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# Postservice Mortality Among Vietnam Veterans

The Centers for Disease Control Vietnam Experience Study

The postservice mortality (through December 1983) of a cohort of 9324 US Army veterans who served in Vietnam was compared with that of 8989 Vietnam-era Army veterans who served in Korea, Germany, or the United States. Over the entire follow-up period, total mortality in Vietnam veterans was 17% higher than for other veterans. The excess mortality occurred mainly in the first five years after discharge from active duty (rate ratio, 1.45; 95% confidence interval, 1.08 to 1.96) and involved motor vehicle accidents, suicide, homicide, and accidental poisonings. Thereafter, mortality among Vietnam veterans was similar to that of other Vietnam-era veterans, except for drug-related deaths, which continued to be elevated. An unexpected finding was a deficit in deaths from diseases of the circulatory system among Vietnam veterans. The excess in postservice mortality due to external causes among Vietnam veterans is similar to that found among men returning from combat areas after World War II and the Korean War.

(JAMA 1987;257:790-796)

MANY Vietnam veterans have been concerned that their health, and that of their children, has been affected by their service in Southeast Asia and possible exposure to the herbicide Agent Orange. To address these concerns, the US Congress directed that appropriate epidemiologic studies be conducted.<sup>1,2</sup>

The Centers for Disease Control (CDC) has proposed three complementary efforts to assess the health of Vietnam veterans: the Agent Orange Study, the Selected Cancers Study, and the Vietnam Experience Study (VES).<sup>3</sup> The VES is a historical cohort study designed to identify the possible adverse health effects of having served in the military in Vietnam. It has three components: (1) an assessment of postservice mortality, (2) a detailed health interview, and (3) a comprehensive medical, psychological, and laboratory evaluation. Although Agent Orange is among the many factors that could have

adversely affected those who served in Vietnam, it is not the main focus of this study. This report is an abbreviated version of the results of the postservice mortality component, published in detail elsewhere.<sup>4</sup>

## SUBJECTS AND METHODS Study Participants

Participation was restricted to men who served in the US Army. To increase comparability between those who served in Vietnam and those who served elsewhere, we selected only veterans who (1) entered military service for the first time between January 1965 and December 1971, (2) served only one term of enlistment, (3) had at least 16 weeks of active service time, (4) earned a military occupational specialty (MOS) other than "trainee" or "duty soldier," and (5) had a pay grade no higher than E5 on discharge from active duty. To be eligible for the Vietnam cohort, a veteran had to have served at least one tour of duty in Vietnam. For the comparison cohort, tours of duty were limited to the United States, Germany, or Korea.

The VES was designed principally to assess morbidity associated with ser-

vice in Vietnam; mortality was examined for completeness. Thus, the sample size for the VES, about 9000 Vietnam and 9000 non-Vietnam veterans, was based on statistical power requirements for the morbidity components.<sup>5</sup> Nevertheless, this sample size provides statistical power of 90% for detecting a 30% relative increase in all-cause mortality, but more limited power for detecting cause-specific increases, particularly for deaths due to natural causes, which in this age group are rare.<sup>4</sup>

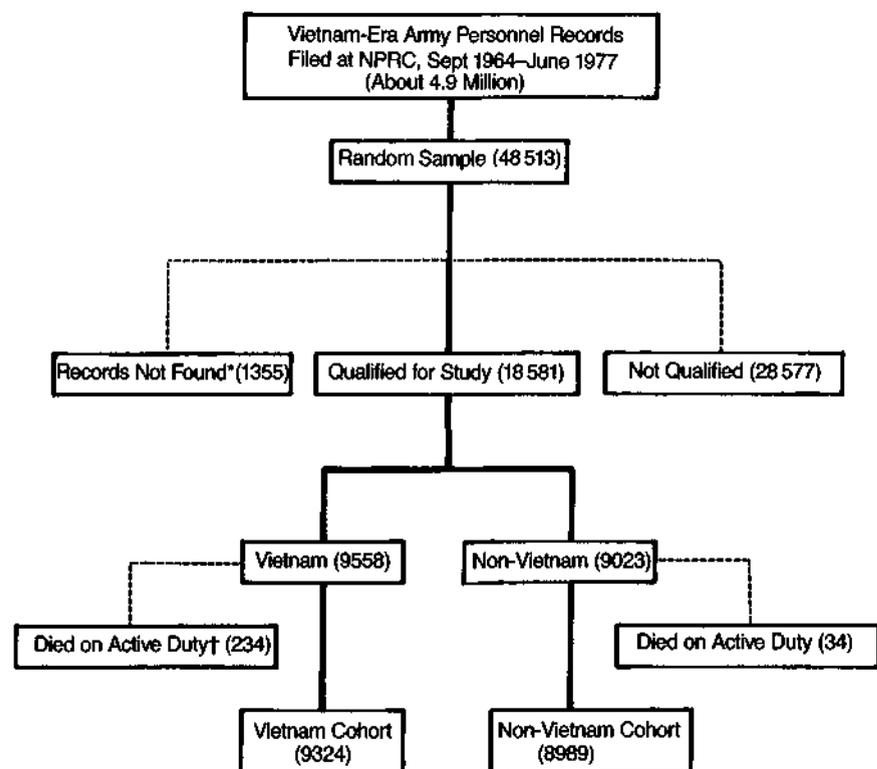
Potential participants were randomly selected from almost 5 million US Army veterans whose service records were received by the National Personnel Records Center (NPRC) between September 1964 and June 1977. Personnel of the NPRC believe that this group includes the vast majority of US Army Vietnam-era veterans who fulfill the study criterion of a single term of enlistment. The Figure outlines the process of participant selection. To achieve the desired sample size of 18 000 veterans with the above study criteria (proportion estimated from a pretest), we randomly selected 48 513 service records. Of the 47 158 records located and reviewed, 60.6% were excluded during the qualification process; these included less than 200 records that did not contain critical data needed to determine eligibility. Characteristics of eligible men as of entry into service and details of their military experience were abstracted from the records. Altogether, 9558 Vietnam and 9023 non-Vietnam veterans qualified for the study. The 234 Vietnam and 34 non-Vietnam veterans who had died during active duty were excluded.

## Vital Status Ascertainment

Follow-up began the day the veteran was discharged alive from active duty

From the Center for Environmental Health, Centers for Disease Control, Atlanta.

Reprint requests to Centers for Disease Control, 1600 Clifton Rd (C-25), Atlanta, GA 30333 (Colonel A. Boyle, PhD).



Selection of study group. NPRC indicates National Personnel Records Center; asterisk, excluded from study; and dagger, 83% (N = 194) of active-duty deaths among Vietnam veterans were due to war-related activities.

and ended on the date of his death or Dec 31, 1983, whichever came first. To identify those who had died after discharge, we checked files of the US Army, Veterans Administration (Beneficiary Identification and Record Locator Subsystem), Social Security Administration, Internal Revenue Service, and National Center for Health Statistics (National Death Index).

For the interview component of the VES, an attempt was made to locate and contact all veterans not identified as deceased by the above sources. Through this method, vital status was confirmed for 93.6% of Vietnam veterans and 91.9% of those who served elsewhere. Entry and military service characteristics of Vietnam veterans whose vital status was uncertain were similar to those of non-Vietnam veterans with uncertain vital status. All men with uncertain vital status were assumed to be alive at the end of 1983. For all but nine of the 446 men reported to have died after discharge, copies of official death certificates were obtained. The other nine deaths were confirmed through other sources. Underlying causes of death were coded according to both the eighth and ninth revisions<sup>6,7</sup> of the *International Classification of Dis-*

*eases (ICD)* by an experienced nosologist at the National Center for Health Statistics who had no knowledge of whether the decedent had served in Vietnam.

#### Medical Review Panel

To address limitations of death certificate-based diagnoses, a review panel of two physicians determined the underlying cause of death, using pertinent medical and legal documents describing the nature and circumstances of each of 426 deaths for which additional information could be obtained. Sources included hospitals, law enforcement agencies, coroners or medical examiners, and private physicians. All causes of death and other significant conditions were coded by the medical review panel according to the Ninth Revision of the *ICD*. To estimate the influence of substance abuse on mortality in this study, special categories of alcohol- and drug-related deaths were developed, and deaths were so classified by the review panel when appropriate.

