A Twin Study of the Effects of the Vietnam Conflict on Alcohol Drinking Patterns

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Abstract: This study examines the association between military service in Southeast Asia and alcohol drinking patterns in 2,169 male-male monozygotic twin pairs who both served on active military duty during the Vietnam era (1965–75). Data on alcohol drinking were collected in 1987 by mail and telephone interview. The alcohol drinking measures include three indicators of abstention (lifetime abstainer, lifetime non-regular drinker, and current abstainer) and two indicators of consumption (average daily ethanol consumption and high consumption). In unadjusted and co-twin adjusted analyses, neither service in Southeast Asia nor combat exposure was significantly associated with any measure of abstention. In the co-twin adjusted analysis, there was no association of Southeast Asia service and combat exposure with average daily ethanol consumption. After adjustment for co-twin effects, 4.0 percent of non-Southeast Asia veterans were high consumers compared to 6.7 percent of Southeast Asia veterans who served in high combat. We conclude that prior military service in a war zone has a relatively modest long-term effect on the alcohol drinking patterns of male veterans. (*Am J Public Health* 1990; 80:570–574.)

Introduction

The relationship between service in the military and alcohol drinking patterns is a subject of considerable debate. Numerous clinical studies have concluded that veterans have high rates of alcoholism.[1–3] The evidence for increased alcohol consumption among veterans in non-clinical population samples is equivocal; some studies conclude that increased consumption among veterans is a function of demographic differences between veterans and nonveterans,[4,5] while other more recent research indicates that veterans consume more alcohol than nonveterans regardless of demographic differences.[6]

A number of investigations have examined the association between military service in Southeast Asia and alcohol consumption. Some studies have found that service in Southeast Asia and exposure to combat are associated with increased rates of alcoholism and problem drinking,[7,8] while other research has failed to demonstrate any association with alcohol consumption patterns.[9–12]

The potential for selection bias is a fundamental problem in all studies of alcohol drinking among veterans. Observed associations between military service experience and alcohol drinking patterns may simply reflect an underlying association of predispositional characteristics with both military service experience and alcohol drinking. The present study addresses this problem by examining alcohol drinking in monozygotic twin pairs contained in the Vietnam Era Twin Registry.

Methods

Data Sources and Study Eligibility

The Vietnam Era Twin Registry contains 7,375 male-male twins who both served in the military during the official Vietnam era (May 1965-August 1975). A complete description of the development of the registry can be found elsewhere,[13] and only a brief overview is presented here.

A survey of all twins on the registry was conducted in early 1987, with the goals of collecting information on a wide range of physical and psychological indicators of health. The overall case-wise response rate was 74 percent and the pair-wise response rate was 65 percent or 4,774 pairs. Twins were eligible for the present study if: both members of the pair responded to the survey, the pair was originally ascertained from the US Department of Defense computer files, and complete information was available for all alcohol drinking measures. After applying the exclusion criteria, the final number of eligible twin pairs was 4,048.

Zygosity was evaluated by using a series of questions on twin similarity and limited blood group typing obtained from the military records.[14] Of the 4,048 pairs meeting the eligibility requirements for the present study, 2,169 (53.6 percent) were monozygotic, 1,773 (43.8 percent) were dizygotic and 106 (2.6 percent) were of indeterminant zygosity. The present study focuses exclusively on the monozygotic twin pairs.

Service in Southeast Asia and Combat Exposure

Military service in Southeast Asia was determined by the response to the following question: "When you were in the military, were you stationed in Vietnam, Laos, or Cambodia; in the waters in or around these countries; or fly in missions over these areas?" Those men who responded in the affirmative were then asked a set of questions about 18 specific combat roles or experiences (see Appendix A). For each item the veterans indicated whether they had that role or experience while serving in Southeast Asia. An index of combat exposure was constructed by taking the summation of all positive responses for an individual. For analytical purposes the combat index was grouped into five levels: (non-Southeast Asia service; Southeast Asia service, no combat; low, combat index = 1–2; medium, combat index = 3–6; high, combat index > 6). Elsewhere,[15] we have demonstrated that in a subset of twins who completed the health survey twice more than a year apart, concordance was high (weighted kappa = 0.84) for the combat exposure index. Likewise, the combat index was found to be significantly correlated with objective indicators of threat to life and limb as measured by combat medals and decorations.

