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Air Force Health Study

An Epidemiologic Investigation of Health Effects in Air Force Personnel Following Exposure to Herbicides

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February 1990

VOLUME I

1987 Followup Examination Results
May 1987 to January 1990

Contract Number F41689-85-D-0010
SAIC Project Number: 1-813-X4-195/254/437/011/942

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION: Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S): USAFSAM-TR-90-2
6a. NAME OF PERFORMING ORGANIZATION: Science Applications International Corporation; 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION: Human Systems Division (HSD)
6c. ADDRESS (City, State, and ZIP Code): McLean, Virginia 22102	7b. ADDRESS (City, State, and ZIP Code): Brooks Air Force Base, Texas 78235-5301
8a. NAME OF FUNDING/SPONSORING ORGANIZATION; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: F41689-85-D-0010
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
65306F	2767	-----	0003

11. TITLE (Include Security Classification)
An Epidemiologic Investigation of Health Effects in Air Force Personnel Following Exposure to Herbicides. 1987 Followup Examination Results.

12. PERSONAL AUTHOR(S) W.F. Thomas, W.D. Grubbs, M.B. Lustik, R.H. Roegner, SAIC; T.G. Karrison, U. of C.; D.E. Williams, SCRF; W.H. Wolfe, J.E. Michalek, J.C. Miner, USAF.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Interim 1985-1987	FROM 5/87 TO 1/90	1990 February	1,452

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Phenoxy Herbicides	Dioxin
06	05		Herbicide Orange	Ranch Hand
			Morbidity	Air Force Health Study

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report represents the results of the health assessment of the 955 Ranch Hands and the 1,299 Comparisons who participated in the 1987 followup examination of the Air Force Health Study. The purpose of the study is to determine whether long-term health effects exist and can be attributed to occupational exposure to herbicides. The Ranch Hands continue to manifest slightly more abnormalities than the comparisons, although the results do not suggest an adverse effect due to exposure to herbicides and their dioxin contaminant. Reanalysis using dioxin body burden levels and continued medical surveillance are indicated. In summary, there is not sufficient evidence at this time to support a causal relationship between herbicide exposure and adverse health in the Ranch Hand group.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	Unclassified

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DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

NOTICE

This report presents the results of the 1987 followup of the Air Force Health Study, the third in a series of epidemiologic studies to investigate the health effects in Air Force personnel following exposure to herbicides. The results of the previous studies, the 1982 Baseline study and the 1985 followup study, were presented in the Baseline Morbidity Study Results (24 February 1984) and the Air Force Health Study First Followup Examination Results (15 July 1987). Given the relationship of the 1987 followup to the previous studies, portions of these documents have been reproduced or paraphrased in this report. In addition, portions of the Air Force Health Study Analytical Plan for the 1987 followup (14 October 1987) have been used in the development of this report. The purpose of this notice is to acknowledge the authors of these documents. No further references are made.

EXECUTIVE SUMMARY

1987 FOLLOWUP MORBIDITY REPORT

The Air Force Health Study is an epidemiologic investigation to determine whether adverse health effects exist and can be attributed to occupational exposure to Herbicide Orange. The study consists of mortality and morbidity components, based on a matched cohort design in a nonconcurrent prospective setting with followup studies. The Baseline study was conducted in 1982, and the first two followup morbidity studies were performed in 1985 and 1987. The purpose of this report is to present the results of the 1987 followup.

In the Baseline morbidity study, each living Ranch Hand was matched to the first living and compliant member of a randomly selected Comparison set based on age, race, and military occupation, producing an approximate 1:1 contrast. The Comparisons had served in numerous flying organizations that transported cargo to, from, and within Vietnam but were not involved in the aerial spraying of Herbicide Orange. All previous participants and refusals, newly located study members, and replacements (matched on reported health status) were invited. Eighty-four percent (995/1,188) of the eligible Ranch Hands and 77 percent (939/1,224) of the eligible Original Comparisons participated in the 1987 followup examination and questionnaire process. Participation among those who were fully compliant at Baseline was very high. Ninety-two percent of the Ranch Hands and 93 percent of the Comparisons who were fully compliant at Baseline also participated in the 1987 followup. In total, 2,294 study subjects, 995 Ranch Hands and 1,299 Comparisons, participated in the 1987 followup.

The followup study was conducted under contract to the Air Force by Science Applications International Corporation, in conjunction with the Scripps Clinic and Research Foundation and the National Opinion Research Center. Most of the data were collected through face-to-face interviews and physical examinations conducted at the Scripps Clinic in La Jolla, California. Other data sources included medical and military records and the 1982 and 1985 data bases. As a contract requirement, all data collection personnel were unaware of each participant's exposure status, and all phases of the study were monitored by stringent quality control. The statistical analyses were based on analysis of variance and covariance, chi-square tests, Fisher's exact tests, general linear models, logistic regression, proportional odds models, t-tests, and log-linear models, all of which were specified in an analytical plan written prior to data analysis.