#### Analyses

Crude death rates were based on person-years at risk since discharge from active duty. An unadjusted rate

ratio (RR) was formed by dividing the crude mortality rate among Vietnam veterans by that for non-Vietnam veterans. The 95% confidence intervals (CIs) for the RRs were computed using procedures described by Laird and Oliver.<sup>7</sup> The Cox proportional hazards regression model<sup>8</sup> was used to consider possible effect modification and confounding by selected covariates. Adjusted RRs were obtained from Cox models stratified on primary MOS and enlistment status (volunteer or draftee), and adjusted for other selected covariates. Two MOS categories were used in the model and can be described roughly as "tactical" (infantry, armor, artillery, and combat engineers) and "other" (all other specialties). Additional covariates considered in the Cox models, chosen on the basis of their associations with mortality in the univariate analyses,<sup>4</sup> included race, age at discharge, Army General Technical Test score (a general aptitude test taken at entry into the service), pay grade at discharge, and year of discharge.

Comparisons were also made between the mortality experience of each veteran cohort and that of the US male population utilizing Monson's software package.<sup>9</sup> Results are expressed as a standardized mortality ratio (SMR) adjusted for age, race, and calendar year.

## RESULTS

There were some differences in both preinduction and military service characteristics between the Vietnam and non-Vietnam cohorts (Table 1). In general, however, the preinduction differences were small. Differences in some of the military service characteristics, such as a greater percentage of Vietnam veterans with tactical MOS classifications and infantry unit assignments, reflect war-related military requirements in Vietnam.

#### All-Cause Mortality

Over the entire follow-up period, the mortality among Vietnam veterans was 17% higher than the rate among non-Vietnam veterans (Table 2). Most of this excess, however, was due to higher mortality among Vietnam veterans during the first five years of follow-up (RR, 1.45; 95% CI, 1.08 to 1.96). By the sixth year, the two cohorts had similar mortality rates that remained so through the end of follow-up (RR, 1.01; 95% CI, 0.79 to 1.28). Because of the variation in relative mortality with time, time-specific results will be presented when appropriate.

To determine whether the association between Vietnam service and mortality was uniform or varied across different

Table 1.—Differences in Selected Characteristics Between Vietnam and Non-Vietnam Veterans at Entry Into Service and During Military Service

Characteristic	Vietnam (N=9324)	Non-Vietnam (N=8989)
At entry into service		
Race,* % white	86.8	86.5
Age at entry (mean)	20.3	20.5
Enlistment status,* % draftee	63.7	65.6
Year of entry into service, % before 1969	72.1	60.6
Army General Technical Test score (mean, scaled to 100)	103.1	105.5
During military service		
Primary military occupational specialty,† % tactical operations	34.3	27.4
Type of unit, % infantry	26.6	14.6
Type of discharge, % honorable	97.2	91.0
Pay grade at discharge, % E4 or E5	88.5	79.8
Year of discharge, % before 1970	48.1	44.6

\*Race and enlistment status were the only two characteristics that were not significantly different ( $P > .05$ ) between the Vietnam and the non-Vietnam groups.

†The job specialty for which the man was trained in the Army.

Table 3.—Number of Deaths Among Vietnam and Non-Vietnam Veterans and Unadjusted Rate Ratios (RRs), by Selected Characteristics and Years Since Discharge From Active Duty, 1965 Through 1983

Characteristic*	Years Since Discharge From Active Duty					
	≤5		6+		All Years	
	No.	RR	No.	RR	No.	RR
Race						
White	146	1.50	193	0.99	339	1.18
Nonwhite	37	1.30	70	1.07	107	1.14
Enlistment status						
Volunteer	79	1.09	111	0.91	190	0.98
Draftee	104	1.80	152	1.06	256	1.31
GT test score†						
<100	97	1.42	141	0.90	238	1.08
100+	83	1.43	119	1.07	202	1.20
Duty MOS‡						
Tactical	63	1.19	89	1.04	152	1.10
Other	120	1.58	174	0.97	294	1.18
Age at discharge						
<21	47	1.83	42	0.67	89	1.14
21+	136	1.41	221	1.10	357	1.21
Pay grade at discharge						
E4-E5	126	1.50	183	1.10	306	1.24
E1-E3	58	1.95	80	1.18	138	1.44
Year of discharge						
<1970	79	2.05	122	0.96	201	1.27
1970+	104	1.16	141	1.06	245	1.10

\*There was no evidence of statistically significant effect modification for any of these characteristics ( $P > .05$ ).

†Army General Technical Test (GT) scores were missing for six veterans.

‡Determined from principal military occupational specialty (MOS) held while on tour of duty.

Table 2.—Number of Deaths, Person-Years, and Death Rates Among Vietnam and Non-Vietnam Veterans and Unadjusted RRs by Years Since Discharge From Active Duty, 1965-1983\*

Years Since Discharge	Vietnam			Non-Vietnam			RR	95% CI
	No. of Deaths	Person-Years	Rate†	No. of Deaths	Person-Years	Rate†		
≤5	110	46350	2.4	73	44747	1.6	1.45	1.08-1.96
6+	136	81547	1.7	127	76582	1.7	1.01	0.79-1.28
All years	246	127897	1.9	200	121329	1.7	1.17	0.97-1.41

\*RR indicates rate ratio; CI, confidence interval.

†Crude death rate per 1000 person-years.

subgroups of veterans, separate analyses were done within these groups (Table 3). Although the results indicated a consistent pattern of elevated mortality associated with Vietnam service limited to the first five years after discharge, there was some variation in the RR among various subgroups of veterans. Tests for effect modification, however, were not statistically significant ( $P > .05$ ).

Possible confounding by selected covariates (age at discharge, race, Army General Technical Test score, pay grade at discharge, and year of discharge) was assessed by including them in stratified Cox models. In the first five years after discharge, adjustment for these characteristics increased the RR to 1.58 (95% CI, 1.16 to 2.14). In the later

follow-up period, adjustment changed the RR to 1.04 (95% CI, 0.81 to 1.33). Results from the Cox model also indicated that Vietnam service had a greater effect on mortality among those who were discharged before age 21 years than those discharged at age 21 years or older ( $P = .02$ ) and among veterans discharged before 1970 compared with those discharged during 1970 or later ( $P = .05$ ).

### Cause-Specific Mortality

**Death Certificates.**—Only four major cause-of-death categories contained sufficient numbers of deaths for formal analysis (Table 4). Rates for Vietnam veterans appeared to differ from rates for non-Vietnam veterans in two of these categories: diseases of the circulatory system (51% decrease in the

death rate) and external causes of death (25% increase in the death rate). The deficit in circulatory disease deaths was evident regardless of time since discharge and type of circulatory disease. There were no differences in mortality from mental disorders or neoplasms. Deaths from specific types of neoplasms were too few for meaningful comparisons.

The excess in external causes of death is examined further in Table 5. Vietnam veterans had significantly higher mortality from motor vehicle accidents (MVAs) (RR, 1.48;  $P = .03$ ) than non-Vietnam veterans. The excess was most pronounced in the first five years after discharge from active duty (RR, 1.93;  $P = .01$ ). After that period, MVA rates were similar in the two cohorts (RR, 1.16). The RRs for suicide and homicide were somewhat increased in the early postdischarge period but not in the later years of follow-up. Accidental poisoning deaths (mostly by drugs) were substantially more common among Vietnam veterans than other veterans over the entire follow-up period (RR, 2.47;  $P = .08$ ). No postservice deaths were attributed to war injuries (ICD-9, E990-E999).

Adjustment for selected covariates did not materially alter the pattern of cause-specific mortality, except for suicide in the earlier follow-up period, where the adjusted RR was 2.59 (95% CI, 1.09 to 6.17).

**Medical Review Panel.**—The medical review analysis was based on 233 (95%) of Vietnam veteran deaths and 193 (97%) of deaths among non-Vietnam veterans. On average, slightly fewer supplemental medical and legal records were recovered for each Vietnam veteran death (mean, 3.3 records) than for each non-Vietnam veteran death (mean, 3.7 records). Overall agreement between the medical review panel diagnoses and death certificate diagnoses, however, was good (82%;  $\kappa = 0.79$ ) and did not differ significantly between the two veteran cohorts.

