

# AIR FORCE HEALTH STUDY

## SUPPLEMENTAL REPORT

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

### 1997 Follow-up Examination Results

### Investigation of Other Neuroses and Other Liver Disorders

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# 1 OTHER NEUROSES ASSESSMENT

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## 1.1 INTRODUCTION

### 1.1.1 Background

The Final Report (1) for the 1997 follow-up of the Air Force Health Study (AFHS) revealed a significant relation between a dependent variable named “other neuroses” and herbicide or dioxin exposure. In particular, for enlisted groundcrew in Model 1 analyses, Ranch Hands had a greater prevalence of other neuroses than Comparisons (64.7% versus 57.1%, Adj. RR=1.44, p=0.011). A significant relation in the prevalence of other neuroses also was seen between Ranch Hands in the low dioxin category and Comparisons in Model 3 analyses (60.3% versus 53.0%, Adj. RR=1.37, p=0.036). The relation in the prevalence of other neuroses between Ranch Hands in the high dioxin category and Comparisons was significant in the unadjusted analysis (Est. RR=1.48, p=0.008), but nonsignificant after adjustment for covariates (p=0.286) in Model 3 analyses. The relation in the prevalence of other neuroses between Ranch Hands in the low plus high dioxin category and Comparisons was significant (Adj. RR=1.27, p=0.038) in Model 3 analyses. The relation between 1987 dioxin and the prevalence of other neuroses in Ranch Hands was significant in the unadjusted Model 4 analysis (Est. RR=1.20, p<0.001), but nonsignificant after adjustment for covariates (p=0.763).

The purpose of this chapter is to categorize the “other neuroses” dependent variable into International Classification of Diseases, 9<sup>th</sup> revision, Clinical Modification (ICD-9-CM) categories and subcategories, and to examine each of the ICD-9-CM categories separately.

### 1.1.2 Parameters for the Other Neuroses Assessment

#### 1.1.2.1 *Dependent Variables*

At the health interview during the 1997 examination, each participant was asked whether he had a mental or emotional disorder since the date of his last interview. Reported disorders for which treatment was obtained were subsequently verified by a medical records review. Information on verified psychological disorders from the 1997 examination was combined with information on verified disorders from the baseline and 1985, 1987, and 1992 follow-up examinations. The “other neuroses” dependent variable included ICD-9-CM codes 300.10–302.9, 305.00–305.03, 305.20–309.9, and 311.

The “other neuroses” dependent variable was divided into 16 categories and subcategories:

- Hysteria (ICD-9-CM 300.1)
- Phobic disorders (ICD-9-CM 300.2)
- Obsessive-compulsive disorders (ICD-9-CM 300.3)
- Neurotic depression (ICD-9-CM 300.4)
- Neurasthenia (ICD-9-CM 300.5)
- Hypochondriasis (ICD-9-CM 300.7)
- Other neurotic disorders (ICD-9-CM 300.8)
- Unspecified neurotic disorder (ICD-9-CM 300.9)

- Personality disorder (ICD-9-CM 301)
- Sexual deviation and disorder (ICD-9-CM 302)
- Nondependent abuse of drugs (ICD-9-CM 305)
- Physiological malfunction arising from mental factors (ICD-9-CM 306)
- Special symptoms or syndromes not elsewhere classified (ICD-9-CM 307)
- Acute reaction to stress (ICD-9-CM 308)
- Adjustment reaction (ICD-9-CM 309)
- Depressive disorder not elsewhere classified (ICD-9-CM 311).

Based on the categories found in the Diagnostic and Statistical Manual of Mental Disorders (Third Edition) (2) and because of a sparse number of abnormalities, the subcategories corresponding to ICD-9-CM codes 300.1–300.9 were combined into one dependent variable named “neurotic disorder” for the purposes of statistical analysis. All other categories listed above (ICD-9-CM codes 301–311) were analyzed as separate dependent variables.

Participants with a verified pre-Southeast Asia (SEA) history of a psychological disorder were excluded from the analyses pertaining to that disorder. In addition, participants who tested positive for the human immunodeficiency virus (HIV) were excluded from all analyses of these dependent variables.