The questionnaire and physical examination data were analyzed by major organ system. The primary focus was on the assessment of differences between the Ranch Hand and Comparison groups based on data from the 1987 followup. Additionally, dose-response relationships within the Ranch Hand group were examined, and longitudinal assessments of differences in the changes of the two groups between the examinations were conducted for selected variables.

In the analyses in this report, Ranch Hand exposure to dioxin was quantified by use of a calculated index based on the quantity of herbicides containing dioxin sprayed each month and the number of Ranch Hands assigned to each occupational category in those months. The statistical relationships between the evaluated conditions and the calculated index were assessed for

significance and patterns suggestive of dose-response. However, early results of serum dioxin studies in Ranch Hand personnel conducted at the Centers for Disease Control indicate the calculated index is not a good measure of actual dioxin exposure. Therefore, the results of analyses using the calculated exposure index should be interpreted with caution. A full report relating the serum assay results to the medical data contained in this report is expected in 1991.

The fixed size of the Ranch Hand cohort limits the ability of the study to detect group differences, particularly for the rare occurrences of soft tissue sarcoma and non-Hodgkin's lymphoma. The study has virtually no statistical power to detect low to moderate group differences for these malignancies. The study has good power to detect relative risks of 2.0 or more with respect to disease occurring at prevalences of at least 5 percent in the Comparison group, such as basal cell carcinoma.

Self-perception of health, appearance of illness or distress, relative age, and percent body fat were similar in the two groups. There has been a decline in the percentage of individuals reporting their health as fair or poor in both groups since the Baseline examination. A significantly greater percentage of Ranch Hands than Comparisons, however, had abnormal erythrocyte sedimentation rates. Only three participants (two Ranch Hands and one Comparison) had rates in excess of 100 mm/hr. The Comparison had lung cancer and died in early 1989. In neither of the Ranch Hands was a diagnosis established during the course of the 1987 followup. A significant difference was also detected at the 1985 followup examination, and it will be important to monitor the sedimentation rates in subsequent examinations.

For all verified neoplasms combined, Ranch Hands had a significantly greater frequency than the Comparisons. Ranch Hands also had a marginally significant greater frequency than the Comparisons when suspected neoplasms were included in the analysis. Because cancers fall into systemic or skin categories, group contrasts were performed within each category. Analyses restricted to systemic neoplasms revealed no significant differences between the Ranch Hands and Comparison groups. Focusing only on skin neoplasms, Ranch Hands had significantly or marginally significant higher frequencies for the following categories: all verified skin neoplasms, all verified and suspected skin neoplasms, all verified malignant skin neoplasms, and sun exposure-related malignant skin neoplasms. Significant group differences for the sun exposure-related malignant skin neoplasms are not surprising because approximately 90 percent of the participants with those neoplasms had verified basal cell carcinomas, and Ranch Hands had significant or marginally significant higher frequencies of verified basal cell carcinoma than the Comparisons.

The neurological assessment did not disclose significant findings detrimental to the health of the Ranch Hands, although several differences were noted. Of the six reported and verified neurological diseases and disorders, the only significant finding was that Ranch Hands had a higher incidence of hereditary and degenerative neurological diseases. Unadjusted analyses for the 30 physical examination variables showed marginally more balance/Romberg sign and coordination abnormalities in the Ranch Hand group than in the Comparison group. In the adjusted analyses, a significant difference in the relative risk for the cranial nerve index (without range of

motion) occurred with insecticide exposure. Stratified results showed that among those who had never been exposed to insecticides, significantly more Ranch Hands than Comparisons were abnormal on this index. Of those who had been exposed to insecticides, the percentage of abnormalities on this index was marginally higher in the Comparisons. The adjusted analysis for coordination detected two significant group-by-covariate interactions (group-by-occupation and group-by-insecticide exposure). Stratified analyses found a significant group difference for enlisted groundcrew after excluding the group-by-insecticide exposure interaction, and a significant adjusted group difference overall after excluding both group-by-covariate interactions. Ranch Hands had significantly more coordination abnormalities than Comparisons for each analysis. The trend of increasing abnormality in the enlisted groundcrew for coordination will be more fully evaluated in the analyses of serum 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) levels.