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Measures of Alcohol Drinking

A negative response to having had more than 20 alcoholic drinks in their entire life defines a lifetime abstainer. Veterans who were not lifetime abstainers, were asked at what age they started drinking alcoholic beverages regularly; as part of the response option to this question the veteran could indicate that he never drank regularly. This is referred to as lifetime non-regular drinker. The next question asked if the veteran drinks alcoholic beverages now. This provides a third measure of alcohol abstention which separates current drinkers from noncurrent drinkers. It should be noted that the lifetime abstainer measure is subsumed by the lifetime non-regular drinker measure, which is subsumed by the current abstainer measure.

For men who are current drinkers quantity was obtained as the average number of drinks consumed on days when the veteran had at least one drink; frequency was obtained in terms of the average number of days per week that the veteran had at least one drink. If the ethanol content of an unspecified drink is assumed to be 0.5 ounces, then average daily ethanol consumption can be calculated as: (frequency × quantity × 0.5)/7. Following the guidelines of the National Institute of Alcohol Abuse and Alcoholism,[16] average daily ethanol consumption can be categorized into four drinking levels: abstainers, average intake of 0.0 ounces ethanol daily; light drinkers, 0.01–0.21 ounces ethanol daily; moderate drinkers, 0.22–0.99 ounces ethanol daily; heavy drinkers, 1.00 or more ounces ethanol daily. A second measure of alcohol consumption is constructed based on the number of ounces of ethanol corresponding to the upper fifth percentile of the average daily ethanol consumption distribution. This measure, referred to as high consumption, conformed to a usual intake of five drinks per day (2.5 ounces of ethanol) in the present study.

Reliability of Alcohol Drinking Measures — In 1985 a pilot study was conducted of 150 veteran twin pairs born in the State of Connecticut. This pilot study was designed as a field test of the methodology to be used in the main study. The measures of alcohol drinking in the field test and the subsequent survey were identical. Because these 150 twin pairs were included in the main study using the Vietnam Era Twin Registry it is possible to evaluate the reliability of the five measures of alcohol drinking.

Complete alcohol drinking data were available from 191 individuals from both studies. Lifetime abstention had a kappa of 0.43, a Yule's Y[17] of 0.77, and a 97 percent overall agreement. Considerably less reliable was the lifetime non-regular drinker measure, which had a kappa of 0.10, Y of 0.37, and a 82 percent overall agreement. The current abstainer measure had a kappa of 0.44, a Y of 0.48, and an overall agreement of 78 percent.

Both of the alcohol consumption measures demonstrated similar levels of reliability. Average daily ethanol consumption had a weighted kappa of 0.55; overall agreement was 81 percent. The measure of high consumption had a kappa of 0.57, a Y of 0.72 and an overall agreement of 92 percent.

Statistical Analysis

The analysis begins by randomly selecting one member of each monozygotic twin pair as the index twin and calculating the association between Southeast Asia service and combat exposure with each of the five alcohol drinking measures. This yields the association of Southeast Asia service and combat exposure with alcohol drinking, unadjusted for co-twin effects. Hypothesis testing for these contingency tables uses standard Chi-square methods and the Mantel extension to test for a linear trend in proportions when appropriate.[18]

The potential confounding effect of co-twin alcohol drinking on the association between index twin alcohol drinking and military service in Southeast Asia is addressed using a logistic regression model. In this model, index twin alcohol drinking is the dependent variable while co-twin alcohol drinking and index twin military service in Southeast Asia are the independent variables. The logistic regression model, adapted for twin data, provides an estimate of the probability of an index twin having an event (e.g., being a lifetime abstainer) based on the co-twin's event history and the index twin's service in Southeast Asia or combat exposure.[19] Hypothesis testing is conducted by dividing the logistic regression coefficient for Southeast Asia service or combat exposure (entered as a five level ordinal variable) by its respective standard error; when squared this follows a Chi-square distribution with one degree of freedom.

The potential confounding effects of demographic and military service factors were examined in a logistic regression model that already included co-twin alcohol drinking. Confounding factors include: years of education at enlistment, branch of service, length of active duty military service, age at enlistment, calendar year of discharge, and score on a general aptitude test taken at enlistment. These factors were examined both singly and in combination, and did not substantially alter the results from the co-twin adjusted analysis.

