
The Vietnam Era Twin Registry: a Resource for Medical Research

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Synopsis

The Vietnam Era Twin Registry consists of 4,774 male-male twin pairs born between 1939 and 1957 with both brothers having served in the United States military during the Vietnam War. The registry was originally developed to provide the best control group for Vietnam-exposed servicemen to study the long-term health consequences of service in Vietnam. Recognizing the potential value of the registry for other areas of medical research, the Department of Veterans Affairs in 1988 opened the registry for use by both VA and non-VA investigators. The existence of centralized VA data bases for deaths and VA hospitalizations will strengthen future followup of the twins. This article describes the characteristics of the registry population and the process for accessing the registry.

THE STUDY OF TWINS offers unique opportunities for understanding the role of genetic and environmental factors in a wide variety of normal biologic processes and illnesses. Twins have been effectively used to study diseases as diverse as Huntington's chorea, leprosy, glaucoma, insulin dependent and independent diabetes mellitus, cancer, ischemic heart disease, cerebrovascular disease, and psychiatric illnesses (1).

Although many twin registries exist in the United States, the National Academy of Sciences-National Research Council Twin Registry of World War II veterans is the only one that is large and nationally based (2).

The Vietnam Era Twin Registry is a new registry that is representative of veterans who served in the Armed Forces of the United States during the Vietnam War. The method used to create the registry will be reviewed, selected characteristics of registry members will be summarized, and procedures by which researchers can access the registry will be outlined.

Construction of the Twin Registry

The registry was assembled from a computer file of discharges from the military maintained by the Depart-

ment of Defense. An algorithm was used that matched data base entries for same last name, different first name, same date of birth, and similar social security numbers. From a list of approximately 5.5 million veterans, 15,711 potential twin pairs were identified. Military records, stored at the National Personnel Records Center in St. Louis, MO, were then searched to evaluate twinship. Twinship was confirmed for 7,369 pairs (46.9 percent). A pilot study demonstrated that, by comparison with a wide variety of sociodemographic and other variables, these twins were representative of all twins who served in the military during the Vietnam War (3). A complete description of the method of registry construction has been published (4).

Components of the Twin Registry

Data on registry members were collected from three sources: military service records, a health survey questionnaire mailed to registry members in 1987, and computer data bases maintained by the Department of Veterans Affairs.

Military record data. Extensive data related to military service were abstracted from military service rec-

ords, including demographic and socioeconomic information, physical characteristics and health, military service variables, and general aptitude tests. Specific data items are listed in the accompanying box.

The 1987 Survey of Health. A survey of health questionnaire was developed by investigators associated with the Vietnam Experience Twin Study. The questionnaire contained questions about zygosity, specific health problems, symptoms of posttraumatic stress disorder, cigarette and alcohol consumption, military experience including combat, homecoming experiences, marital status and fertility, education, employment, and income.

The questionnaire was mailed to each registry member, a total of 14,738 persons. Three mailings and telephone followup of nonresponses resulted in 4,774 pairs who completed the survey (64.8 percent response rate by completed pairs) and 1,433 singletons who completed the survey without their brother's doing so (74.5 percent response rate by 10,981 persons).

Department of Veterans Affairs computer data bases. Data have been abstracted from two centralized computer data bases maintained by the Department of Veterans Affairs: the Patient Treatment File and the Beneficiary Identification and Records Locator Subsystem.

The Patient Treatment File is a list of patients discharged from VA hospitals (U.S. Veterans Administration: VAccess Helpbook. Unpublished document, 1987). Initiated in 1970, the file contains nearly 20 million records, 1 for every hospitalization. Coded data include ICDA (International Classification of Diseases Adapted) discharge diagnoses and surgical procedures. The value of the Patient Treatment File is limited because only 16.5 percent of veterans have received hospital care from the Department of Veterans Affairs (5).

The Beneficiary Identification and Records Locator Subsystem data base includes records of all veterans receiving benefits such as compensation, pension, loan guarantees, and education. Widespread use of death benefits has created a highly reliable resource for survival status and date of death if the veteran is deceased. A death certificate is usually available (U.S. Veterans Administration: Beneficiary Identification and Records Locator Subsystem. Unpublished document, 1968).