The medical review analyses indicated differences in only two ICD-9 categories that were not evident from the death certificate analysis. The RR for mental disorders from the medical review panel analysis was 2.85 (95% CI, 0.92 to 8.82) compared with 0.95 from the death certificate analysis. Most mental disorder deaths were related to alcohol or drugs and are examined in more detail in Table 6. The RR for neoplasms based on medical review panel diagnoses was 1.21 (95% CI, 0.55 to 2.66) compared with 0.82 based on death certificates. This difference was

Table 4.—Number of Deaths by Cause (From Death Certificate), Death Rates Among Vietnam and Non-Vietnam Veterans, and Unadjusted RRs, 1965 Through 1983\*

Underlying Cause of Death (ICD-9)†	Vietnam		Non-Vietnam		RR‡	95% CI
	No.	Rate‡	No.	Rate‡		
Infectious and parasitic diseases (001-139)	1	0.8	1	0.8	...	...
Neoplasms (140-239)	12	9.4	14	11.5	0.82	0.38-1.76
Mental disorders (290-319)	7	5.5	7	5.8	0.96	0.33-2.70
Diseases of nervous system (320-389)	2	1.6	1	0.8	...	...
Diseases of circulatory system (390-459)	12	9.4	23	19.0	0.49	0.25-0.99
Diseases of respiratory system (460-519)	5	3.9	4	3.3	...	...
Diseases of digestive system (520-579)	5	3.9	3	2.5	...	...
Diseases of genitourinary system (580-611)	4	3.1	0	...	...	...
Congenital anomalies (740-759)	1	0.8	1	0.8	...	...
Symptoms, signs, and ill-defined conditions (780-799)	2	1.6	1	0.8	...	...
External causes (E800-E999)	188	147.0	143	117.9	1.25	1.00-1.55
No death certificate	7	...	2	...	...	...

\*RR indicates rate ratio; CI, confidence interval.  
 †ICD-9 indicates International Classification of Diseases, ninth revision. No deaths were categorized to diseases of blood and blood-forming organs; endocrine, metabolic or nutritional diseases; diseases of the skin; or diseases of the musculoskeletal system. Therefore, these categories are not shown.  
 ‡Crude death rate per 100 000 person-years.  
 §If the total number of deaths for a cause-of-death category in both groups combined was less than ten, RRs are not shown.

Table 5.—Number of Deaths From Specific External Causes (From Death Certificate) Among Vietnam and Non-Vietnam Veterans and Unadjusted RRs, by Years Since Discharge From Active Duty, 1965 Through 1983\*

External Cause of Death (ICD-9)	Years Since Discharge From Active Duty†								
	≤5			6+			All Years		
	No.	RR	95% CI	No.	RR	95% CI	No.	RR	95% CI
Motor vehicle accident (E810-E825, E929.0)	66	1.93	1.18-3.22	67	1.16	0.72-1.87	133	1.48	1.04-2.09
Accidental poisoning (E850-E869, E929.2)	11	1.69	0.49-5.77	7	...	...	18	2.47	0.88-6.92
Other accidents‡	23	1.05	0.46-2.37	39	0.89	0.48-1.67	62	0.95	0.58-1.56
Suicide (E950-E959)	25	1.72	0.76-3.88	32	0.64	0.32-1.30	57	0.98	0.58-1.65
Homicide (E960-E969)	18	1.52	0.59-3.91	33	0.78	0.39-1.55	51	0.99	0.57-1.71
Undetermined Intentionality (E980-E989)	4	...	...	6	...	...	10	3.79	0.81-17.87

\*RR indicates rate ratio; CI, confidence interval; ICD-9, International Classification of Diseases, ninth revision.  
 †Time-specific RRs are not presented for categories with less than ten deaths in both Vietnam and non-Vietnam groups combined.  
 ‡Includes ICD-9 categories E800 to E807, E826 to E849, E870 to E928, E929.1, E929.3 to E929.9, E930 to E949, E970 to E978, and E990 to E999.

primarily the result of two deaths from neoplasms among non-Vietnam veterans being reclassified elsewhere by the medical review panel and the opposite occurrence among Vietnam veterans. There was no particular type of neoplasm in excess in the Vietnam cohort.

Supplemental information collected for the medical review allowed further exploration of MVA deaths. Single- and multiple-vehicle crash deaths as well as daytime and nighttime events all occurred more frequently among Vietnam veterans during the early postdischarge period. Vietnam veterans had a modest excess of alcohol-related MVA deaths

during this period (RR, 1.35; 95% CI, 0.60 to 3.04).

Alcohol-related natural causes of death were too few for formal analysis in the early postdischarge period, but the RR in the later period showed no difference between the two groups (Table 6). A modest elevation in alcohol-related traumatic deaths among Vietnam veterans was limited to the first five years after discharge. For drug-related deaths, the RR was slightly elevated during the early postdischarge period and more elevated during the later follow-up period. Although the number of deaths is too small for formal analysis,

further refinement of the later follow-up period suggests the upward trend in drug-related mortality continues into the most recent years. Further, Vietnam service seems to be associated with an especially high rate of drug-related mortality among those drafted into service, those whose jobs were in tactical or combat operations, and those who served during 1969.

Again, as in the death certificate results, adjustment for selected covariates increased the RR for suicide in the early follow-up period to 2.56 (95% CI, 1.11 to 5.87). No other RR presented in the medical review results was materially altered by adjustment.

### General Population Comparison

Both groups of veterans had a significantly lower overall mortality rate for "natural causes" than the general US male population (Table 7). During the first five years after discharge, Vietnam veterans had a higher death rate from external causes, whereas non-Vietnam veterans have a lower rate relative to the general population. In the later time period both groups of veterans showed a similar deficit in external cause mortality. Although these data are not presented in Table 7, over the entire follow-up period, Vietnam veterans had a striking deficit of circulatory disease deaths (SMR, 0.48; 95% CI, 0.25 to 0.85), whereas non-Vietnam veterans had only a slight deficit (SMR, 0.87; 95% CI, 0.54 to 1.34).

### COMMENT

The intent of this study was to assess the effect of military service in Vietnam on subsequent mortality. The "Vietnam experience" includes a wide variety of possible health-influencing factors such as psychological stresses associated with war, infectious diseases prevalent in Vietnam, and exposure to the herbicide Agent Orange.

The modest excess of deaths among Vietnam veterans was concentrated in the first five years after discharge, where all-cause mortality was 45% higher than in the non-Vietnam group. External causes accounted for most of this increase, with the largest elevation in relative mortality due to MVAs.

A more detailed examination of MVA deaths did not indicate any particular factor that could explain the overall excess in Vietnam veterans. The increased risk did not appear to be related to elevated blood alcohol levels at the time of death, and the excess was apparent across various types of MVAs. Drug-use information on MVA victims was limited; the medical review panel

Table 6.—Number of Deaths From Alcohol and Drug-Related Causes (From Medical Review) Among Vietnam and Non-Vietnam Veterans and Unadjusted RRs, by Years Since Discharge From Active Duty, 1965 Through 1983\*

Cause of Death	Years Since Discharge From Active Duty								
	≤5			6+			All Years		
	No.	RR	95% CI	No.	RR	95% CI	No.	RR	95% CI
Alcohol-related natural causes†	5	...	...	25	0.87	0.40-1.90	30	1.08	0.53-2.22
Alcohol-related traumatic causes‡	42	1.29	0.70-2.37	61	1.04	0.63-1.71	103	1.13	0.77-1.67
Drug-related causes§	18	1.21	0.48-3.06	22	2.01	0.82-4.94	40	1.58	0.83-3.00

\*RR indicates rate ratio; CI, confidence interval.

†Includes the following diagnoses determined to be the underlying or contributing cause of death: alcoholic psychoses (291.0 to 291.9); alcohol dependence syndrome (303); nondependent alcohol abuse (305.0); alcoholic polyneuropathy (357.5); alcoholic cardiomyopathy (425.5); alcoholic gastritis (535.3); alcoholic liver disease (571.0 to 571.3); and excessive blood level of alcohol (790.3).

‡Includes deaths in which the underlying cause is accidental poisoning by alcohol (E860.0 to E860.9) or any traumatic death (E800 to E999) in which either nondependent abuse of alcohol (305.0) or excessive blood level of alcohol (790.3) is a contributing cause of death.

§Deaths for which one of the following drug-specific diagnoses is the underlying or contributing cause of death: drug psychoses (292.0 to 292.9); drug dependence (304.0 to 304.9); nondependent abuse of drugs (305.2 to 305.9); accidental poisoning by drugs (E850.0 to E850.2, E850.5, E850.8, E851-E854, E855.1 to E855.2, E866.6, and E869.0); suicide by drugs (E950.0 to E950.5); and poisoning by drugs, intentionality undetermined (E980.0 to E980.5).