Results

Table 1 displays the nearly identical distribution of the three measures of alcohol abstention and the two measures of alcohol consumption for index twins and co-twins separately.

Table 2 displays the joint frequency distribution of the alcohol drinking measures with service in Southeast Asia and combat exposure for index twins. There is no evidence of a trend in the prevalence of lifetime abstention, lifetime non-regular drinking, and current abstaining with increasing levels of combat exposure. Conversely, veterans who served in Southeast Asia tend to consume more alcohol than

TABLE 1—Distribution of Alcohol Drinking Measures for Monozygotic Twin Pairs in the Vietnam Era Twin Registry

Alcohol Drinking Measures	Index Twin (n = 2,169) %	Co-Twin (n = 2,169) %
A. Lifetime Abstainer		
Yes	6.2	6.5
No	93.8	93.5
B. Lifetime Non-Regular Drinker		
Yes	24.2	24.9
No	75.8	75.1
C. Current Abstainer		
Yes	37.3	37.2
No	62.7	62.8
D. Average Daily Ethanol Consumption		
Abstainer	37.3	37.2
Low	19.8	20.8
Moderate	24.2	23.9
Heavy	18.7	18.2
E. High Consumption		
Yes	5.5	5.4
No	94.5	94.6

TABLE 2—Distribution of Alcohol Drinking Measures by Southeast Asia (SEA) Service and Combat Exposure in Monozygotic Index Twins

Alcohol Drinking Measures	Service in Southeast Asia: No (n = 1,340) %	Service in Southeast Asia: Yes (n = 829) %	Combat Exposure: Non SEA (n = 1,340) %	SEA No Combat (n = 196) %	SEA Low Combat (n = 222) %	SEA Med Combat (n = 245) %	SEA High Combat (n = 166) %
A. Lifetime Abstainer							
Yes	6.6	5.6	6.6	7.6	3.2	5.3	6.6
No	93.4	94.4	93.4	92.4	96.8	94.7	93.4
	(X^2 = 0.916, p = 0.339)			(X^2_{trend} = 0.835 with 1 d.f., p = 0.361)			
B. Lifetime Non-Regular Drinker							
Yes	24.6	23.4	24.6	28.6	22.1	20.0	24.1
No	75.4	76.6	75.4	71.4	77.9	80.0	75.9
	(X^2 = 0.419, p = 0.517)			(X^2_{trend} = 1.352 with 1 d.f., p = 0.245)			
C. Non-Current Drinker							
Yes	38.4	35.5	38.4	39.8	33.3	33.1	36.8
No	61.6	64.5	61.6	60.2	66.7	66.9	63.2
	(X^2 = 1.929, p = 0.165)			(X^2_{trend} = 2.395 with 1 d.f., p = 0.122)			
D. Average Daily Ethanol Consumption							
Abstainer	38.4	35.5	38.4	39.8	33.3	33.1	36.8
Light	19.6	20.1	19.6	21.9	22.5	16.7	19.9
Moderate	24.9	23.0	24.9	23.0	23.4	25.7	18.7
Heavy	17.0	21.4	17.0	15.3	20.7	24.5	24.7
	(X^2 = 3.738, p = 0.053)			(X^2_{trend} = 6.625 with 1 d.f., p = 0.010)			
E. High Consumption							
Yes	4.6	7.0	4.6	5.6	5.0	8.6	9.0
No	95.4	93.0	95.4	94.4	95.0	91.4	91.0
	(X^2 = 5.898, p = 0.015)			(X^2_{trend} = 9.320 with 1 d.f., p = 0.002)			

veterans who did not serve in Southeast Asia (p = 0.053). The prevalence of light and moderate consumption is similar regardless of where a veteran served, but there are 4.4 percent more Southeast Asia veterans than non-Southeast Asia veterans who are heavy alcohol consumers. The extent of combat exposure is directly associated with increased average daily ethanol consumption. Non-Southeast Asia veterans and Southeast Asia veterans who experienced no combat consume about the same amount of alcohol, but veterans who have been exposed to either medium or high combat are found to consume more alcohol. When high consumption is examined, a 2.4 percent excess of high consumers is found in Southeast Asia veterans compared to non-Southeast Asia veterans. Further, a nearly monotonic gradient is observed in the prevalence of high alcohol consumption with combat exposure.