Characteristics of the Registry Population

Tables 1–6 present characteristics of the Vietnam Era Twin Registry population. The numbers in the tables do not always add to the total population because of some

Information Abstracted from the Military Records of 7,369 Pairs of Twins in the Vietnam Era Twin Registry

Demographic and socioeconomic information: date of birth, place of birth, race, sex, marital status, education, religion, number of siblings, employment.

Physical features and health: height, weight, eye color, hair color, relatives with cancer, handedness, blood pressure, blood type—ABO, Rh, build, vision, pulse.

Military service variables: branch of service, enlistment date, separation date, time lost, service schools, appointments and reductions, assignments, separation type, rank, foreign service, Vietnam service, medals and decorations.

Special tests: Armed Forces Qualification Test and General Combat Test are batteries of tests given at induction into the service that measure intelligence, mechanical aptitude, clerical skills, and other abilities; other aptitude tests.

missing values on the 1987 Survey of Health Questionnaire.

Zygosity. Two general approaches are available for determining zygosity in large twin registries: analysis of genetic marker systems in blood specimens and analysis of responses of twins to questions about sibling similarity. Although the genetic marker system approach is more reliable, blood specimens are not available for Vietnam Era Twin Registry members. Therefore, zygosity was determined using the responses to a series of questions, supplemented with blood group typing data abstracted from military records. Using this technique, 2,556 (53.5 percent) of the twin pairs who responded to the questionnaire are monozygotic, 2,092 (43.8 percent) dizygotic, and 126 (2.7 percent) are of indeterminate zygosity.

Other investigators have demonstrated that this classification technique determines zygosity with a reliability of greater than 96 percent. A detailed account of the zygosity determination methodology used in the registry has been published (6).

Demographic and socioeconomic characteristics. Table 1 presents selected demographic characteristics of registry members. Eighty-five percent are in the 35–44 year age group, 93 percent are white, and 6.5 percent are black. Seventy-five percent are currently married, 11 percent were never married, and 77 percent have fathered at least one child. More than 95 percent of registry members who responded to the survey questionnaire are high school graduates, 91 percent are employed full time, and 63 percent have family incomes between \$20,000 and \$49,999 (table 2).

Table 1. Demographic characteristics of the 4,774 twin pairs (9,548 men) who responded to the 1987 Survey of Health

Characteristic	Survey respondents	
	Number	Percent
<i>Age (years)</i>		
30-34	1,272	13.3
35-39	4,978	52.2
40-44	3,135	32.9
45-49	154	1.6
<i>Race</i>		
White	8,870	93.0
Black	625	6.5
Other	44	0.5
<i>Marital status</i>		
Married	7,146	74.9
Widowed	23	0.2
Divorced	1,135	11.9
Separated	98	1.0
Never married	1,064	11.1
Other	82	0.9
<i>Number of children</i>		
None	2,173	23.2
1	1,847	19.7
2	3,258	34.7
3	1,510	16.1
4	417	4.4
5 or more	173	1.9

Table 2. Socioeconomic characteristics of the 4,774 twin pairs (9,548 men) who responded to the 1987 Survey of Health

Characteristic	Survey respondents	
	Number	Percent
<i>Education</i>		
Elementary	57	0.6
Some high school	411	4.3
High school graduate	4,485	47.0
Some college	2,404	25.2
College graduate	1,122	11.8
Graduate school	1,055	11.1
<i>Employment</i>		
Full time	8,553	90.9
Part time	195	2.1
Unemployed	664	7.0
<i>Family income</i>		
Less than \$9,999	539	5.8
\$10,000-\$19,999	1,235	13.2
\$20,000-\$49,999	5,874	63.1
\$50,000 or more	1,663	17.9

Military service. Extensive data are available about military service experiences; only a small fraction of this information is presented in this paper. The majority of registry members (51 percent) served in the Army, followed by the Navy (23 percent), Air Force (18 percent), and Marines (7 percent). Thirty-eight percent served in Vietnam. Three percent were officers.