#### *1.1.2.2 Covariates*

Covariates examined in the adjusted statistical analyses of the psychological assessment included age, race, military occupation, education level (high school, college), lifetime alcohol history (drink-years), current total household income, current employment (yes, no), current marital status (married, not married), and current parental status (currently having a child under the age of 18: yes, no). Age, race, and military occupation were determined from military records. Current total household income information was collected in the questionnaire in categories with \$5,000 increments, between \$5,000 and \$100,000. The midpoint of each category was used as the current total household income, with \$102,500 used for the \$100,000 or more category. Educational level, current employment, current parental status, and current marital status were all based on self-reported information from the questionnaire.

Lifetime alcohol history was based on information from the 1997 questionnaire and combined with similar information gathered at the 1987 and 1992 follow-up examinations. Each participant was asked about his drinking patterns throughout his lifetime. When a participant’s drinking patterns changed, he was asked to describe how his alcohol consumption differed and the duration of time that the drinking pattern lasted. The participant’s average daily alcohol consumption was determined for each of the reported drinking pattern periods throughout his lifetime, and an estimate of the corresponding total number of drink-years was derived. One drink-year was the equivalent of drinking 1.5 ounces of an 80-proof alcoholic beverage, one 12-ounce beer, or one 5-ounce glass of wine per day for 1 year.

The covariates current total household income, current employment, current marital status, and current parental status were used in the analysis of these dependent variables. Although these dependent variables capture a history of the condition, and the covariates described above were based on the current status of a participant’s life, the covariates were used as surrogate information to describe the participant’s life experience.

### 1.1.3 Statistical Methods

Table 1-1 summarizes the statistical analyses performed for the assessment of the categorization of the dependent variable named “other neuroses.” The first part of this table lists the dependent variables analyzed, data source, data form, cutpoints, covariates, and statistical analysis methods. The second part of this table provides a description of covariates examined. A covariate was used in its continuous form whenever possible for all adjusted analyses; if the covariate is inherently discrete, the covariate was categorized as shown in Table 1-1.

**Table 1-1. Statistical Analysis for the Categorization of Other Neuroses**

**Dependent Variables**

Variable (Units)	Data Source	Data Form	Cutpoints	Covariates <sup>a</sup>	Exclusions <sup>b</sup>	Statistical Analysis and Methods
Neurotic Disorder (ICD-9-CM 300)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Personality Disorder (ICD-9-CM 301)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Sexual Deviation and Disorder (ICD-9-CM 302)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Nondependent Abuse of Drugs (ICD-9-CM 305)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Physiological Malfunctioning Arising from Mental Factors (ICD-9-CM 306)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Special Symptoms or Syndromes Not Elsewhere Classified (ICD-9-CM 307)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Acute Reaction to Stress (ICD-9-CM 308)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Adjustment Reaction (ICD-9-CM 309)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Depressive Disorder Not Elsewhere Classified (ICD-9-CM 311)	MR-V	D	Yes No	(1)	(a)	U:LR A:LR

<sup>a</sup>Covariates:

(1): age, race, military occupation, education, lifetime alcohol history, current total household income, current employment, current marital status, current parental status.

<sup>b</sup>Exclusions:

(a): participants with a pre-SEA history of the disorder, participants testing positive for HIV.

**Table 1-1. Statistical Analysis for the Categorization of Other Neuroses (Continued)**

**Covariates**

Variable (Units)	Data Source	Data Form	Cutpoints
Age (years)	MIL	C	--
Race	MIL	D	Black Non-Black
Occupation	MIL	D	Officer Enlisted Flyer Enlisted Groundcrew
Education	Q-SR	D	College High School
Lifetime Alcohol History (drink-years)	Q-SR	C	--
Current Total Household Income (dollars)	Q-SR	C	--
Current Employment	Q-SR	D	Yes No
Current Marital Status	Q-SR	D	Married Not Married
Current Parental Status	Q-SR	D	Child <18 years old No child <18 years old

**Abbreviations**

Data Source: MIL: Air Force military records  
 MR-V: Medical records (verified)  
 Q-SR: Health questionnaires (self-reported)

Data Form: D: Discrete analysis  
 C: Continuous analysis

Statistical Analysis: U: Unadjusted analysis  
 A: Adjusted analysis

Statistical Methods: LR: Logistic regression analysis

## 1.2 RESULTS

### 1.2.1 Summary Statistics for Other Neuroses by ICD-9-CM Category or Subcategory

Table 1-2 presents summary statistics for neuroses classified by the 16 ICD-9-CM categories or subcategories. The summary statistics are further presented by group (Ranch Hand, Comparison) and military occupation (officer, enlisted flyer, enlisted groundcrew) and include sample size (n) and the number and percentage of participants with the specific neurosis.