Table 7.—Observed and Expected Numbers of Deaths by Cause Among Vietnam and Non-Vietnam Veterans and SMRs, by Years Since Discharge From Active Duty, 1965 Through 1983\*

Years Since Discharge	Cause of Death† (ICDA-8)		Vietnam	Non-Vietnam	
≤5	All natural causes (000-796)	Observed	13	16	
		Expected‡	24.2	23.4	
		SMR	0.54	0.68	
		95% CI	0.29-0.92	0.39-1.11	
	External causes (E800-E999)	Observed	92	55	
		Expected	72.5	69.4	
		SMR	1.27	0.79	
		95% CI	1.02-1.56	0.60-1.03	
	6+	All natural causes (000-796)	Observed	38	39
			Expected	65.8	63.4
SMR			0.58	0.62	
95% CI			0.41-0.79	0.44-0.84	
External causes (E800-E999)		Observed	96	88	
		Expected	102.7	96.6	
		SMR	0.93	0.91	
		95% CI	0.76-1.14	0.73-1.12	
All years		All natural causes (000-796)	Observed	51	55
			Expected	90.0	66.8
	SMR		0.57	0.63	
	95% CI		0.42-0.75	0.48-0.82	
	External causes (E800-E999)	Observed	186	143	
		Expected	175.2	166.0	
		SMR	1.07	0.86	
		95% CI	0.93-1.24	0.73-1.01	

\*SMR indicates standardized mortality ratio; CI, confidence interval; and ICDA-8, *International Classification of Diseases, Adapted for Use in the United States*, eighth revision.

†Excludes nine deaths (seven Vietnam, two non-Vietnam) for which death certificates were not recovered.

‡Expected number is based on the mortality rates among US men, standardized for age, calendar year, and race.

identified only one drug-related MVA death.

Suicide and homicide also occurred somewhat more frequently among Vietnam veterans during the early post-discharge period. Accidental poisoning deaths (mainly by drugs) were elevated throughout the entire follow-up period, although the number of such deaths was small.

By the sixth year after discharge,

both all-cause and external-cause mortality among Vietnam veterans had fallen to levels found in the non-Vietnam group, except for deaths due to drug abuse, where the rate was actually higher in the more recent follow-up period.

These findings are unlikely to be the result of a serious flaw in study design or execution. The study groups were selected in a manner that minimized dif-

ferences in their preservice characteristics; vital status was verified for 93% of all participants; death certificates were recovered for 98% of deaths; and supplemental medical and legal documents, which allowed an independent assessment of cause of death by standardized criteria, were obtained for 96% of deaths. Moreover, the pattern of excess deaths was remarkably consistent across various subgroups of Vietnam veterans and appears not to be an artifact of confounding. It should be noted, however, that sample size constraints limited our ability to detect excesses in mortality in subgroups of veterans and for the less frequent causes of death in this relatively young group.

Our findings can be viewed against the results of five previous mortality studies of Vietnam veterans. Four<sup>10-13</sup> are proportional mortality studies, which may not be directly comparable with this study because of incompleteness of data and inherent limitations of this analytic method.<sup>14</sup> The fifth, a cohort study of Australian Vietnam veterans, is very similar in design to our study and thus is a more appropriate comparison.<sup>15</sup> The US Air Force "Ranch Hand" study is not discussed here, since its principal concern is the adverse health effects of herbicide exposure in a unique group of veterans.<sup>16</sup>

The 30% excess of external-cause mortality among Australian Vietnam veterans relative to non-Vietnam veterans is similar to what is seen here.<sup>15</sup> Although the Australian investigators did not examine external cause mortality by time since discharge, there was a suggestion of a decline in relative mortality with increasing time since discharge in their all-cause mortality results. Deaths from suicide, homicide, and accidental poisoning also occurred more frequently among their Vietnam veterans. Mortality from MVA was not elevated overall, but an excess in the youngest age group was suggested.

Findings for external-cause mortality from the four proportional mortality studies are not consistent with our results. A nonsignificant increase in deaths from MVA among Vietnam veterans relative to other veterans was present in only one of the studies.<sup>12</sup> The relative frequencies of suicide and homicide were not unusual, although there was one instance of a nonsignificant increase in both of these causes.<sup>11</sup> Accidental poisonings were analyzed in only one of the studies, and the result was a small, nonsignificant elevation among Vietnam veterans.<sup>11</sup>

Australian Vietnam veterans had an excess of deaths from alcohol-related

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but the number of men assigned to engineer units was relatively small. Furthermore, possible differences between US and Australian engineering units in training and composition may make this comparison inappropriate.

The excess in postservice external-cause mortality among Vietnam veterans seen here could be due to some peculiarity in the assignment of men to Vietnam whereby those who were sent tended to have characteristics that placed them at increased risk of dying from external causes after discharge from active duty. This explanation appears doubtful for several reasons. Most importantly, if Vietnam veterans tended to have an inherent predisposition to traumatic events, it might be expected to manifest itself in increased mortality from such causes throughout the period of observation, not just in the first few years, as observed here.

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did non-Vietnam veterans in our study. Although the influence of factors specific to the Vietnam experience cannot be completely ruled out, our findings and previous studies suggest that the postservice excess of traumatic deaths among Vietnam veterans is probably due to unusual stresses endured while stationed in a hostile fire zone.

The mortality assessment of Vietnam veterans presented here is an incomplete evaluation of the health experience of this group. Additional data on the present and past health status of living Vietnam veterans will be forthcoming from the health interview and medical, psychological, and laboratory evaluation components of the VES. Because this group of veterans has not yet reached the age where chronic diseases have an important impact on mortality, continued monitoring of mortality among VES participants may provide additional insights.

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## References

1. Veterans Health Programs Extension and Improvement Act of 1979, Public Law 96-151 (HR 8392), Dec 20, 1979, 93 STAT 1092-1096.
2. Veterans' Health Care, Training, and Small Business Loan Act of 1981, Public Law 97-72 (HR 3499), Nov 3, 1981, 95 STAT 1047-1063.
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5. International Classification of Diseases, Adapted for Use in the United States, rev 8, PHS publication 1698. US Dept of Health, Education, and Welfare, 1967.
6. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, rev 9. Geneva, World Health Organization, 1977.
7. Laird N, Oliver D: Covariance analysis of censored survival data using log-linear analysis techniques. *J Am Stat Assoc* 1981;76:231-241.
8. Cox DR, Oakes D: *Analysis of Survival Data*. London, Chapman & Hall, 1964.
9. Monson RR: Analysis of relative survival and proportional mortality. *Comp Biomed Res* 1974;7:

325-332.

10. Anderson HA, Hanrahan LP, Jensen M, et al: *Wisconsin Vietnam Veteran Mortality Study*. Madison, Wis, Wisconsin Division of Health, 1985.
11. Lawrence CE, Reilly AA, Quickenton P, et al: Mortality patterns of New York State Vietnam veterans. *Am J Public Health* 1985;75:277-279.
12. Kogan MD, Clapp RW: *Mortality Among Vietnam Veterans in Massachusetts, 1972-1983*. Boston, Massachusetts Dept of Public Health, 1985.
13. Holmes AP: *West Virginia Vietnam-Era Veterans Mortality Study*. Charleston, WV, West Virginia Health Dept, 1986.
14. Wong O, Decouffé P: Methodological issues involving the standardized mortality ratio and proportionate mortality ratio in occupational studies. *J Occup Med* 1982;24:299-304.
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1984.

16. Lathrop GD, Moynahan PM, Albanese RA, et al: *Project Ranch Hand II. An Epidemiologic Investigation of Health Effects in Air Force Personnel Following Exposure to Herbicides: Baseline Mortality Study Results*. San Antonio, Tex, Brooks Air Force Base, US Air Force School of Aerospace Medicine, 1988.
17. Ritter C, Clayton RR, Voss HL: Vietnam military service and marijuana use. *Am J Drug Alcohol Abuse* 1985;11:119-130.
18. Robins LN, Helzer JE, Davis DH: Narcotic use in Southeast Asia and afterward. *Arch Gen Psychiatry* 1975;32:956-961.
19. Yager T, Laufer R, Gallops M: Some problems associated with war experience in men of the Vietnam generation. *Arch Gen Psychiatry* 1984; 41:327-333.
20. Seltzer CC, Jablon S: Effects of selection on mortality. *Am J Epidemiol* 1974;100:367-372.
21. Nefzger MD: Follow-up studies of World War II and Korean War prisoners: I. Study plan and mortality findings. *Am J Epidemiol* 1970;91: 123-138.