Combat was assessed on the health survey by asking respondents whether or not they had participated in 18

different combat experiences. A combat index was calculated by the simple addition of all "yes" answers. Of servicemen who served in Vietnam, 77 percent experienced some combat. Twenty-five percent were classified as having low combat exposure (combat index 1 or 2), 29.7 percent medium combat (3 to 6), and 22.1 percent high combat (7 and above).

Health characteristics and health habits. A series of four multiple-part questions about 14 health problems experienced by registry members was asked on the health questionnaire. The first two health questions asked respondents if they experienced the health problem at any time since 1975 or since discharge from active duty and if they are currently experiencing the problem. The last two asked respondents if they have ever seen a physician or been hospitalized for the problem.

In general, disease category frequencies were highest for reporting a health problem at any time since 1975 or discharge from active duty, second highest for reporting having seen a physician for a health problem since 1975 or discharge, third highest for reporting a current health problem, and lowest for reporting a hospitalization. Table 3 provides a summary of the results of the first of these four questions by zygosity and whether the twins were concordant with a positive response, discordant, or concordant with a negative response.

Table 4 presents current cigarette smoking and alcohol drinking patterns of registry members. Relatively large subsets of twin pairs (between 617 and 771 monozygotic and 752 and 786 dizygotic twin pairs) reported discordance for these two important risk factors.

Diagnoses from the patient treatment file. The original group of 7,369 twin pairs were matched with the VA Patient Treatment File of hospital discharges between 1970 and 1985. Table 5 presents the frequencies of twin pairs who are concordant for having a diagnosis, discordant for having a diagnosis, and concordant for not having a diagnosis, grouped by major ICDA disease categories. If a patient had multiple hospitalizations for the same diagnosis, he was counted only once. The "indeterminate zygosity" category contains a large number of pairs because the health questionnaire was not returned by 3,757 registry members.

Although relatively large numbers of twin pairs concordant and discordant for several disease system-specific categories have been identified (for example, infectious diseases, mental disorders, and diseases of the nervous, circulatory, respiratory, digestive, and musculoskeletal systems, and of the skin), the numbers with individual diseases within these systems may be

Table 3. Health characteristics of the 4,774 twin pairs¹ who responded to the following question in the 1987 Survey of Health: Have you had any of the following health problems at any time since 1975 or discharge from active duty?

Health problem	Twin pair responses					
	Yes—Yes		Yes—No		No—No	
	MZ	DZ	MZ	DZ	MZ	DZ
High blood pressure	157	97	479	479	1,796	1,426
Respiratory conditions (lung trouble, persistent cough, and so forth)	56	30	369	356	2,007	1,616
Cancer	1	0	51	32	2,380	1,970
Heart trouble	11	4	136	123	2,285	1,875
Stroke	1	0	16	10	2,415	1,992
Kidney, bladder, urinary (stones, infection, kidney failure, and so forth)	75	33	391	362	1,966	1,607
Skin conditions (severe acne, rashes, and so forth)	98	50	413	471	1,921	1,481
Diabetes	10	2	37	43	2,385	1,957
Stomach, digestive disorders (ulcers, inflammation, and so forth)	116	70	547	504	1,769	1,428
Liver problems (hepatitis, cirrhosis, and so forth)	8	3	108	89	2,316	1,910
Blood disorders (anemia, blood clots, and so forth)	6	0	64	61	2,362	1,941
Nerve disorders (epilepsy, migraines, and so forth)	33	16	215	197	2,184	1,789
Joint, skeletal disorders (arthritis, swollen joints, and so forth)	129	76	504	503	1,799	1,423
Hearing problems	119	96	494	463	1,819	1,443
Mental, emotional problem ²	34	15	241	221	2,225	1,816
Presumptive diagnosis of posttraumatic stress disorder ²	52	34	331	299	2,021	1,623

¹Twins of indeterminate zygosity are not included in the table since there were only 126 pairs.