**Table 1-2. Frequencies of Other Neuroses by ICD-9-CM Classification**

Neurosis (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%)
				Yes
Hysteria (ICD-9-CM 300.1)	<i>All</i>	<i>Ranch Hand</i>	<b>867</b>	<b>2 (0.2)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>3 (0.2)</b>
	Officer	Ranch Hand	341	0 (0.0)
		Comparison	493	1 (0.2)
	Enlisted Flyer	Ranch Hand	151	1 (0.7)
		Comparison	187	1 (0.5)
	Enlisted Groundcrew	Ranch Hand	375	1 (0.3)
		Comparison	569	1 (0.2)
Phobic Disorders (ICD-9-CM 300.2)	<i>All</i>	<i>Ranch Hand</i>	<b>867</b>	<b>12 (1.4)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>27 (2.2)</b>
	Officer	Ranch Hand	341	4 (1.2)
		Comparison	493	6 (1.2)
	Enlisted Flyer	Ranch Hand	151	3 (2.0)
		Comparison	187	6 (3.2)
	Enlisted Groundcrew	Ranch Hand	375	5 (1.3)
		Comparison	569	15 (2.6)
Obsessive-Compulsive Disorders (ICD-9-CM 300.3)	<i>All</i>	<i>Ranch Hand</i>	<b>867</b>	<b>12 (1.4)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>16 (1.3)</b>
	Officer	Ranch Hand	341	6 (1.8)
		Comparison	493	10 (2.0)
	Enlisted Flyer	Ranch Hand	151	1 (0.7)
		Comparison	187	2 (1.1)
	Enlisted Groundcrew	Ranch Hand	375	5 (1.3)
		Comparison	569	4 (0.7)

**Table 1-2. Frequencies of Other Neuroses by ICD-9-CM Classification (Continued)**

Neurosis (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%) Yes
Neurotic Depression (ICD-9-CM 300.4)	<i>All</i>	<i>Ranch Hand</i>	<b>866</b>	<b>51 (5.9)</b>
		<i>Comparison</i>	<b>1,246</b>	<b>71 (5.7)</b>
	Officer	Ranch Hand	341	15 (4.4)
		Comparison	493	23 (4.7)
	Enlisted Flyer	Ranch Hand	151	8 (5.3)
		Comparison	187	15 (8.0)
	Enlisted Groundcrew	Ranch Hand	374	28 (7.5)
		Comparison	566	33 (5.8)
Neurasthenia (ICD-9-CM 300.5)	<i>All</i>	<i>Ranch Hand</i>	<b>867</b>	<b>1 (0.1)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>1 (0.1)</b>
	Officer	Ranch Hand	341	0 (0.0)
		Comparison	493	0 (0.0)
	Enlisted Flyer	Ranch Hand	151	0 (0.0)
		Comparison	187	1 (0.5)
	Enlisted Groundcrew	Ranch Hand	375	1 (0.3)
		Comparison	569	0 (0.0)
Hypochondriasis (ICD-9-CM 300.7)	<i>All</i>	<i>Ranch Hand</i>	<b>867</b>	<b>2 (0.2)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>1 (0.1)</b>
	Officer	Ranch Hand	341	0 (0.0)
		Comparison	493	0 (0.0)
	Enlisted Flyer	Ranch Hand	151	0 (0.0)
		Comparison	187	0 (0.0)
	Enlisted Groundcrew	Ranch Hand	375	2 (0.5)
		Comparison	569	1 (0.2)
Other Neurotic Disorders (ICD-9-CM 300.8)	<i>All</i>	<i>Ranch Hand</i>	<b>867</b>	<b>2 (0.2)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>1 (0.1)</b>
	Officer	Ranch Hand	341	1 (0.3)
		Comparison	493	1 (0.2)
	Enlisted Flyer	Ranch Hand	151	0 (0.0)
		Comparison	187	0 (0.0)
	Enlisted Groundcrew	Ranch Hand	375	1 (0.3)
		Comparison	569	0 (0.0)