The psychological assessment was based on the analysis of 52 variables, which included reported illnesses verified by medical record review, reported sleep disorders, and scores from two clinical psychological tests. The results showed that significant or marginally significant differences between the Ranch Hands and the Comparisons were found for some verified psychological disorders, reported sleep disorders, and the self-administered Symptom Checklist-90-Revised and Millon Clinical Multiaxial Inventory psychological examinations. For these differences, the Ranch Hands generally manifested higher percentages of abnormalities or higher mean scores than the Comparisons. However, this is not surprising since individuals who perceive themselves as having been harmed might be more likely to report the symptoms found to be significant in this analysis. These results will be reexamined for positive correlations between the complaints and dioxin levels when the serum assay data become available. Additionally, significant group-by-covariate interactions were frequently observed in the adjusted analysis, which often made direct contrast of the two groups with adjustment for significant covariates difficult. The covariates of age, alcohol history, and presence of post-traumatic stress disorder showed strong effects on many of the psychological measurements. There was generally a lack of consistency in the findings of similar variables in the psychological tests.

The gastrointestinal assessment found no significant group difference for historical liver disease, historical and current ulcer, and current hepatomegaly. The Ranch Hand alkaline phosphatase mean was significantly higher than the Comparison mean, but group differences for the other laboratory examination variables (aspartate aminotransferase, alanine aminotransferase, gamma-glutamyl transpeptidase, total bilirubin, direct bilirubin, lactic dehydrogenase, cholesterol, high density lipoprotein [HDL], cholesterol-HDL ratio, triglycerides, creatine kinase, and fasting glucose) were not significant.

In the dermatologic assessment, no cases of chloracne were diagnosed. For participants with no history of acne before the start of the first Southeast Asia (SEA) tour, a greater percentage of Ranch Hands than Comparisons reported the occurrence of acne after the start of the first SEA tour. However, the anatomic pattern of these lesions was not suggestive of chloracne. No other significant group differences were detected in the remainder of the analyses. The exposure index and longitudinal analyses were also essentially negative; the few positive findings were inconsistent with

dose-response effects and the available knowledge of current serum TCDD levels in the Ranch Hand group.

The cardiovascular evaluation showed that the health of the two groups was similar for reported and verified heart disease and central cardiac function. With regard to peripheral vascular function, the Ranch Hands manifested a marginally higher mean diastolic blood pressure than the Comparisons, but the percentage of individuals with a diastolic blood pressure above 90 mm Hg was not significantly different in the two groups. The Ranch Hands had a marginally higher percentage of individuals with carotid bruits, and there were also significant, or marginally significant, differences with respect to femoral pulses, dorsalis pedis pulses, and three aggregates pulse indices (leg, peripheral, and all pulses), as assessed by manual palpation. Significantly more pulse abnormalities in the Ranch Hands were also found at Baseline, when pulses were measured by manual palpation, but not in the 1985 followup, when both manual and Doppler measurements were utilized.

In the hematologic evaluation, red blood cell count, hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration were not significantly different in the two groups. The mean white blood cell and platelet counts were significantly greater in the Ranch Hands than in the Comparisons, but the magnitude of the difference was small in each case. The difference in platelet counts was significant despite that in the longitudinal analysis of the changes from Baseline to the 1987 followup examination, platelet counts in the Ranch Hands decreased to a significantly greater degree than in the Comparisons. The percentage of individuals with abnormally high platelet counts was also significantly greater in the Ranch Hand group, but the relative risk was less than 2. In addition, no platelet count was elevated into a pathologic range. Exposure index analyses did not generally support dose-response relationships.

The groups did not differ significantly in reported history of kidney disease/stones or for urinary protein, urinary occult blood, urinary white blood cell count, blood urea nitrogen, or urine specific gravity based on unadjusted analyses. In the adjusted analyses, there was no pattern of results that suggested a detriment to either group.

For the endocrinologic assessment, the Ranch Hand thyroid stimulating hormone (TSH) mean was marginally significantly higher than the Comparison TSH mean, but results of the TSH discrete analyses did not show statistically significant group differences. Mean levels for triiodothyronine percent (T_3 %) uptake, testosterone, and 2-hour postprandial glucose were similar between groups. The percentage of abnormal levels for each of these variables, and the composite diabetes indicator, was higher for the Ranch Hand group than for the Comparison group, but none of these differences was statistically significant. Self-reported data on current thyroid function and past history of thyroid disease were similar between groups. Also, the percentages of participants with thyroid or testicular abnormalities diagnosed at the physical examination were not statistically different between groups. Overall, the endocrinologic health status of the Ranch Hand group does not appear substantially different from the Comparison group.

For the immunologic assessment of the 1987 followup, Ranch Hands and Comparisons did not differ on the cell surface markers, functional stimulation

tests, total lymphocyte counts, or quantitative immunoglobulins. Statistical analyses of the natural killer cell assay variables adjusting for covariate information were conducted within the Black and nonblack strata. These analyses showed that Black Ranch Hands had higher adjusted mean counts and average percent releases than the Black Comparisons for the natural killer assay measures. The meaning of this observation is unknown. Without adjusting for covariate information, significantly more Ranch Hands had a possibly abnormal reading on the composite skin reaction test than the Comparisons. Adjusting for covariate information resulted in performing group contrasts on the composite skin reaction variable within strata of the lifetime cigarette smoking history variable. For the heavier smoking participants, significantly more Ranch Hands had a possibly abnormal reading on the composite skin reaction test than the Comparisons. Within the other strata, there were no significant differences.