²These questions were in the context of currently having the health problems. NOTE: MZ = monozygotic; DZ = dizygotic.

Table 4. Health habits of the 4,774 twin pairs¹ who responded to the 1987 Survey of Health

Health habit	Twin pair responses					
	Yes—Yes		Yes—No		No—No	
	MZ	DZ	MZ	DZ	MZ	DZ
Current cigarette smoker	682	496	617	752	1,235	817
Current drinker of alcoholic beverages	1,218	959	771	786	548	329

¹Twins of indeterminate zygosity are not included in the table since there were only 126 pairs.

NOTE: MZ = monozygotic; DZ = dizygotic.

Table 5. Discharge diagnoses for all Vietnam Era Twin Registry members (7,369 twin pairs) who have been hospitalized at VA Medical Centers (ICDA-9 codes given in parentheses)

Hospital diagnosis	Twin responses (number of pairs)								
	Yes-Yes			Yes-No			No-No		
	MZ	DZ	IZ	MZ	DZ	IZ	MZ	DZ	IZ
Infectious and parasitic diseases (001–139)	1	1	3	14	8	20	3,270	2,780	1,272
Neoplasms (140–239)	0	0	0	7	3	5	3,278	2,786	1,290
Endocrine, nutritional, and metabolic diseases and immunity disorders (240–279)	0	0	1	3	1	4	3,282	2,788	1,290
Diseases of the blood and blood-forming organs (280–289)	1	0	0	1	2	7	3,283	2,787	1,288
Mental disorders (290–319)	17	8	33	13	11	29	3,255	2,770	1,233
Diseases of nervous system and sense organs (320–389)	1	2	2	12	6	16	3,272	2,781	1,277
Diseases of circulatory system (390–459)	5	1	2	5	4	20	3,275	2,784	1,273
Diseases of respiratory system (460–519)	1	1	4	17	9	20	3,267	2,779	1,271
Diseases of digestive system (520–579)	7	3	13	20	10	36	3,258	2,776	1,246
Diseases of genitourinary system (580–629)	1	0	2	9	4	10	3,275	2,785	1,283
Diseases of skin and subcutaneous tissue (680–709)	3	2	1	12	11	28	3,270	2,776	1,266
Diseases of musculoskeletal system and connective tissue (710–739)	4	2	0	17	8	20	3,264	2,779	1,275
Congenital anomalies (740–759)	0	0	0	1	2	2	3,284	2,787	1,293
Symptoms, signs, and ill-defined conditions (780–799)	3	1	3	10	8	33	3,272	2,780	1,259
Injury and poisoning (800–999)	9	5	10	18	13	38	3,258	2,771	1,247

NOTE: MZ = monozygotic; DZ = dizygotic; IZ = zygosity indeterminate.

Table 6. Geographic distribution of individuals and twin pairs on the Vietnam Era Twin Registry

State or Territory	Number of individuals	Number of twin pairs ¹
Northeast	1,538	550
Maine	31	8
Vermont	24	7
New Hampshire	31	6
Massachusetts	129	45
Rhode Island	26	7
Connecticut	188	73
New York	414	150
Pennsylvania	493	191
New Jersey	202	63
Middle Atlantic	928	310
Maryland	165	47
Delaware	19	4
Washington, DC	12	2
Virginia	231	65
West Virginia	87	32
North Carolina	240	94
South Carolina	174	66
Southeast	1,265	430
Kentucky	158	63
Tennessee	211	80
Georgia	239	84
Florida	334	91
Alabama	115	40
Mississippi	70	21
Louisiana	138	51
North Central	2,463	925
Ohio	513	202
Indiana	259	90
Illinois	405	144
Michigan	388	163
Wisconsin	293	115
Minnesota	229	85
Iowa	186	66
Nebraska	90	30
South Dakota	43	12
North Dakota	57	18
South Central	1,215	415
Missouri	239	84
Kansas	129	46
Arkansas	68	18
Texas	635	219
Oklahoma	144	48
Rocky Mountain	561	146
Montana	36	11
Idaho	38	10
Colorado	200	47
Utah	67	21
New Mexico	63	18
Arizona	131	35
Wyoming	26	4
Far West	1,561	517
California	980	345
Oregon	163	50
Washington	296	96
Nevada	51	7
Hawaii	30	7
Alaska	41	12
Other	17	3
Puerto Rico	4	2
Virgin Islands	1	0
Guam	1	0
In foreign country	11	1
Total	9,548	3,296

¹Both twin siblings reside in same State.

low. More detailed information is available upon request.