**Table 1-2. Frequencies of Other Neuroses by ICD-9-CM Classification (Continued)**

Neurosis (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%) Yes
Unspecified Neurotic Disorder (ICD-9-CM 300.9)	<i>All</i>	<i>Ranch Hand</i>	<b>864</b>	<b>18 (2.1)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>18 (1.4)</b>
	Officer	Ranch Hand	340	4 (1.2)
		Comparison	493	6 (1.2)
	Enlisted Flyer	Ranch Hand	150	7 (4.7)
		Comparison	187	1 (0.5)
	Enlisted Groundcrew	Ranch Hand	374	7 (1.9)
		Comparison	569	11 (1.9)
Personality Disorder (ICD-9-CM 301)	<i>All</i>	<i>Ranch Hand</i>	<b>866</b>	<b>7 (0.8)</b>
		<i>Comparison</i>	<b>1,248</b>	<b>17 (1.4)</b>
	Officer	Ranch Hand	341	1 (0.3)
		Comparison	493	3 (0.6)
	Enlisted Flyer	Ranch Hand	151	1 (0.7)
		Comparison	186	3 (1.6)
	Enlisted Groundcrew	Ranch Hand	374	5 (1.3)
		Comparison	569	11 (1.9)
Sexual Deviations and Disorders (ICD-9-CM 302)	<i>All</i>	<i>Ranch Hand</i>	<b>866</b>	<b>26 (3.0)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>22 (1.8)</b>
	Officer	Ranch Hand	340	10 (2.9)
		Comparison	493	12 (2.4)
	Enlisted Flyer	Ranch Hand	151	5 (3.3)
		Comparison	187	1 (0.5)
	Enlisted Groundcrew	Ranch Hand	375	11 (2.9)
		Comparison	569	9 (1.6)
Nondependent Abuse of Drugs (ICD-9-CM 305)	<i>All</i>	<i>Ranch Hand</i>	<b>866</b>	<b>43 (5.0)</b>
		<i>Comparison</i>	<b>1,249</b>	<b>66 (5.3)</b>
	Officer	Ranch Hand	341	16 (4.7)
		Comparison	493	26 (5.3)
	Enlisted Flyer	Ranch Hand	151	4 (2.6)
		Comparison	187	14 (7.5)
	Enlisted Groundcrew	Ranch Hand	374	23 (6.1)
		Comparison	569	26 (4.6)

**Table 1-2. Frequencies of Other Neuroses by ICD-9-CM Classification (Continued)**

Neurosis (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%) Yes
Physiological Malfunction Arising from Mental Factors (ICD-9-CM 306)	<i>All</i>	<b><i>Ranch Hand</i></b>	<b>865</b>	<b>116 (13.4)</b>
		<b><i>Comparison</i></b>	<b>1,247</b>	<b>163 (13.1)</b>
	Officer	Ranch Hand	340	33 (9.7)
		Comparison	493	42 (8.5)
	Enlisted Flyer	Ranch Hand	151	25 (16.6)
Comparison		187	29 (15.5)	
Enlisted Groundcrew	Ranch Hand	374	58 (15.5)	
	Comparison	567	92 (16.2)	
Special Symptoms or Syndromes Not Elsewhere Classified (ICD-9-CM 307)	<i>All</i>	<b><i>Ranch Hand</i></b>	<b>866</b>	<b>16 (1.8)</b>
		<b><i>Comparison</i></b>	<b>1,248</b>	<b>18 (1.4)</b>
	Officer	Ranch Hand	341	2 (0.6)
		Comparison	492	6 (1.2)
	Enlisted Flyer	Ranch Hand	150	5 (3.3)
Comparison		187	5 (2.7)	
Enlisted Groundcrew	Ranch Hand	375	9 (2.4)	
	Comparison	569	7 (1.2)	
Acute Reaction to Stress (ICD-9-CM 308)	<i>All</i>	<b><i>Ranch Hand</i></b>	<b>867</b>	<b>49 (5.7)</b>
		<b><i>Comparison</i></b>	<b>1,248</b>	<b>73 (5.8)</b>
	Officer	Ranch Hand	341	9 (2.6)
		Comparison	492	25 (5.1)
	Enlisted Flyer	Ranch Hand	151	12 (7.9)
Comparison		187	8 (4.3)	
Enlisted Groundcrew	Ranch Hand	375	28 (7.5)	
	Comparison	569	40 (7.0)	
Adjustment Reaction (ICD-9-CM 309)	<i>All</i>	<b><i>Ranch Hand</i></b>	<b>867</b>	<b>14 (1.6)</b>
		<b><i>Comparison</i></b>	<b>1,248</b>	<b>14 (1.1)</b>
	Officer	Ranch Hand	341	4 (1.2)
		Comparison	493	6 (1.2)
	Enlisted Flyer	Ranch Hand	151	2 (1.3)
Comparison		186	1 (0.5)	
Enlisted Groundcrew	Ranch Hand	375	8 (2.1)	
	Comparison	569	7 (1.2)	