The pulmonary health of the two groups was reasonably similar based on the analyses without adjustment for covariates, although the Ranch Hands had significantly more thorax and lung abnormalities and marginally higher prevalence rates for hyperresonance. When significant interactions involving group were ignored, no significant differences were found in the adjusted analyses. Exploration of the interactions did not identify a consistent pattern. The adverse effects of smoking were evident in all analyses.

The process of inferring causality is complex and must be based on careful consideration of many factors. Any interpretations of the data must consider the biological plausibility, clinical significance, specificity and consistency of the findings, and a host of statistical factors, such as strength of the association, lack of independence of the measurements, and multiple testing. Based on direct and indirect evidence, it is concluded that this study is free of overt bias and the measurement systems used to obtain the data were accurate and valid.

In summary, there is not sufficient evidence at this time to implicate a causal relationship between herbicide exposure and adverse health in the Ranch Hand group. No cases of chloracne or porphyria cutanea tarda, the two most commonly accepted effects of dioxin exposure, were detected in this study. There was a single case of soft tissue sarcoma in each group and one case of non-Hodgkin's lymphoma in a Ranch Hand. The differences noted indicate that reanalysis using dioxin body burden levels and continued medical surveillance are warranted.

ACKNOWLEDGMENTS

The authors of the report gratefully acknowledge the outstanding support of all the contributors to this project. To all the individuals, named and unnamed, whose dedication and hard work over the past 3 years have made this report possible, the authors wish to express their sincere appreciation.

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CHAPTER 1

INTRODUCTION

This chapter briefly describes the background of the Air Force Health Study (AFHS) and provides an overview of the study design, the morbidity component, and the purpose of this report.

BACKGROUND

In January 1962, President John F. Kennedy approved a program of aerial herbicide dissemination, for the purpose of defoliation and crop destruction, in support of tactical military operations in the Republic of Vietnam (RVN). Under this program, code-named Operation Ranch Hand, approximately 19 million gallons of herbicides were dispersed on an estimated 10 to 20 percent of South Vietnam.[1,2] From 1962 to 1971, approximately 11 million gallons of Herbicide Orange, the primary defoliant of the six herbicides utilized in the program, were disseminated.

Operation Ranch Hand was the subject of intense scrutiny from the start due to the controversial nature of the program and political sensitivity to chemical warfare charges contained in enemy propaganda. The concerns, which were initially based on military, political, and ecological issues, shifted during 1977 to health issues. Numerous claims of exposure to herbicides, particularly Herbicide Orange and its dioxin contaminant, and subsequent adverse health effects among U.S. military service personnel have resulted in class action litigation and substantial controversy. Social concern for the Herbicide Orange issue continues to be manifest by continuing scientific research, media presentations, congressional hearings, and legal action.

The U.S. Air Force Medical Service's concern for the health of Air Force personnel exposed to herbicides was demonstrated in October 1978 when the Air Force Deputy Surgeon General made a commitment to Congress and to the White House to conduct a health study on the Ranch Hand personnel, the men who disseminated the majority of the defoliants in the RVN. The prevailing reasons for the study commitment included the availability of a definitive occupational exposure to herbicides, a sufficient sample size for survey and clinical research, the ability to ascertain the population at risk, and an opportunity for the Air Force Medical Corps to fulfill its adage "we care" to the Air Force community.

The Air Force School of Aerospace Medicine, Brooks Air Force Base, Texas, was tasked by the Surgeon General to develop the Study Protocol. In 1982, after extensive peer review, the epidemiologic study began, and the Protocol was published.[3]

Since 1978, numerous animal and human studies of dioxin effects have been planned or initiated by governmental agencies, universities, and industrial firms. The key scientific issue in these studies was the extent of exposure, e.g., who was exposed and how much each individual was exposed. Unfortunately, population identification and exposure estimation, which are critical for a valid study of ground troops, have been scientifically elusive.

It is believed that of all the military personnel who served in the RVN, the Ranch Hand population was the most highly exposed to herbicides. In 1987, the Air Force initiated a collaborative study with the Centers for Disease Control (CDC) to measure the serum dioxin levels in the AFHS morbidity population. The results of that study clearly demonstrate that substantially elevated levels of dioxin can still be found in the serum of some Ranch Hands, as opposed to the absence of elevated levels found in ground troups by CDC.[4,5] Based on the principle of dose-response, the Ranch Hands should manifest more and/or earlier evidence of adverse health. Thus, the results of the AFHS should serve as an indicator of herbicide effects in ground personnel.