The association of the five alcohol drinking measures with Southeast Asia service and combat exposure, after adjustment for co-twin effects, is displayed in Table 3. None of the three abstention measures as well as average daily ethanol consumption are associated with Southeast Asia service or combat exposure. However, of all index twins who served in Southeast Asia, 5.6 percent are classified as high consumers, compared to 3.9 percent of index twins who did not serve in Southeast Asia (p = 0.048). Similarly, the ordinal index of combat exposure remains positively correlated with the co-twin adjusted prevalence of index twins who are classified as high consumers (p = 0.034).

Discussion

Our results demonstrate a complex pattern of association between military service experience and alcohol drinking patterns. The abstention measures are not associated with military service experience in either the unadjusted or adjusted analysis. In the unadjusted analysis there is a strong relationship of both measures of alcohol consumption with Southeast Asia service and combat exposure. In the cotwin adjusted analysis, average daily ethanol consumption is no longer significantly related to service in Southeast Asia and combat exposure; the association of high consumption with Southeast Asia service and combat is substantially diminished.

What is the likelihood that our findings are due to bias? The principal biases that are likely to be operating in this study relate to uncontrolled confounding, non-response, and flaws in measurement due to the self-reporting of military service experience and alcohol drinking. The principal uncontrolled confounding factor in this study is the pattern of alcohol drinking prior to entering military service. We chose not to collect measures of pre-military service alcohol drinking because of the potential of biased recall. It seems highly probable that the recollection of alcohol drinking patterns 15 to 20 years ago might be influenced by whether a veteran served in Southeast Asia.

Non-response bias might distort our results if veterans who responded are systematically different from veterans who did not respond *and* this difference is related to both alcohol drinking and military service in Southeast Asia. To gain further insight into the possibility of non-response bias we compared the association of Southeast Asia service with demographic and military service confounding factors (years of education at enlistment, branch of service, length of active duty military service, age at enlistment, calendar year of discharge, and score of the general aptitude test taken at enlistment), in responders and nonresponders. This analysis revealed that the potential for bias exists for education at enlistment and age at enlistment. In particular, education at enlistment was directly related to the probability of Southeast Asia service in responders and inversely related to the

TABLE 3—Distribution of Alcohol Drinking Measures by Southeast Asia (SEA) Service and Combat Exposure in Monozygotic Index Twins Adjusted for Co-Twin Alcohol Drinking Measures

	Service in Southeast Asia		Combat Exposure				
	No	Yes	Non SEA	SEA No Combat	SEA Low Combat	SEA Med Combat	SEA High Combat
Alcohol Drinking Measures	%	%	%	%	%	%	%
A. Lifetime Abstainer							
Yes	4.1	3.9	4.1	4.1	4.0	3.9	3.9
No	95.9	96.1	95.9	95.9	96.0	96.1	96.1
	(X^2 = 0.07, p = 0.789)			(X^2 = 0.05 with 1 d.f., p = 0.815)			
B. Lifetime Non-Regular Drinker							
Yes	21.5	21.6	21.8	21.5	21.2	20.9	20.6
No	78.5	78.4	78.2	78.5	78.8	79.1	79.4
	(X^2 = 0.01, p = 0.934)			(X^2 = 0.200 with 1 d.f., p = 0.654)			
C. Non-Current Drinker							
Yes	36.8	34.9	36.8	36.1	35.3	34.5	33.7
No	63.2	65.1	63.2	63.9	64.7	65.5	66.3
	(X^2 = 0.72, p = 0.396)			(X^2 = 0.94 with 1 d.f., p = 0.333)			
D. Average Daily Ethanol Consumption							
Abstainer	35.0	33.1	35.2	34.2	33.2	32.2	31.2
Light	23.8	23.6	23.8	23.7	23.6	23.5	23.4
Moderate	26.7	27.7	26.6	27.2	27.7	28.2	28.7
Heavy	14.5	15.6	14.4	14.9	15.5	16.1	16.7
	(X^2 = 1.07, p = 0.301)			(X^2 = 2.29 with 1 d.f., p = 0.131)			
E. High Consumption							
Yes	3.9	5.6	4.0	4.5	5.2	5.9	6.7
No	96.1	94.4	96.0	95.5	94.8	94.1	93.3
	(X^2 = 3.89, p = 0.048)			(X^2 = 4.52 with 1 d.f., p = 0.034)			

probability of Southeast Asia service in non-responders. Likewise, there was no difference in Southeast Asia service by age at enlistment in responders, but in non-responders there was an increased probability of serving in Southeast Asia for veterans who enlisted after the age of 19.

