4	0**	-	0/1.9	0	-	0/3.5	0*	-
All Other Cardiovascular Diseases (415-429, 440-459)	61/58.6	104	(80-134)	31/30.2	103	(70-146)	30/28.4	106	(71-151)

*poisson p value $\leq$ .05
**poisson p value $\leq$ .005

TABLE 9

CANCER MORTALITY
Vietnam Veterans vs. Nonveterans
West Virginia, 1968-83

MALIGNANT NEOPLASMS (140-209)	ALL VETERANS vs. NONVETERANS			IN-COUNTRY VETERANS vs. NONVETERANS			ERA VETERANS vs. NONVETERANS		
	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)	O/E	sPMR	(95% CI)
Respiratory System (160-163)	58/43.1	135*	(102-174)	29/22.2	131*	(87-187)	29/20.9	139*	(93-199)
Trachea, Bronchus, and Lung (162)	50/40.7	123	(91-162)	25/21.2	118	(76-174)	25/19.5	128	(83-189)
Larynx (161)	6/1.3	462*	(168-997)	3/0.7	429*	(95-1349)	3/0.7	429*	(95-1349)
Digestive Organs and Peritoneum (150-159)	21/26.9	78	(48-119)	11/14.0	79	(39-141)	10/13.0	77	(37-142)
Malignant Melanoma of the Skin (172)	12/6.6	182*	(94-318)	4/2.7	148	(40-378)	8/3.9	205*	(89-406)
Lymphoma (200-203, 208-209)	10/12.7	79	(38-145)	7/6.2	113	(45-233)	3/6.4	47	(10-136)
Hodgkins Disease (201)	6/4.7	128	(46-276)	5/2.4	208	(69-497)	1/2.4	42	(1-233)
Male Genital Organs (185-187)	7/5.7	123	(50-254)	4/2.2	182	(49-461)	3/3.6	83	(18-254)
Leukemia (204-207)	6/13.1	46*	(17-100)	3/6.3	48	(10-139)	3/6.8	44	(9-129)
Oral Cavity (140-149)	4/3.1	129	(36-334)	2/1.4	143	(17-508)	2/1.7	118	(5-435)
Brain & Nervous System (191-192)	4/10	40*	(11-102)	1/4.1	24	(=1-137)	3/5.9	51	(10-148)
Soft and Connective Tissue (171)	3/1.2	250	(52-731)	3/0.7	429*	(90-1271)	0/0.5	0	-
Bone (170)	2/1.4	143	(18-531)	1/0.5	200	(5-1071)	1/0.8	125	(3-663)
Urinary Organs (188-189)	2/5.6	36	(4-129)	0/2.9	0*	-	2/2.7	74	(10-305)
All Other Malignancies	16/15.6	103	(59-166)	6/7.7	78	(29-170)	10/7.9	127	(60-231)

*poisson p value =.05

TABLE 10

CANCER MORTALITY FOR VIETNAM VETERANS
In-Country Veterans vs. Era Veterans
West Virginia, 1968-83

	OBSERVED/EXPECTED	sPMR	(95% CI)	POISSON p VALUE (Fisher's exact)
Respiratory System (160-163)	29/31.0	93	(63-134)	NS
Digestive Organs and Peritoneum (150-159)	11/10.0	110	(55-197)	NS
Lymphoma (200-203, 208-209)	7/2.5	280	(113-577)	0.014
Hodgkins Disease (201)	5/0.6	833	(271-1945)	0.0004
Male Genital Organs (185-187)	4/1.8	222	(62-579)	NS
Cancer of the Testis (186)	3/0.6	500	(103-1461)	0.023
Malignant Melanoma of the Skin (172)	4/8.7	46	(12-118)	0.066
Soft and Connective Tissue (171)	3/0	∞	-	-
Leukemias (204-207)	3/1.9	158	(33-461)	NS
Oral Cavity (140-149)	2/2.4	83	(10-301)	NS
All Others	8/12.7	63	(27-124)	NS

the skin also accounted for a significantly greater-than-expected proportion of cancer deaths among all veterans, but the contribution of in-country veterans to this excess was trivial in comparison with that of era veterans. Deaths from leukemias and malignant neoplasms of the nervous system each occurred less frequently than expected among both veteran groups. For soft tissue tumors, a significant difference between observed and expected deaths was not found for all veterans combined. These tumors occurred only among in-country veterans and not among era veterans, however. When in-country veterans alone were contrasted with nonveterans, they had a significantly elevated standardized proportionate cancer mortality ratio for soft tissue tumors.

The contrast between in-country and era veteran cancer deaths shows the difference in the observed (3) and expected (0) soft tissue tumors for in-country veterans (Table 10). In-country veterans also have significantly elevated standardized proportionate cancer mortality ratios for lymphoma when contrasted with era veterans. The difference is more specifically attributable to Hodgkin's disease, for which there were five deaths in this group, compared with an expected 0.6. Finally, there was a statistically significant excess in the sPMR from testicular cancer among the in-country veterans.

Discussion

The present study demonstrates that the mortality experience

among persons who served in the military during the Vietnam Conflict differs substantially from that of nonveterans. It also suggests that there may be important differences between the veterans who served in Vietnam and those who did not with respect to their cancer mortality experience.

