

Air Force Health Study

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

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<p>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.</p>						
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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.

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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.

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 troops 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.

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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		p-Value
		Ranch Hand	Comparison	
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		p-Value
		Ranch Hand	Comparison	
Alcohol Variables				
Current Alcohol Use (drinks/day) (discrete)	n Number/% 0-1 >1-4 >4	990 790 79.8% 172 17.4% 28 2.8%	1,298 1,026 79.0% 226 17.4% 46 3.5%	0.628
(continuous)	Mean	$\bar{x}=0.74$	$\bar{x}=0.79$	0.408
Lifetime Alcohol History (drink-years) (discrete)	n Number/% 0 >0-40 >40	985 97 9.8% 675 68.5% 213 21.6%	1,296 108 8.3% 885 68.3% 303 23.4%	0.334
(continuous)	Mean	$\bar{x}=30.88$	$\bar{x}=30.03$	0.683
Current Wine Use (drinks/day) (discrete)	n Number/% Yes No	989 382 38.6% 607 61.4%	1,297 578 44.6% 719 55.4%	0.005
(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		p-Value
		Ranch Hand	Comparison	
Lifetime Wine History (drink-years) (discrete)	n Number/% 0 >0-10 >10	989 528 53.4% 416 42.1% 45 4.6%	1,296 627 48.4% 615 47.5% 54 4.2%	0.037
(continuous)	Mean	$\bar{x}=2.18$	$\bar{x}=1.96$	0.469
Smoking Variables				
Current Cigarette Smoking (cigarettes/day) (discrete)	n Number/% 0-Never 0-Former >0-20 >20	995 266 26.7% 372 37.4% 181 18.2% 176 17.7%	1,299 362 27.9% 535 41.2% 209 16.1% 193 14.9%	0.086
(continuous)	Mean	$\bar{x}=9.1$	$\bar{x}=7.7$	0.014
Lifetime Cigarette Smoking History (pack-years) (discrete)	n Number/% 0 >0-10 >10	995 267 26.8% 272 27.3% 456 45.8%	1,299 362 27.9% 361 27.8% 576 44.3%	0.764
(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				p-Value
		Ranch Hand		Comparison		
Current Cigar Smoking	n	995		1,299		0.120
	Number/%					
	Yes	238	23.9%	349	26.9%	
	No	757	76.1%	950	73.1%	
Current Pipe Smoking	n	995		1,299		0.342
	Number/%					
	Yes	43	4.3%	45	3.5%	
	No	952	95.7%	1,254	96.5%	
History of Marijuana Use ^a	n	982		1,291		0.294
	Number/%					
	Yes	266	27.1%	394	30.6%	
	No	716	72.9%	897	69.4%	
Marijuana Use Within Past 30 Days ^a	n	986		1,294		0.485
	Number/%					
	Yes	80	8.1%	126	9.8%	
	No	906	91.9%	1,168	90.2%	
<u>Sun Exposure-Related Variables</u>						
Average Lifetime Residential Latitude ^b	n	936		1,213		<0.001
	Number/%					
	Latitude <37°	399	42.6%	609	50.2%	
	Latitude ≥37°	537	57.4%	604	49.8%	

TABLE 2-1. (continued)
Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group		p-Value
		Ranch Hand	Comparison	
Ethnic Background ^{b, c}	n	914	1,191	0.530
	Number/%			
	A	686 75.1%	890 74.7%	
	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	0.557
	Number/%			
	Dark	1 0.1%	1 0.1%	
	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	0.385
	Number/%			
	Black	170 18.1%	257 21.1%	
	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		p-Value
		Ranch Hand	Comparison	
Eye Color ^b	n	937	1,217	0.377
	Number/%			
	Brown	272 29.0%	375 30.8%	
	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 (Assum- ing several preceding epi- sodes) ^b	n	938	1,218	0.775
	Number/%			
	Burns Painfully	65 6.9%	75 6.2%	
	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	0.494
	Number/%			
	Freckles With No Tan	18 1.9%	29 2.4%	
	Tans Mildly	133 14.2%	186 15.3%	
	Tans Moderately	472 50.3%	628 51.6%	
Composite Sun Reaction Index ^{b,d}	n	938	1,217	0.259
	Number/%			
	Low	696 74.2%	873 71.7%	
	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				p-Value
		Ranch Hand		Comparison		
Carcinogen Exposure Variables						
Asbestos Exposure	n	995		1,299		0.296
	Number/%					
	Yes	236	23.7%	334	25.7%	
	No	759	76.3%	965	74.3%	
Ionizing Radiation Exposure	n	995		1,299		<0.001
	Number/%					
	Yes	199	20.0%	352	27.1%	
	No	796	80.0%	947	72.9%	
Herbicide Exposure	n	995		1,299		<0.001
	Number/%					
	Yes	935	94.0%	430	33.1%	
	No	60	6.0%	869	66.9%	
Insecticide Exposure	n	995		1,299		<0.001
	Number/%					
	Yes	716	72.0%	736	56.7%	
	No	279	28.0%	563	43.3%	
Industrial Chemical Exposure	n	995		1,299		0.136
	Number/%					
	Yes	528	53.1%	731	56.3%	
	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 Number/% Yes No	995		1,299		0.754
		594	59.7%	785	60.4%	
		401	40.3%	514	39.6%	
Anthracene Exposure	n Number/% Yes No	994		1,297		0.368
		1	0.1%	5	0.4%	
		993	99.9%	1,292	99.6%	
Arsenic Exposure	n Number/% Yes No	994		1,297		0.070
		24	1.3%	17	2.4%	
		970	98.7%	1,280	97.6%	
Benzene Exposure	n Number/% Yes No	995		1,298		0.520
		38	3.8%	42	3.2%	
		957	96.2%	1,256	96.8%	
Benzidine Exposure	n Number/% Yes No	995		1,296		0.999
		10	1.0%	14	1.1%	
		985	99.0%	1,282	98.9%	

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

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

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

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

TABLE 2-1. (continued)

Analysis of Personal Characteristics and Habits by Group

Variable	Statistic	Group				p-Value
		Ranch Hand		Comparison		
Vinyl Chloride Exposure	n Number/% Yes No	994 16 978	 1.6% 98.4%	1,297 18 1,279	 1.4% 98.6%	0.790
Composite Carcinogen Exposure	n Number/% Yes No	982 267 715	 27.2% 72.8%	1,288 304 984	 23.6% 76.4%	
Personal and Family Health Variables						
Cholesterol (mg/dl) (discrete)	n Number/% <200 >200-230 >230	994 334 314 346	 33.6% 31.6% 34.8%	1,297 447 413 437	 34.5% 31.8% 33.7%	0.844
(continuous)	Mean	\bar{x} =218.40		\bar{x} =216.79		
HDL (mg/dl) (discrete)	n Number/% <40 >40-50 >50	994 328 336 330	 33.0% 33.8% 33.2%	1,297 397 484 416	 30.6% 37.3% 32.1%	0.204
(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		p-Value
		Ranch Hand	Comparison	
Cholesterol-HDL Ratio (discrete)	n	994	1,297	0.597
	Number/%			
	<4.2	328 33.0%	453 34.9%	
	>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	0.782
	Number/%			
	Normal	750 75.8%	995 77.0%	
	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	0.182
	Number/%			
	<0.6	317 33.0%	413 33.8%	
	>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	0.113
	Number/%			
	Lean/Normal: <25%	803 80.7%	1,012 77.9%	
	Obese: >25%	192 19.3%	287 22.1%	
(continuous)	Mean	$\bar{x}=21.46$	$\bar{x}=21.67$	0.335