STUDY DESIGN

The purpose of the study is to determine whether adverse health effects exist and can be attributed to occupational exposure to Herbicide Orange. The study, consisting of mortality and morbidity components, is based on a matched cohort design in a nonconcurrent prospective setting with followup studies. The interwoven study elements of multiple mortality assessments, a Baseline morbidity study, and five followup morbidity studies over 20 years provide a comprehensive approach to the detection of attributable adverse health effects. Complete details on the design are provided in the Study Protocol.

For the Baseline study, the population ascertainment process identified 1,264 Ranch Hand personnel who served in the RVN between 1962 and 1971. By the time the first followup began in 1985, an additional 9 Ranch Hands had been identified. Two years later for the second followup, four additional Ranch Hands were identified. A Comparison group was formed, consisting of individuals assigned to Air Force units operating C-130 cargo aircraft in Southeast Asia. Using a computerized nearest neighbor selection procedure, a maximum of 10 Comparisons was selected for each Ranch Hand, matching on age, race, and military occupation. After personnel record reviews, each Ranch Hand who was determined to be eligible and fully suitable for study had an average of 8.2 Comparison subjects.

The mortality component addresses mortality from the time of the RVN assignment. A Baseline mortality study was conducted in 1982, and the mortality followup consists of annual mortality updates for 20 years. For the Baseline study and the first four updates, five individuals were randomly selected from the matched Comparison set for each Ranch Hand for a 1:5 design. Subsequent to 1987, the design was expanded to include all of the individuals in the Comparison population.

The Baseline morbidity component, begun in 1982, reconstructed the medical history of each participant by reviewing and coding past medical records. A cross-sectional element, designed to assess the participant's current state of mental and physical health, was based on comprehensive questionnaires and physical examinations given to the participants. For this component of the study, each living Ranch Hand and the first living member of his Comparison set were selected to participate in the examination. Sequential questionnaires, medical record reviews, and physical examinations in 1985, 1987, 1992, 1997, and 2002 comprise the morbidity study followup.

MORBIDITY COMPONENT

The Baseline morbidity assessment, conducted in 1982, disclosed some differences between the Ranch Hands and Comparisons, but those differences were generally not traditional indicators of dioxin-related disease. The sustained commitment of Congress and the Air Force to pursue the Agent Orange question to its scientific conclusion was demonstrated by the conduct of the first two morbidity followups in 1985 and 1987. The first (1985) followup provided the first opportunity to confirm or refute some of the Baseline findings and to explore longitudinal changes. For the 1985 followup, the mental and physical health status of the participants during the 3-year interval since the Baseline study was assessed. The results of the 1985 followup approximated those of the Baseline examination; however, the Ranch Hands continued to manifest slightly more adverse health conditions than the Comparisons.

In 1987, the second followup was initiated. During a 2-1/2 year period, the data were collected, automated, and analyzed. The 1987 followup was conducted by Science Applications International Corporation (SAIC) in conjunction with Scripps Clinic and Research Foundation and National Opinion Research Center, working as a team with the Air Force.

PURPOSE

The 1987 morbidity followup is the subject of this report. The objective of the morbidity followup is to continue the investigation of the possible long-term health effects following exposure to herbicides containing 2,3,7,8-tetrachlorodibenzo-p-dioxin (or TCDD). This report describes the procedures and results of the second morbidity followup of the AFHS. Although the blood samples for the measurement of serum dioxin levels were collected during the 1987 followup, the results of this testing were not available for inclusion in this report.

This report is written primarily for clinical epidemiologists, clinicians, and biostatisticians so that they may fully evaluate the data and analytic techniques. Complete familiarity with the Study Protocol and prior mortality and morbidity reports is essential in the full understanding of this report. It should be noted that the intent of the background sections of the clinical chapters is to provide a broad overview of the literature with respect to dioxin endpoints. In addition, statistical analyses in this report were prescribed in an analytic plan developed prior to analysis of the 1987 followup data and are not ad hoc analyses. The report format has been established to be complete, rigorous, and straightforward on all issues. A summary of this report, more suited to the general reader, is available.

This report, prepared by SAIC, is submitted as partial fulfillment of Air Force Contract No. F41689-85-D-0010.

CHAPTER 1

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CHAPTER 2

POPULATION CHARACTERISTICS

This chapter describes the characteristics of the fully compliant study population of the 1987 Air Force Health Study (AFHS) followup.

INTRODUCTION

Eligibility of the Ranch Hands and candidate Comparisons was determined at Baseline through detailed searches of Air Force and other Government records. Except as noted in Chapter 5, participants were recruited for the 1987 followup in accordance with the Study Protocol.