Differences in the mortality experience between veteran and nonveteran groups are influenced by a selection bias initiated at the time of induction to the military service. In order to assure that healthy individuals serve in the military, the preinduction screening process excludes persons with preexisting conditions such as diabetes and other metabolic disorders, allergies, asthma, hypertension, rheumatic heart disease, and clinically apparent malignancies. Because of this selection, veterans have substantially lower mortality rates than the nonveteran population for many years following their induction. This is known as the "healthy veteran effect." In the present study, this selection bias is the most plausible hypothesis to account for the significant sPMR deficits observed among veterans for mortality from allergic, metabolic, and endocrine disorders, all other causes, rheumatic heart disease, and hypertension. Moreover, it may also have contributed to the less prominently diminished sPMRs among veterans for cardiovascular, digestive, and respiratory diseases.

While real differences in the mortality rates between veteran and nonveteran groups for selected causes are reflected

in the sPMRs, they also complicate the interpretation of proportionate mortality for other causes. Since the proportionate contribution from all separate causes must sum to 100, the proportionate contributions among "healthy" veterans from causes that are not screened by the induction process become artificially inflated relative to their contribution among the "unhealthy" population.

Injury, the leading cause of death for both veterans and nonveterans, played a significantly greater role among veterans, accounting for 58% of their deaths as opposed to an expected 51%. Since the study did not adjust for discrepancies in the health status between veterans and nonveterans, part of the excess in injury among veterans must be due to the relative absence of deaths from conditions that would exclude persons from military service. While an excess of these deaths among nonveterans reciprocally diminishes the proportion of their mortality attributable to injury, there may be a real difference in life style and the propensity for risk-taking behavior between veterans and nonveterans. An evaluation of injury mortality alone, performed to eliminate distortion from the healthy veteran bias, showed only that homicide was significantly less important as a cause of injury death among veterans than among nonveterans. On the other hand, while not significant, the difference between the observed and expected number of veteran deaths from motor-vehicle accidents would suggest that this is at least one area where veterans may be at a substantially greater

risk of death than nonveterans. This issue, however, and previous assertions that veterans are at greater risk of death from suicide cannot be adequately addressed by this analysis in the absence of more complete data on the populations at risk.

While malignancies as a group accounted for similar proportions of veteran and nonveteran deaths, deaths from tumors of the respiratory system were a significantly more prominent cause of cancer death among veterans than among nonveterans. A probable explanation for this finding would be a greater prevalence of smoking among military as compared with nonmilitary personnel, but this cannot be substantiated from the limited information available on death certificates.

In general, the pattern of death among in-country veterans from all causes, and within the subcategories of "accidents, poisoning, and violence" and "cardiovascular diseases," were similar to those observed for all veterans combined, and there were no substantial differences in the mortality patterns between in-country and era veterans for these categories. Among cancer deaths, however, there was strong statistical evidence to suggest that Hodgkin's disease, cancer of the testis, and soft tissue tumors were more common among veterans who served in Vietnam than among veterans who did not. These findings must be interpreted cautiously, however, since the expected proportions of site-specific cancer deaths for in-country veterans were derived from a relatively small number (74) of cancer deaths among era

veterans and would therefore be subject to considerably large random fluctuations. At the same time, the difference between the observed and expected numbers of soft tissue tumors among in-country veterans supports similar findings in a previous proportionate mortality study conducted by the Massachusetts Department of Public Health. Neither the Wisconsin study nor the New York study found significant differences between in-country and era veterans in the occurrence of soft tissue sarcomas. These studies, however, and the present one are limited by the absence of precise exposure data, unknown sizes of the candidate populations at risk, and insufficient follow-up time to account for latency from exposures that might have been unique to in-country veterans. Also, by including deaths from as early as 1968, the present study may have been biased against finding an excess occurrence of cancers with long latency periods.

This study only suggests the possibility that the risk of death from soft tissue sarcomas, Hodgkin's disease, and testicular cancer are elevated among veterans who served in Vietnam. We are currently awaiting the records of the in-country veterans who died from these tumors in order to speculate about possible exposure histories and to generate hypotheses that may have some biologic plausibility. To take advantage of latency periods, cancer-specific proportionate mortality studies could be repeated in several years. Also, by excluding deaths that occurred in the late-Vietnam and early post-Vietnam period, and by improving ascertainment of exposure histories, studies can

focus more sharply on etiologic hypotheses relating to possible exposures in Vietnam. On the other hand, since proportionate mortality studies are more useful to explore than to confirm hypotheses, it is recommended that more precise risk-assessment studies of Vietnam cohorts be performed using national data to further test the hypothesis that Hodgkin's disease, testicular malignancies, and soft tissue tumors may be important causes of cancer mortality among veterans who served in Vietnam.

BIBLIOGRAPHY

Dienstfrey, Stephen J., and James J. Bryne. Veterans in the United States: A Statistical Portrait from the 1980 Census. Washington, D.C.: Veterans Administration, 1985.

"Final Toll for U.S. in Indo-China." U.S. News & World Report (Sept. 24, 1973): 73.

Kogan, Michael D., and Clapp, Richard W. Mortality among Vietnam Veterans in Massachusetts, 1972-1983. Boston: Massachusetts Department of Public Health, 1985.

Lawrence, Charles E. et al. "Mortality Patterns of New York State Vietnam Veterans." American Journal of Public Health 75 (March 1985): 277-79.

Shottenfeld, David, and Joseph F. Fraumeni, Jr., Cancer Epidemiology and Prevention. Philadelphia: W.B. Saunders Company, 1982.