**Table 1-2. Frequencies of Other Neuroses by ICD-9-CM Classification (Continued)**

Neurosis (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%)
				Yes
Depressive Disorder Not Elsewhere Classified (ICD-9-CM 311)	<i>All</i>	<i>Ranch Hand</i>	865	96 (11.1)
		<i>Comparison</i>	1,249	149 (11.9)
	Officer	Ranch Hand	341	31 (9.1)
		Comparison	493	59 (12.0)
	Enlisted Flyer	Ranch Hand	151	19 (12.6)
		Comparison	187	25 (13.4)
	Enlisted Groundcrew	Ranch Hand	373	46 (12.3)
		Comparison	569	65 (11.4)

The largest category of other neuroses resulted from a physiological malfunction arising from mental factors (Ranch Hands: 13.4%, Comparisons: 13.1%). The physiological malfunctions included psychogenic physical symptoms and physiological manifestations. These neuroses were greater in enlisted personnel than in officers. Depressive disorders not elsewhere classified also showed a high prevalence (Ranch Hands: 11.1%, Comparisons: 11.9%).

### 1.2.2 Exposure Analysis

As described above, the subcategories corresponding to ICD-9-CM codes 300.1–300.9 were combined into one dependent variable named “neurotic disorder” for the purposes of statistical analysis. All other categories listed above (ICD-9-CM codes 301–311) were analyzed as separate dependent variables, which resulted in statistical analysis of nine dependent variables. The following section presents results of the statistical analyses of the dependent variables shown in Table 1-1.

Four models were examined for each dependent variable given in Table 1-1. The analyses of these models are presented below. Further details on dioxin and the modeling strategy are found in Chapters 2 and 7 of the Final Report (1) for the 1997 follow-up of the AFHS, respectively. These analyses were performed both unadjusted and adjusted for relevant covariates. Model 1 examined the relation between the dependent variable and group (i.e., Ranch Hand or Comparison). In this model, herbicide exposure was defined as “yes” for Ranch Hands and “no” for Comparisons without regard to the magnitude of the herbicide exposure. As an attempt to quantify exposure, three contrasts of Ranch Hands and Comparisons were performed along with the overall Ranch Hand versus Comparison contrast. These three contrasts compared Ranch Hands and Comparisons within each occupational category (i.e., officers, enlisted flyers, and enlisted groundcrew). As described in previous reports and Table 2-8 of the Final Report (1) for the 1997 follow-up of the AFHS, the average levels of dioxin were highest for enlisted groundcrew, followed by enlisted flyers, then officers.

Model 2 explored the relation between the dependent variable and an extrapolated initial dioxin measure for Ranch Hands who had a 1987 dioxin measurement greater than 10 parts per trillion (ppt). If a participant did not have a 1987 dioxin level, the 1992 level was used to estimate the initial dioxin level. If a participant did not have a 1987 or a 1992 dioxin level, the 1997 level was used to estimate the initial dioxin level. A statistical adjustment for the percentage of body fat at the time of the participant’s blood measurement of dioxin was included in this model to account for body-fat-related differences in elimination rate (3).