For the Baseline study, all locatable Ranch Hands and the first living member of the randomly ordered Comparison set (who was matched to the corresponding Ranch Hand by age, race, and occupation) were invited to participate. The age groupings of born in or after 1942, born between 1923 and 1941, and born in or before 1922 were used for presentation in this report, corresponding to cutpoints of 40 and 60 years of age at the 1982 Baseline examination. A study subject was classified as officer, enlisted flyer, or enlisted groundcrew according to his Vietnam military occupation. If a Comparison refused or was unlocatable at Baseline, the next Comparison in the set was contacted and invited to participate.

In the 1985 followup, all study subjects invited to the Baseline study were recruited for the followup in addition to the newly verified and locatable Ranch Hands and their matched Comparisons. A Comparison who refused or was unlocatable was replaced by the next Comparison who had not been invited previously and whose self-perception of health was the same as the Comparison he replaced.

All participants contacted for enrollment at Baseline and the 1985 followup were recruited for the 1987 followup. Newly verified/located Ranch Hands and their matched Comparisons were invited to join the study. Due to noncompliance among the Comparisons, replacements from the previously uncontacted candidate Comparisons were selected for enrollment. As in the 1985 followup, replacements were matched on self-perception of health. The replacement strategy is summarized in Chapter 3. Selection and participation issues are discussed extensively in Chapter 5.

In the 1987 followup, there were 995 Ranch Hands and 1,299 Comparisons who completed the health interval questionnaire and physical examination. The data collected on these 2,294 participants are analyzed extensively in this report. This chapter contrasts the personal characteristics and habits of the Ranch Hands and Comparisons, with the results summarized in Table 2-1. Many of the variables examined are used as covariates in subsequent analyses of clinical endpoints.

Since participants could refuse to answer any question or refuse any portion of the examination, data could be missing for some participants. Thus, not all of the analyses summarized in Table 2-1 are based on 995 Ranch Hands and 1,299 Comparisons. The actual number of participants providing data on each variable is shown in the table.

TABLE 2-1.

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Matching Variables						
Age at Baseline (years) (discrete)	n	995		1,299		
	Number/%					
	Born >1942	405	40.7%	552	42.5%	0.617
	Born 1923-1941	555	55.8%	698	53.7%	
	Born <1922	35	3.5%	49	3.8%	
(continuous)	Mean	$\bar{x}$=43.88		$\bar{x}$=43.67		0.532
Race	n	995		1,299		
	Number/%					
	Nonblack	938	94.3%	1,219	93.8%	0.734
	Black	57	5.7%	80	6.2%	
Occupation	n	995		1,299		
	Number/%					
	Officer	379	38.1%	495	38.1%	0.842
	Enlisted Flyer	171	17.2%	212	16.3%	
	Enlisted Groundcrew	445	44.7%	592	45.6%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand	Group: Comparison	p-Value
Alcohol Variables				
Current Alcohol Use (drinks/day) (discrete)	n	990	1,298	
	Number/%			
	0-1	790 79.8%	1,026 79.0%	0.628
	>1-4	172 17.4%	226 17.4%	
	>4	28 2.8%	46 3.5%	
(continuous)	Mean	$\bar{x}$=0.74	$\bar{x}$=0.79	0.408
Lifetime Alcohol History (drink-years) (discrete)	n	985	1,296	
	Number/%			
	0	97 9.8%	108 8.3%	0.334
	>0-40	675 68.5%	885 68.3%	
	>40	213 21.6%	303 23.4%	
(continuous)	Mean	$\bar{x}$=30.88	$\bar{x}$=30.03	0.683
Current Wine Use (drinks/day) (discrete)	n	989	1,297	
	Number/%			
	Yes	382 38.6%	578 44.6%	0.005
	No	607 61.4%	719 55.4%	
(continuous)	Mean	$\bar{x}$=0.10	$\bar{x}$=0.11	0.620

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Lifetime Wine History (drink-years) (discrete)	n	989		1,296		
	Number/%					
	0	528	53.4%	627	48.4%	0.037
	>0-10	416	42.1%	615	47.5%	
	>10	45	4.6%	54	4.2%	
(continuous)	Mean	$\bar{x}$=2.18		$\bar{x}$=1.96		0.469
Smoking Variables						
Current Cigarette Smoking (cigarettes/day) (discrete)	n	995		1,299		
	Number/%					
	0-Never	266	26.7%	362	27.9%	0.086
	0-Former	372	37.4%	535	41.2%	
	>0-20	181	18.2%	209	16.1%	
	>20	176	17.7%	193	14.9%	
(continuous)	Mean	$\bar{x}$=9.1		$\bar{x}$=7.7		0.014
Lifetime Cigarette Smoking History (pack-years) (discrete)	n	995		1,299		
	Number/%					
	0	267	26.8%	362	27.9%	0.764
	>0-10	272	27.3%	361	27.8%	
	>10	456	45.8%	576	44.3%	
(continuous)	Mean	$\bar{x}$=15.0		$\bar{x}$=13.9		0.159