Postservice Mortality Among Vietnam Veterans

The Centers for Disease Control

Vietnam Experience Study

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## ABSTRACT

The postservice mortality (through December 1983) of a cohort of 9324 US Army veterans who served in Vietnam was compared with that of 8989 Vietnam-era Army veterans who served in Korea, Germany, or the United States. Over the entire follow-up period, total mortality in Vietnam veterans was 17% higher than for other veterans. The excess mortality occurred mainly in the first five years after discharge from active duty (rate ratio, 1.45; 95% confidence interval, 1.08 to 1.96) and involved motor vehicle accidents, suicide, homicide, and accidental poisonings. Thereafter, mortality among Vietnam veterans was similar to that of other Vietnam-era veterans, except for drug-related deaths, which continued to be elevated. An unexpected finding was a deficit in deaths from diseases of the circulatory system among Vietnam veterans. The excess in postservice mortality due to external causes among Vietnam veterans is similar to that found among men returning from combat areas after World War II and the Korean War.

## INTRODUCTION

Many Vietnam veterans have been concerned that their health, and that of their children, has been affected by their service in Southeast Asia and possible exposure to the herbicide Agent Orange. To address these concerns, the US Congress directed that appropriate epidemiologic studies be conducted.<sup>1,2</sup>

The Centers for Disease Control (CDC) has proposed three complementary efforts to assess the health of Vietnam veterans: the Agent Orange Study, the Selected Cancers Study, and the Vietnam Experience Study (VES).<sup>3</sup> The VES is a historical cohort study designed to identify the possible adverse health effects of having served in the military in Vietnam. It has three components: 1) an assessment of postservice mortality, 2) a detailed health interview, and 3) a comprehensive medical, psychological, and laboratory evaluation. Although Agent Orange is among the many factors that could have adversely affected those who served in Vietnam, it is not the main focus of this study. This report is an abbreviated version of the results of the postservice mortality component, published in detail elsewhere.<sup>4</sup>

## SUBJECTS AND METHODS

### Study Participants

Participation was restricted to men who served in the US Army. To increase comparability between those who served in Vietnam and those who served elsewhere, we selected only veterans who 1) entered military service for the first time between January 1965 and December 1971, 2) served only one term of enlistment, 3) had at least 16 weeks of active service time, 4) earned a military occupational specialty (MOS) other than "trainee" or "duty soldier," and 5) had a pay grade no higher than E5 on discharge from active duty. To be eligible for the Vietnam cohort, a veteran had to have served at least one tour of duty in Vietnam. For the comparison cohort, tours of duty were limited to the United States, Germany, or Korea.

The VES was designed principally to assess morbidity associated with service in Vietnam; mortality was examined for completeness. Thus, the sample size for the VES, about 9000 Vietnam and 9000 non-Vietnam veterans, was based on statistical power requirements for the morbidity components.<sup>3</sup> Nevertheless, this sample size provides statistical power of 90% for detecting a 30% relative increase in all-cause mortality, but more limited power for detecting cause-specific increases, particularly for deaths due to natural causes, which in this age group are rare.<sup>4</sup>

Potential participants were randomly selected from almost 5 million US Army veterans whose service records were received by the National Personnel Records Center (NPRC) between September 1964 and June 1977. Personnel of the NPRC believe that this group includes the vast majority of US Army Vietnam-era veterans who fulfill the study criterion of a single term of enlistment.

The figure outlines the process of participant selection. To achieve the desired sample size of 18000 veterans with the above study criteria (proportion estimated from a pretest), we randomly selected 48513 service records. Of the 47158 records located and reviewed, 60.6% were excluded during the qualification process; these included less than 200 records that did not contain critical data needed to determine eligibility. Characteristics of eligible men as of entry into service and details of their military experience were abstracted from the records. Altogether, 9558 Vietnam and 9023 non-Vietnam veterans qualified for the study. The 234 Vietnam and 34 non-Vietnam veterans who had died during active duty were excluded.

### Vital Status Ascertainment

Follow-up began the day the veteran was discharged alive from active duty and ended on the date of his death or Dec 31, 1983, whichever came first. To identify those who had died after discharge, we checked files of the US Army, Veterans Administration (Beneficiary Identification and Record Locator Subsystem), Social Security Administration, Internal Revenue Service, and National Center for Health Statistics (National Death Index).

For the interview component of the VES, an attempt was made to locate and contact all veterans not identified as deceased by the above sources. Through this method, vital status was confirmed for 93.6% of Vietnam veterans and 91.9% of those who served elsewhere. Entry and military service

characteristics of Vietnam veterans whose vital status was uncertain were similar to those of non-Vietnam veterans with uncertain vital status. All men with uncertain vital status were assumed to be alive at the end of 1983. For all but nine of the 446 men reported to have died after discharge, copies of official death certificates were obtained. The other nine deaths were confirmed through other sources. Underlying causes of death were coded according to both the Eighth and Ninth Revisions<sup>5,6</sup> of the International Classification of Diseases (ICD) by an experienced nosologist at the National Center for Health Statistics who had no knowledge of whether the decedent had served in Vietnam.

#### Medical Review Panel

To address limitations of death certificate-based diagnoses, a review panel of two physicians determined the underlying cause of death, using pertinent medical and legal documents describing the nature and circumstances of each of 426 deaths for which additional information could be obtained. Sources included hospitals, law enforcement agencies, coroners or medical examiners, and private physicians. All causes of death and other significant conditions were coded by the medical review panel according to the Ninth Revision of the ICD. To estimate the influence of substance abuse on mortality in this study, special categories of alcohol- and drug-related deaths were developed, and deaths were so classified by the review panel when appropriate.

#### Analyses

Crude death rates were based on person-years at risk since discharge from active duty. An unadjusted rate ratio (RR) was formed by dividing the crude mortality rate among Vietnam veterans by that for non-Vietnam veterans. The 95% confidence intervals (CIs) for each RRs were computed using the procedures described by Laird and Oliver.<sup>7</sup> The Cox proportional hazards regression model<sup>8</sup> was used to consider possible effect modification and confounding by selected covariates. Adjusted RRs were obtained from Cox models stratified on primary MOS and enlistment status (volunteer or draftee), and adjusted for other selected covariates. Two MOS categories were used in the model and can be described roughly as "tactical" (infantry, armor, artillery, and combat engineers) and "other" (all other specialties). Additional covariates considered in the Cox models, chosen on the basis of their associations with mortality in the univariate analyses,<sup>4</sup> included race, age at discharge, Army General Technical Test score (a general aptitude test taken at entry into the service), pay grade at discharge, and year of discharge.

Comparisons were also made between the mortality experience of each veteran cohort and that of the US male population utilizing Monson's software package.<sup>9</sup> Results are expressed as a standardized mortality ratio (SMR) adjusted for age, race, and calendar year.

## RESULTS

There were some differences in both preinduction and military service characteristics between the Vietnam and non-Vietnam cohorts (Table 1). In general, however, the preinduction differences were small. Differences in some of the military service characteristics, such as a greater percentage of Vietnam veterans with tactical MOS classifications and infantry unit assignments, reflect war-related military requirements in Vietnam.

### All-Cause Mortality

Over the entire follow-up period, the mortality among Vietnam veterans was 17% higher than the rate among non-Vietnam veterans (Table 2). Most of this excess, however, was due to higher mortality among Vietnam veterans during the first five years of follow-up (RR, 1.45; 95% CI, 1.08 to 1.96). By the sixth year, the two cohorts had similar mortality rates that remained so through the end of follow-up (RR, 1.01; 95% CI, 0.79 to 1.28). Because of the variation in relative mortality with time, time-specific results will be presented when appropriate.

To determine whether the association between Vietnam service and mortality was uniform or varied across different subgroups of veterans, separate analyses were done within these groups (Table 3). Although the results indicated a consistent pattern of elevated mortality associated with Vietnam service limited to the first five years after discharge, there was some variation in the RR among various subgroups of veterans. Tests for effect modification, however, were not statistically significant ( $P > .05$ ).

Possible confounding by selected covariates (age at discharge, race, Army General Technical Test score, pay grade at discharge, and year of discharge) was assessed by including them in stratified Cox models. In the first five years after discharge, adjustment for these characteristics increased the RR to 1.58 (95% CI, 1.16 to 2.14). In the later follow-up period, adjustment changed the RR to 1.04 (95% CI, 0.81 to 1.33). Results from the Cox model also indicated that Vietnam service had a greater effect on mortality among those who were discharged before age 21 years than to those discharged at age 21 years or older ( $P = .02$ ) and among veterans discharged before 1970 compared with those discharged during 1970 or later ( $P = .05$ ).

### Cause-Specific Mortality

Death Certificates. — Only four major cause-of-death categories contained sufficient numbers of deaths for formal analysis (Table 4). Rates for Vietnam veterans appeared to differ from rates for non-Vietnam veterans in two of these categories: diseases of the circulatory system (51% decrease in the death rate) and external causes of death (25% increase in the death rate). The deficit in circulatory disease deaths was evident regardless of time since discharge and type of circulatory disease. There were no differences in mortality from mental disorders or neoplasms. Deaths from specific types of neoplasms were too few for meaningful comparisons.