Bias due to self-reported military service experiences is unlikely to provide an explanation for our results. The measurement of Southeast Asia service is in accord with Southeast Asia service as determined from the military record (kappa = 0.86). We have previously demonstrated that the index of combat exposure is reliable and valid.[15] Likewise, the five alcohol drinking measures used in this study demonstrated acceptable reliabilities.

It is difficult to relate our findings to previous research on alcohol drinking among Vietnam era veterans[7,8,11,20,21] because of the major methodological differences among studies. The definition of "exposed" and "unexposed" cohorts is highly variable across studies. Some compare Vietnam era veterans with non-veterans without any measure of actual service in Southeast Asia[22] while others compare combat exposed and non-exposed Southeast Asia veterans without any non-veteran comparison group.[20] Each of the studies uses a different set of indicators for alcohol drinking behavior, ranging from a diagnosis of alcohol abuse and dependence,[8] to measures of usual alcohol beverage consumption.[21] The time interval between exposure and the measurement of alcohol drinking behavior also displays great variability across studies. For example, Robins'[10] initial data collection took place within two years of discharge from active duty while Kulka, *et al*,[12] collected data more than 15 years following discharge. Finally, and perhaps most importantly, there are major differences in the way each study addresses the issue of confounding. If factors related to both military service and alcohol consumption are not adequately controlled in the study design or analysis, then the observed results could be wholly or partially confounded.

Boscarino,[21] using data collected in 1977, found a positive association between service in Southeast Asia and three measures of alcohol consumption (usual daily intake, heavy drinking during the past 30 days, and binge drinking). That study is especially troublesome since it failed to exclude females from the analysis and the confounder adjustment was based solely on demographic factors. In a recent study, the Centers for Disease Control[8] found an increased prevalence of alcohol abuse and dependence in Southeast Asia and combat exposed veterans compared with non-Southeast Asia veterans. That study controlled for potential confounders by restricting the study participants to male Army veterans and by matching Southeast Asia veterans to non-Southeast Asia veterans based on period of service and age. During the analysis numerous potential confounders were examined and found to have no effect. However, the analysis failed to account for familial alcohol drinking patterns.

Card[9] used a single question on heavy alcoholic beverage intake to compare an age-matched cohort of non-veterans, veterans who did not serve in Southeast Asia, and veterans who served in Southeast Asia. Using a complex research design that involved matching on over 50 premilitary service factors, she found no difference in the prevalence of heavy drinking according to service in Southeast Asia. Roth[11] found a small but significant association between military service in Southeast Asia and a composite measure of alcohol intake and problem drinking, after multi-factor adjustment; she found no association between combat exposure and the same composite drinking measure. Yager, *et al*,[7] using a slightly different measure of alcohol drinking in this same cohort, came to a different conclusion; neither an indicator of heavy daily alcohol consumption nor a problem drinking scale was related to service in Southeast Asia. A significant association was found between combat and a measure of heavy daily

consumption. These conflicting reports obtained from the same data decrease the credibility of both studies.

Based on our findings, and the inconsistent evidence from previous research, we conclude that service in Southeast Asia and exposure to combat have relatively modest long-term effects on the alcohol drinking patterns of Vietnam era veterans.

APPENDIX A

Eighteen Indicators of Combat Exposure

1. In an artillery unit which fired on the enemy
2. Flew in an aircraft (reconnaissance, or fixed wing F-14, B-52, etc.)
3. Flew helicopter attack gunships or medivacs
4. Stationed at a forward observation post
5. Tunnel rat checking enemy base camps
6. Served on river patrol or gunboat
7. Demolitions expert in the field
8. Assigned to graves and registration to retrieve dead bodies from the field
9. Served as a medic in combat
10. Received incoming fire
11. Encountered mines and booby traps
12. Received sniper or sapper fire
13. Unit patrol ambushed
14. Flew in aircraft (fixed wing or helicopters) and was shot down
15. Engaged VC and/or NVA in firefight
16. Saw Americans killed, and/or saw Vietnamese killed
17. Wounded
18. Captured by the enemy

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