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Current Cigar Smoking	n	995		1,299		
	Number/%					
	Yes	238	23.9%	349	26.9%	0.120
	No	757	76.1%	950	73.1%	
Current Pipe Smoking	n	995		1,299		
	Number/%					
	Yes	43	4.3%	45	3.5%	0.342
	No	952	95.7%	1,254	96.5%	
History of Marijuana Use[a]	n	982		1,291		
	Number/%					
	Yes	266	27.1%	394	30.6%	0.294
	No	716	72.9%	897	69.4%	
Marijuana Use Within Past 30 Days[a]	n	986		1,294		
	Number/%					
	Yes	80	8.1%	126	9.8%	0.485
	No	906	91.9%	1,168	90.2%	
Sun Exposure-Related Variables						
Average Lifetime Residential Latitude[b]	n	936		1,213		
	Number/%					
	Latitude $<37°$	399	42.6%	609	50.2%	<0.001
	Latitude $\geq 37°$	537	57.4%	604	49.8%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Ethnic Background[b,c]	n	914		1,191		
	Number/%					
	A	686	75.1%	890	74.7%	0.530
	B	190	20.8%	238	20.0%	
	C	25	2.7%	34	2.9%	
	D	12	1.3%	28	2.4%	
	E	1	0.1%	1	0.1%	
Skin Color[b]	n	937		1,219		
	Number/%					
	Dark	1	0.1%	1	0.1%	0.557
	Medium	38	4.1%	35	2.9%	
	Pale	162	17.3%	208	17.1%	
	Dark Peach	514	54.9%	698	57.3%	
	Pale Peach	222	23.7%	277	22.7%	
Hair Color[b]	n	938		1,218		
	Number/%					
	Black	170	18.1%	257	21.1%	0.385
	Dark Brown	457	48.7%	574	47.1%	
	Light Brown	259	27.6%	317	26.0%	
	Blonde	47	5.0%	59	4.8%	
	Red	5	0.5%	11	0.9%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Eye Color[b]	n	937		1,217		
	Number/%					
	Brown	272	29.0%	375	30.8%	0.377
	Hazel	215	23.0%	240	19.7%	
	Green	51	5.4%	68	5.6%	
	Grey	43	4.6%	48	3.9%	
	Blue	356	38.0%	486	39.9%	
Reaction of Skin to Sun After at Least 2 Hours (Assuming several preceding episodes)[b]	n	938		1,218		
	Number/%					
	Burns Painfully	65	6.9%	75	6.2%	0.775
	Burns	118	12.6%	166	13.6%	
	Becomes Red	388	41.4%	512	42.0%	
	No Reaction	367	39.1%	465	38.2%	
Reaction of Skin to Sun After Repeated Exposure[b]	n	938		1,218		
	Number/%					
	Freckles With No Tan	18	1.9%	29	2.4%	0.494
	Tans Mildly	133	14.2%	186	15.3%	
	Tans Moderately	472	50.3%	628	51.6%	
	Tans Deep Brown	315	33.6%	375	30.8%	
Composite Sun Reaction Index[b,d]	n	938		1,217		
	Number/%					
	Low	696	74.2%	873	71.7%	0.259
	Medium	167	17.8%	251	20.6%	
	High	75	8.0%	93	7.6%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Carcinogen Exposure Variables						
Asbestos Exposure	n	995		1,299		
	Number/%					
	Yes	236	23.7%	334	25.7%	0.296
	No	759	76.3%	965	74.3%	
Ionizing Radiation Exposure	n	995		1,299		
	Number/%					
	Yes	199	20.0%	352	27.1%	<0.001
	No	796	80.0%	947	72.9%	
Herbicide Exposure	n	995		1,299		
	Number/%					
	Yes	935	94.0%	430	33.1%	<0.001
	No	60	6.0%	869	66.9%	
Insecticide Exposure	n	995		1,299		
	Number/%					
	Yes	716	72.0%	736	56.7%	<0.001
	No	279	28.0%	563	43.3%	
Industrial Chemical Exposure	n	995		1,299		
	Number/%					
	Yes	528	53.1%	731	56.3%	0.136
	No	467	46.9%	568	43.7%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group				p-Value
		Ranch Hand		Comparison		
Degreasing Chemical Exposure	n	995		1,299		
	Number/%					
	Yes	594	59.7%	785	60.4%	0.754
	No	401	40.3%	514	39.6%	
Anthracene Exposure	n	994		1,297		
	Number/%					
	Yes	1	0.1%	5	0.4%	0.368
	No	993	99.9%	1,292	99.6%	
Arsenic Exposure	n	994		1,297		
	Number/%					
	Yes	24	1.3%	17	2.4%	0.070
	No	970	98.7%	1,280	97.6%	
Benzene Exposure	n	995		1,298		
	Number/%					
	Yes	38	3.8%	42	3.2%	0.520
	No	957	96.2%	1,256	96.8%	
Benzidine Exposure	n	995		1,296		
	Number/%					
	Yes	10	1.0%	14	1.1%	0.999
	No	985	99.0%	1,282	98.9%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group		Group		p-Value
		Ranch Hand		Comparison		
Chromate Exposure	n	992		1,297		
	Number/%					
	Yes	60	6.0%	54	4.2%	0.052
	No	932	94.0%	1,243	95.8%	
Coal Tar Exposure	n	995		1,298		
	Number/%					
	Yes	32	3.2%	45	3.5%	0.834
	No	963	96.8%	1,253	96.5%	
Creosote Exposure	n	995		1,298		
	Number/%					
	Yes	86	8.6%	103	7.9%	0.592
	No	909	91.4%	1,195	92.1%	
Aminodiphenyl Exposure	n	995		1,296		
	Number/%					
	Yes	3	0.3%	4	0.3%	0.999
	No	992	99.7%	1,292	99.7%	
Chloromethyl Ether Exposure	n	993		1,298		
	Number/%					
	Yes	13	1.3%	19	1.5%	0.900
	No	980	98.7%	1,279	98.5%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Mustard Gas Exposure	n	995		1,298		
	Number/%					
	Yes	4	0.4%	7	0.5%	0.880
	No	991	99.6%	1,291	99.5%	
Naphthylamine Exposure	n	994		1,297		
	Number/%					
	Yes	36	3.6%	29	2.2%	0.064
	No	958	96.4%	1,268	97.8%	
Cutting Oil Exposure	n	995		1,298		
	Number/%					
	Yes	142	14.3%	156	12.0%	0.128
	No	853	85.7%	1,142	88.0%	
Trichloro-ethylene Exposure	n	990		1,297		
	Number/%					
	Yes	100	10.1%	130	10.0%	0.999
	No	890	89.9%	1,167	90.0%	
Ultraviolet (Not Sun) Light Exposure	n	995		1,297		
	Number/%					
	Yes	26	2.6%	33	2.5%	0.999
	No	969	97.4%	1,264	97.5%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Vinyl Chloride Exposure	n	994		1,297		
	Number/%					
	Yes	16	1.6%	18	1.4%	0.790
	No	978	98.4%	1,279	98.6%	
Composite Carcinogen Exposure	n	982		1,288		
	Number/%					
	Yes	267	27.2%	304	23.6%	0.058
	No	715	72.8%	984	76.4%	
Personal and Family Health Variables						
Cholesterol (mg/dl) (discrete)	n	994		1,297		
	Number/%					
	<200	334	33.6%	447	34.5%	0.844
	≥200-230	314	31.6%	413	31.8%	
	>230	346	34.8%	437	33.7%	
(continuous)	Mean	$\bar{x}$=218.40		$\bar{x}$=216.79		0.329
HDL (mg/dl) (discrete)	n	994		1,297		
	Number/%					
	<40	328	33.0%	397	30.6%	0.204
	≥40-50	336	33.8%	484	37.3%	
	>50	330	33.2%	416	32.1%	
(continuous)	Mean	$\bar{x}$=46.89		$\bar{x}$=46.99		0.845