The excess in external causes of death is examined further in Table 5. Vietnam veterans had significantly higher mortality from motor vehicle accidents (MVAs) (RR, 1.48;  $P = .03$ ) than non-Vietnam veterans. The excess was most pronounced in the first five years after discharge from active duty

(RR, 1.93;  $P=.01$ ). After that period, MVA rates were similar in the two cohorts (RR, 1.16). The RRs for suicide and homicide were somewhat increased in the early postdischarge period but not in the later years of follow-up. Accidental poisoning deaths (mostly by drugs) were substantially more common among Vietnam veterans than other veterans over the entire follow-up period (RR, 2.47;  $P=.08$ ). No postservice deaths were attributed to war injuries (ICD-9, E990-E999).

Adjustment for selected covariates did not materially alter the pattern of cause-specific mortality, except for suicide in the earlier follow-up period, where the adjusted RR was 2.59 (95% CI, 1.09 to 6.17).

Medical Review Panel. - The medical review analysis was based on 233 (95%) of Vietnam veteran deaths and 193 (97%) of deaths among non-Vietnam veterans. On average, slightly fewer supplemental medical and legal records were recovered for each Vietnam veteran death (mean, 3.3 records) than for each non-Vietnam veteran death (mean, 3.7 records). Overall agreement between the medical review panel diagnoses and death certificate diagnoses, however, was good (82%; kappa = 0.79) and did not differ significantly between the two veteran cohorts.

The medical review analyses indicated differences in only two ICD-9 categories that were not evident from the death certificate analysis. The RR for mental disorders from the medical review panel analysis was 2.85 (95% CI, 0.92 to 8.82) compared with 0.95 from the death certificate analysis. Most mental disorder deaths were related to alcohol or drugs and are examined in more detail in Table 6. The RR for neoplasms based on medical review panel diagnoses was 1.21 (95% CI, 0.55 to 2.66) compared with 0.82 based on death certificates. This difference was primarily the result of two deaths from neoplasms among non-Vietnam veterans being reclassified elsewhere by the medical review panel and the opposite occurrence among Vietnam veterans. There was no particular type of neoplasm in excess in the Vietnam cohort.

Supplemental information collected for the medical review allowed further exploration of MVA deaths. Single- and multiple-vehicle crash deaths as well as daytime and nighttime events all occurred more frequently among Vietnam veterans during the early postdischarge period. Vietnam veterans had a modest excess of which were alcohol-related MVA deaths during this period (RR, 1.35; 95% CI, 0.60 to 3.04).

Alcohol-related natural causes of death were too few for formal analysis in the early postdischarge period, but the RR in the later period showed no difference between the two groups (Table 6). A modest elevation in alcohol-related traumatic deaths among Vietnam veterans was limited to the first five years after discharge. For drug-related deaths, the RR was slightly elevated during the early postdischarge period and more elevated during the later follow-up period. Although the number of deaths is too small for formal analysis, further refinement of the later follow-up period suggests the upward trend in drug-related mortality continues into the most recent years. Further, Vietnam service seems to be associated with an especially high rate of drug-related mortality among those drafted into service, those whose jobs were in tactical or combat operations, and those who served during 1969.

Again, as in the death certificate results, adjustment for selected covariates increased the RR for suicide in the early follow-up period to 2.56 (95% CI, 1.11 to 5.87). No other RR presented in the medical review results was materially altered by adjustment.

#### General Population Comparison

Both groups of veterans had a significantly lower overall mortality rate for "natural causes" than the general US male population (Table 7). During the first five years after discharge, Vietnam veterans had a higher death rate from external causes, whereas non-Vietnam veterans have a lower rate relative to the general population. In the later time period both groups of veterans showed a similar deficit in external cause mortality. Although these data are not presented in Table 7, over the entire follow-up period, Vietnam veterans had a striking deficit of circulatory disease deaths (SMR, 0.48; 95% CI, 0.25 to 0.85), whereas non-Vietnam veterans had only a slight deficit (SMR, 0.87; 95% CI, 0.54 to 1.34).

COMMENT

The intent of our study was to assess the effect of military service in Vietnam on subsequent mortality. The "Vietnam experience" includes a wide range of possible health-influencing factors such as psychological stresses associated with war, infectious diseases prevalent in Vietnam and exposure to the herbicide Agent Orange.

The modest excess of deaths among Vietnam veterans was concentrated in the first five years after discharge, where all-cause mortality was 45% higher than in the non-Vietnam group. External causes accounted for most of this increase, with the largest elevation in relative mortality due to MVAs.

A more detailed examination of MVA deaths did not indicate any particular factor that could explain the overall excess in Vietnam veterans. The increased risk did not appear to be related to elevated blood alcohol levels at the time of death, and the excess was apparent across various types of MVAs. Drug-use information on MVA victims was limited; the medical review panel identified only one drug-related MVA death.

Suicide and homicide also occurred somewhat more frequently among Vietnam veterans during the early postdischarge period. Accidental poisoning deaths (mainly by drugs) were elevated throughout the entire follow-up period, although the number of such deaths was small.

By the sixth year after discharge, both all-cause and external-cause mortality among Vietnam veterans had fallen to levels found in the non-Vietnam group, except for deaths due to drug abuse, where the rate was actually higher in the more recent follow-up period.

These findings are unlikely to be the result of a serious flaw in study design or execution. The study groups were selected in a manner that minimized differences in their preservice characteristics; vital status was verified for 93% of all participants; death certificates were recovered for 98% of deaths; and supplemental medical and legal documents, which allowed an independent assessment of cause of death by standardized criteria, were obtained for 96% of deaths. Moreover, the pattern of excess deaths was remarkably consistent across various subgroups of Vietnam veterans and appears not to be an artifact of confounding. It should be noted, however, that sample size constraints limited our ability to detect excesses in mortality in subgroups of veterans and for the less frequent causes of death in this relatively young group.

Our findings can be viewed against the results of five previous mortality studies of Vietnam veterans. Four<sup>10-13</sup> are proportional mortality studies, which may not be directly comparable with this study because of incompleteness of data and inherent limitations of this analytic method.<sup>14</sup> The fifth, a cohort study of Australian Vietnam veterans, is very similar in design to our study and thus is a more appropriate comparison.<sup>15</sup> The US Air Force "Ranch Hand" study is not discussed here, since its principal concern is the adverse health effects of herbicide exposure in a unique group of veterans.<sup>16</sup>

The 30% excess of external-cause mortality among Australian Vietnam veterans relative to non-Vietnam veterans is similar to what is seen here.<sup>15</sup> Although the Australian investigators did not examine external cause mortality by time since discharge, there was a suggestion of a decline in relative

mortality with increasing time since discharge in their all-cause mortality results. Deaths from suicide, homicide, and accidental poisoning also occur more frequently among their Vietnam veterans. Mortality from MVA was not elevated overall, but an excess in the youngest age group was suggested.

Findings for external-cause mortality from the four proportional mortality studies are not consistent with our results. A nonsignificant increase in deaths from MVA among Vietnam veterans relative to other veterans was present in only one of the studies.<sup>12</sup> The relative frequencies of suicide and homicide were not unusual, although there was one instance of a nonsignificant increase in both of these causes.<sup>11</sup> Accidental poisonings were analyzed in only one of the studies, and the result was a small, nonsignificant elevation among Vietnam veterans.<sup>11</sup>