Geographic distribution. Table 6 gives the number of individuals and number of twin pairs residing in each State. All but 17 veterans reside in the continental United States, Alaska, and Hawaii. Some States, such as California, Texas, Ohio, Pennsylvania, Michigan, New York, and Illinois, have large numbers of twin pairs that might permit some twin studies to be performed within a small geographic area.

Limitations of the Registry

Potential limitations of the Vietnam Era Twin Registry are related to the intrinsic nature of the population and to the methods of construction of the registry.

The population consists of male veterans, the great majority of whom are between the ages of 35 and 49. Women were excluded since there are too few for meaningful statistical analyses. The prevalence of most chronic illnesses is currently low because of the relative youth of participants. The minimum health status required for induction into military service suggests that registry members are healthier than the general population of United States adult males. For a similar reason, the health of twin siblings in the registry is probably more alike than the general population of adult male twin siblings.

A pilot study (3) suggested that the population of all male-male twin pairs born from 1939 to 1955 with both brothers in the U.S. military during the Vietnam War is at least twice the size of the Vietnam Era Twin Registry. Many twin pairs were not found because the Department of Defense computer file of discharges was established in the middle of the war. The pilot study showed that the only factors for which twins in and not in the registry differed were related to an underrepresentation of the early war years. While this might have some effect on research about the effects of the war experience, it should not influence more general twin studies.

The response rates to the initial health survey were 74.5 percent for individuals and 64.8 percent for completed pairs. A comparison of responders and nonresponders showed that a higher proportion of whites (77.4 percent) responded than nonwhites (57.3 percent), those with higher educational attainment were more likely to respond (83.5 percent of those with more than a high school education responded, while 62.3 percent of those without a high school diploma responded), respondents were older at the time of enlistment (78.5 percent of those 20 years of age and older responded, while 72.0 percent of those younger than 20 years responded), and respondents were more likely to have

Participants in the Vietnam Era Twin Registry, VA Cooperative Study Program No. 256

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served in Southeast Asia (77.5 percent of those who served in Southeast Asia responded versus 74.4 percent of those who did not serve in Southeast Asia).

Maintenance and Access to the Twin Registry

The Vietnam Era Twin Registry is supervised by a director and maintained by staff at the Hines Department of Veterans Affairs Cooperative Studies Program Coordinating Center.

A broad range of requests for use of the registry will

be considered, including questionnaire surveys, clinical examinations, examinations of biologic samples (blood, for example), requests for data already contained in the registry for analysis and publication, and requests for limited data analyses performed by the Hines Department of Veterans Affairs Cooperative Studies Program Coordinating Center to support research protocol planning. Similar studies using twin registries of both World War II and Vietnam veterans could explore cohort effects and changes over time in genetic and environmental influences.

The registry is guided by an Advisory Committee, composed of experts in the fields of epidemiology, genetics, twin studies, and biostatistics (see accompanying box). The committee provides the Hines staff with advice on maintenance of the registry and reviews the scientific merit of applications. An important principle for the committee is the need to balance the promotion of high-quality research with protection of the registry from overuse. The Human Rights Committee of the Hines Cooperative Studies Coordinating Center also reviews the protocols. All manuscripts and presentations based on registry members must be approved by the director prior to submission for publication or presentation. This policy will ensure the maintenance of high scientific standards. After an investigation is completed, all data become a permanent part of the registry and are available for use by other investigators.

The Vietnam Era Twin Registry does not provide research funding. Researchers interested in using the registry should contact the director for application guidelines.

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