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		p-Value
Cholesterol-HDL Ratio (discrete)	n	994		1,297		
	Number/%					
	<4.2	328	33.0%	453	34.9%	0.597
	≥4.2-5.5	356	35.8%	458	35.3%	
	>5.5	310	31.2%	386	29.8%	
(continuous)	Mean	$\bar{x}$=4.95		$\bar{x}$=4.88		0.270
Diabetic Class*	n	990		1,292		
	Number/%					
	Normal	750	75.8%	995	77.0%	0.782
	Impaired	142	14.3%	176	13.6%	
	Diabetic	98	9.9%	121	9.4%	
Differential Cortisol Response (1985) (mg/dl) (discrete)	n	960		1,223		
	Number/%					
	<0.6	317	33.0%	413	33.8%	0.182
	≥0.6-4.0	349	36.4%	409	32.8%	
	>4.0	294	30.6%	401	33.4%	
(continuous)	Mean	$\bar{x}$=2.30		$\bar{x}$=2.49		0.265
Percent Body Fat (discrete)	n	995		1,299		
	Number/%					
	Lean/Normal: ≤25%	803	80.7%	1,012	77.9%	0.113
	Obese: >25%	192	19.3%	287	22.1%	
(continuous)	Mean	$\bar{x}$=21.46		$\bar{x}$=21.67		0.335