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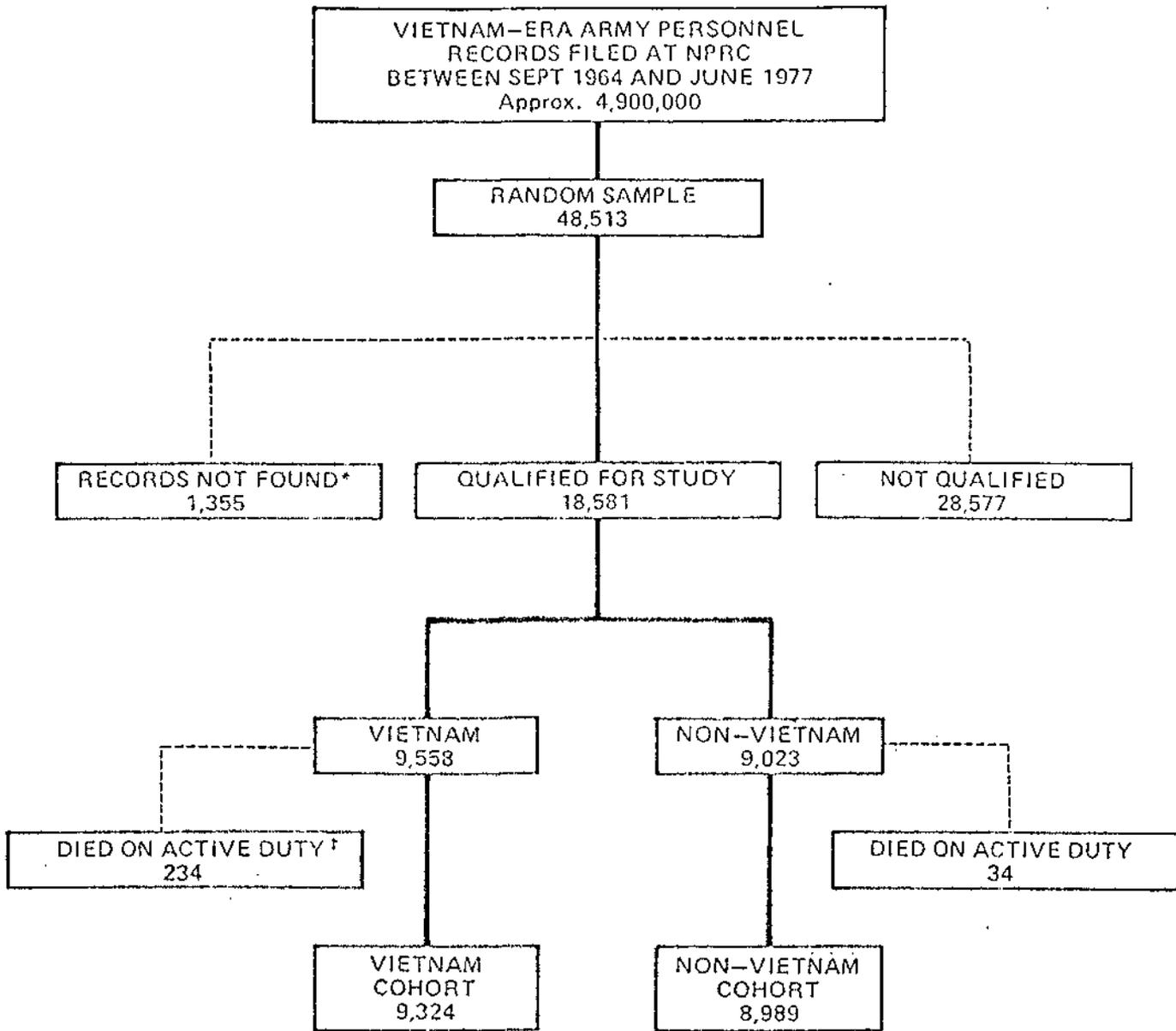
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## REFERENCES

1. Veterans Health Programs Extension and Improvement Act of 1979, Public Law 96-151 (HR 3892), Dec 20, 1979, 93 STAT 1092-1098.
2. Veterans' Health Care, Training, and Small Business Loan Act of 1981, Public Law 97-72 (HR 3499), Nov 3, 1981, 95 STAT 1047-1063.
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4. Postservice Mortality Among Vietnam Veterans. Atlanta, Centers for Disease Control, 1987.
5. International Classification of Diseases, Adapted for Use in the United States, rev 8, PHS publication 1693. US Dept of Health, Education, and Welfare, 1967.
6. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, rev 9. Geneva, World Health Organization, 1977.
7. Laird N, Oliver D: Covariance analysis of censored survival data using log-linear analysis techniques. J Am Stat Assoc 1981;76:231-241.
8. Cox DR, Oakes D: Analysis of Survival Data. London, Chapman and Hall, 1984.
9. Monson RR: Analysis of relative survival and proportional mortality. Comp Biomed Res 1974;7:325-332.
10. Anderson HA, Hanrahan LP, Jensen M, et al: Wisconsin Vietnam Veteran Mortality Study. Madison, Wisc, Wisconsin Division of Health, 1985.
11. Lawrence CE, Reilly AA, Quickenton P, et al: Mortality patterns of New York State Vietnam veterans. Am J Public Health 1985;75:277-279.
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13. Holmes AP: West Virginia Vietnam-Era Veterans Mortality Study. Charleston, W VA, West Virginia Health Department, 1986.
14. Wong O, Decoufle P: Methodological issues involving the standardized mortality ratio and proportionate mortality ratio in occupational studies. J Occup Med 1982;24:299-304.
15. Fett MJ, Dunn M, Adena MA, et al: Australian Veterans Health Studies: The Mortality Report. Part I. A Retrospective Cohort Study of Mortality Among Australian National Servicemen of the Vietnam Conflict Era, and an Executive Summary of the Mortality Report. Canberra, Australia, Australian Government Publishing Service, 1984.

16. Lathrop GD, Moynahan PM, Albanese RA, et al: Project Ranch Hand II. An Epidemiologic Investigation of Health Effects in Air Force Personnel Following Exposure to Herbicides: Baseline Mortality Study Results. San Antonio, Tex, Brooks Air Force Base, US Air Force School of Aerospace Medicine, 1983.
17. Ritter C, Clayton RR, Voss HL: Vietnam military service and marijuana use. Am J Drug Alcohol Abuse 1985;11:119-130.
18. Robins LN, Helzer JE, Davis DH: Narcotic use in Southeast Asia and afterward. Arch Gen Psychiatry 1975;32:955-961.
19. Yager T, Laufer R, Gallops M: Some problems associated with war experience in men of the Vietnam generation. Arch Gen Psychiatry 1984;41:327-333.
20. Seltzer CC, Jablon S: Effects of selection on mortality. Am J Epidemiol 1974;100:367-372.
21. Neftzger MD: Follow-up studies of World War II and Korean War prisoners. I. Study plan and mortality findings. Am J Epidemiol 1970;91:123-138.



Selection of study group, NPRC indicates National Personnel Records Center; asterisk, excluded from study; and dagger, eighty-three percent (N=194) of active duty deaths among Vietnam veterans were due to war-related activities.

Table 1. Differences in Selected Characteristics Between Vietnam and Non-Vietnam Veterans at Entry Into Service and During Military Service

Characteristic	Vietnam (N=9324)	Non-Vietnam (N=8989)
<u>At entry into service</u>		
Race,* (% white)	86.8	86.5
Age at entry, (mean)	20.3	20.5
Enlistment status,* (% draftee)	63.7	65.6
Year of entry into service, (% before 1969)	72.1	60.6
Army General Technical Test score (mean, scaled to 100)	103.1	105.5
<u>During military service</u>		
Primary military occupational specialty <sup>+</sup> % tactical operations	34.3	27.4
Type of unit, % infantry	26.6	14.6
Type of discharge, % honorable	97.2	91.0
Pay grade at discharge, % E4 or E5	88.5	79.8
Year of discharge, % before 1970	48.1	44.6

\* Race and enlistment status were the only two characteristics that were not significantly different ( $P > .05$ ) between the Vietnam and the non-Vietnam groups.

+ The job specialty for which the man was trained in the Army.

Table 2. Number of Deaths, Person-Years, and Death Rates Among Vietnam and Non-Vietnam Veterans and Unadjusted RRs by Years Since Discharge From Active Duty, 1965-1983\*

Years Since Discharge	Vietnam			Non-Vietnam			RR	95% CI
	No. of deaths	Person-years	Rate <sup>+</sup>	No. deaths	Person-years	Rate <sup>+</sup>		
≤5	110	46,350	2.4	73	44,747	1.6	1.45	1.08-1.96
6+	136	81,547	1.7	127	76,582	1.7	1.01	0.79-1.28
All years	246	127,897	1.9	200	121,329	1.7	1.17	0.97-1.41

\* RR indicates rate ratio; CI, confidence interval.

+ Crude death rate per 1000 person-years.

Table 3. Number of Deaths Among Vietnam and Non-Vietnam Veterans and Unadjusted Rate Ratios (RRs), by Selected Characteristics and Years Since Discharge from Active Duty, 1965-1983

Characteristic *	Years Since Discharge From Active Duty					
	≤5		6+		All years	
	No.	RR	No.	RR	No.	RR
<b>Race</b>						
White	146	1.50	193	0.99	339	1.18
Non-white	37	1.30	70	1.07	107	1.14
<b>Enlistment status</b>						
Volunteer	79	1.09	111	0.91	190	0.98
Draftee	104	1.80	152	1.06	256	1.31
<b>GT test score<sup>†</sup></b>						
<100	97	1.42	141	0.90	238	1.08
100+	83	1.43	119	1.07	202	1.20
<b>Duty MOS<sup>‡</sup></b>						
Tactical	63	1.19	89	1.04	152	1.10
Other	120	1.58	174	0.97	294	1.18
<b>Age at discharge</b>						
<21	47	1.83	42	0.67	89	1.14
21+	136	1.41	221	1.10	357	1.21
<b>Pay grade at discharge</b>						
E4 - E5	125	1.50	183	1.10	308	1.24
E1 - E3	58	1.95	80	1.16	138	1.44
<b>Year of discharge</b>						
<1970	79	2.05	122	0.96	201	1.27
1970+	104	1.16	141	1.06	245	1.10

\* There was no evidence of statistically significant effect modification for any of these characteristics ( $P > 0.05$ ).

<sup>†</sup> Army General Technical Test (GT) scores were missing for six veterans.

<sup>‡</sup> Determined from principal military occupational specialty (MOS) held while on tour of duty.

Table 4. Number of Deaths by Cause (From Death Certificate), Death Rates Among Vietnam and Non-Vietnam Veterans, and Unadjusted RRs, 1965-1983<sup>x</sup>

Underlying cause of death (ICD-9) <sup>+</sup>	Vietnam		Non-Vietnam		RR <sup>§</sup>	95% CI
	No.	Rate <sup>†</sup>	No.	Rate <sup>†</sup>		
Infectious and parasitic diseases (001-139)	1	0.8	1	0.8	—	—
Neoplasms (140-239)	12	9.4	14	11.5	0.82	0.38-1.76
Mental disorders (290-319)	7	5.5	7	5.8	0.95	0.33-2.70
Diseases of nervous system (320-389)	2	1.6	1	0.8	—	—
Diseases of circulatory system (390-459)	12	9.4	23	19.0	0.49	0.25-0.99
Diseases of respiratory system (460-519)	5	3.9	4	3.3	—	—
Diseases of digestive system (520-579)	5	3.9	3	2.5	—	—
Diseases of genitourinary system (580-611)	4	3.1	0	—	—	—
Congenital anomalies (740-759)	1	0.8	1	0.8	—	—

Table 4. Number of Deaths by Cause (From Death Certificate), Death Rates Among Vietnam and Non-Vietnam Veterans, and Unadjusted RRs, 1965-1983\* (continued)

Symptoms, signs, and ill-defined conditions (780-799)	2	1.6	1	0.8	-	-
External causes (E800-E999)	188	147.0	143	117.9	1.25	1.00-1.55
No death certificate	7	-	2	-	-	-

\* RR indicates rate ratio; CI, confidence interval.

+ ICD-9 indicates International Classification of Diseases, ninth revision. No deaths were categorized to diseases of blood and blood-forming organs; endocrine, metabolic or nutritional diseases; diseases of the skin; or diseases of the musculoskeletal system. Therefore, these categories are not shown.

† Crude death rate per 100,000 person-years.

§ If the total number of deaths for a cause-of-death category in both groups combined was less than ten, RRs are not shown.

Table 5. Number of Deaths From Specific External Causes (From Death Certificate) Among Vietnam and Non-Vietnam Veterans and Unadjusted RRs, by Years Since Discharge From Active Duty, 1965-1983\*

External cause of death (ICD-9)	Years Since Discharge From Active Duty†								
	<5			6+			All Years		
	No.	RR	95% CI	No.	RR	95% CI	No.	RR	95% CI
Motor vehicle accident (E810-E825, E929.0)	66	1.93	1.16-3.22	67	1.16	0.72-1.87	133	1.48	1.04-2.09
Accidental poisoning (E850-E869, E929.2)	11	1.69	0.49-5.77	7	-	-	18	2.47	0.88-6.92
Other accidents ‡	23	1.05	0.46-2.37	39	0.89	0.48-1.67	62	0.95	0.58-1.56
Suicide (E950-E959)	25	1.72	0.76-3.88	32	0.64	0.32-1.30	57	0.98	0.58-1.65
Homicide (E960-E969)	18	1.52	0.59-3.91	33	0.78	0.39-1.55	51	0.99	0.57-1.71
Undetermined intentionality (E980-E989)	4	-	-	6	-	-	10	3.79	0.81-17.87

\* RR indicates rate ratio; CI, confidence interval; ICD-9, International Classification of Diseases, ninth revision.

† Time-specific RRs are not presented for categories with less than 10 deaths in both Vietnam and non-Vietnam groups combined.

‡ Includes ICD-9 categories E800 to E807, E826 to E849, E870 to E928, E929.1, E929.3 to E929.9, E930 to E949, E970 to E978, and E990 to E999.

Table 6. Number of Deaths From Alcohol and Drug-Related Causes (From Medical Review) Among Vietnam and Non-Vietnam Veterans and Unadjusted RRs, by Years Since Discharge From Active Duty, 1965-1983\*

Cause of death	Years Since Discharge From Active Duty								
	<5			6+			All Years		
	No.	RR	95% CI	No.	RR	95% CI	No.	RR	95% CI
Alcohol-related natural causes <sup>+</sup>	5	--	--	25	0.87	0.40-1.90	30	1.08	0.53-2.22
Alcohol-related traumatic causes <sup>‡</sup>	42	1.29	0.70-2.37	61	1.04	0.63-1.71	103	1.13	0.77-1.67
Drug-related causes <sup>§</sup>	18	1.21	0.48-3.06	22	2.01	0.82-4.94	40	1.58	0.83-3.00

\* RR indicates rate ratio; CI, confidence interval.

<sup>+</sup> Includes the following diagnoses determined to be the underlying or contributing cause of death: alcoholic psychoses (291.0 to 291.9); alcohol dependence syndrome (303); nondependent alcohol abuse (305.0); alcoholic polyneuropathy (357.5); alcoholic cardiomyopathy (425.5); alcoholic gastritis (535.3); alcoholic liver disease (571.0 to 571.3); and excessive blood level of alcohol (790.3).

<sup>‡</sup> Includes deaths in which the underlying cause is accidental poisoning by alcohol (E860.0 to E860.9) or any traumatic death (E800-E989) in which either nondependent abuse of alcohol (305.0) or excessive blood level of alcohol (790.3) is a contributing cause of death.

<sup>§</sup> Deaths for which one of the following drug-specific diagnoses is the underlying or contributing cause of death; drug psychoses (292.0 to 292.9); drug dependence (304.0 to 304.9); nondependent abuse of drugs (305.2 to 305.9); accidental poisoning by drugs (E850.0 to E850.2, E850.5, E850.8, E851-E854, E855.1 to E855.2, E866.6 and E869.0); suicide by drugs (E950.0 to E950.5); and poisoning by drugs, intentionality undetermined (E980.0 to E980.5).

Table 7. Observed and Expected Numbers of Deaths by Cause Among Vietnam and Non-Vietnam Veterans and SMRs, by Years Since Discharge From Active Duty, 1965-1983\*

Years since discharge	Cause of Death <sup>+</sup> (ICDA-8)		Vietnam	Non-Vietnam
≤5	All natural causes (000-796)	Observed	13	16
		Expected †	24.2	23.4
		SMR	0.54	0.68
		95% CI	0.29-0.92	0.39-1.11
	External causes (E800-E999)	Observed	92	55
		Expected	72.5	69.4
		SMR	1.27	0.79
		95% CI	1.02-1.56	0.60-1.03
6+	All natural causes (000-796)	Observed	38	39
		Expected	65.8	63.4
		SMR	0.58	0.62
		95% CI	0.41-0.79	0.44-0.84
	External causes (E800-E999)	Observed	96	88
		Expected	102.7	96.6
		SMR	0.93	0.91
		95% CI	0.76-1.14	0.73-1.12
All years	All natural causes (000-796)	Observed	51	55
		Expected	90.0	86.8
		SMR	0.57	0.63
		95% CI	0.42-0.75	0.48-0.82
	External causes (E800-E999)	Observed	188	143
		Expected	175.2	166.0
		SMR	1.07	0.86
		95% CI	0.93-1.24	0.73-1.01

\* SMR indicates standardized mortality ratio; CI, confidence interval; and ICDA-8, International Classification of Diseases, Adapted for Use in the United States, eighth revision.

+ Excludes nine deaths (seven Vietnam, two non-Vietnam) for which death certificates were not recovered.

† Expected number is based on the mortality rates among US men, standardized for age, calendar year, and race.