Model 3 divided the Ranch Hands examined in Model 2 into two categories based on their initial dioxin measures. These two categories are referred to as “low Ranch Hand” and “high Ranch Hand.” Two additional categories, Ranch Hands with 1987 serum dioxin levels at or below 10 ppt and Comparisons with 1987 serum dioxin levels at or below 10 ppt, were formed and included in the model. Ranch Hands with 1987 serum dioxin levels at or below 10 ppt are referred to as the “background Ranch Hand” category. Dioxin levels in 1992 were used if the 1987 level was not available, and dioxin levels in 1997 were used if the 1987 and 1992 levels were not available. These four categories—Comparisons, background Ranch Hands, low Ranch Hands, and high Ranch Hands—were used in Model 3 analyses. The relation between the dependent variable in each of the three Ranch Hand categories and the dependent variable in the Comparison category was examined. A fourth contrast, exploring the relation of the dependent variable in the combined low and high Ranch Hand categories relative to Comparisons, also was conducted. This combination is referred to in the tables as the “low plus high Ranch Hand” category. As in Model 2, a statistical adjustment for the percentage of body fat at the time of the participant’s blood measurement of dioxin was included in this model.

Model 4 examined the relation between the dependent variable and 1987 lipid-adjusted dioxin levels in all Ranch Hands with a dioxin measurement. If a participant did not have a 1987 dioxin measurement, the 1992 measurement was used to determine the dioxin level. If a participant did not have a 1987 or a 1992 dioxin measurement, the 1997 measurement was used to determine the dioxin level.

1.2.2.1 *Neurotic Disorder (ICD-9-CM 300)*

The unadjusted and adjusted Models 1 and 2 analyses of neurotic disorders were nonsignificant (Table 1-3(a-d):  $p > 0.23$  for each analysis).

**Table 1-3. Analysis of Neurotic Disorders**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
<b>Occupational Category</b>	<b>Group</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<i>Ranch Hand</i>	<i>863</i>	<i>100 (11.6)</i>	<i>1.05 (0.80,1.38)</i>	<i>0.715</i>
	<i>Comparison</i>	<i>1,246</i>	<i>138 (11.1)</i>		
Officer	Ranch Hand	340	30 (8.8)	0.92 (0.57,1.48)	0.728
	Comparison	493	47 (9.5)		
Enlisted Flyer	Ranch Hand	150	20 (13.3)	0.95 (0.51,1.78)	0.880
	Comparison	187	26 (13.9)		
Enlisted Groundcrew	Ranch Hand	373	50 (13.4)	1.19 (0.80,1.77)	0.380
	Comparison	566	65 (11.5)		

**Table 1-3. Analysis of Neurotic Disorders (Continued)**

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
<b>Occupational Category</b>	<b>Adjusted Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<i>1.06 (0.80,1.40)</i>	<i>0.680</i>
Officer	0.95 (0.59,1.55)	0.843
Enlisted Flyer	0.93 (0.49,1.74)	0.809
Enlisted Groundcrew	1.21 (0.81,1.80)	0.358

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
<b>Initial Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>a</sup></b>	
<b>Initial Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>b</sup></b>	<b>p-Value</b>
Low	159	12 (7.6)	1.13 (0.93,1.37)	0.233
Medium	162	27 (16.7)		
High	157	26 (16.6)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
471	1.08 (0.86,1.36)		0.514

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,208	132 (10.9)		
Background RH	378	34 (9.0)	0.82 (0.55,1.23)	0.339
Low RH	238	27 (11.3)	1.04 (0.67,1.61)	0.868
High RH	240	38 (15.8)	1.51 (1.02,2.23)	0.041
Low plus High RH	478	65 (13.6)	1.25 (0.91,1.73)	0.172

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 1-3. Analysis of Neurotic Disorders (Continued)**

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,193		
Background RH	371	0.89 (0.59,1.34)	0.570
Low RH	235	1.03 (0.66,1.62)	0.893
High RH	236	1.39 (0.92,2.09)	0.115
Low plus High RH	471	1.20 (0.86,1.67)	0.284

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	286	26 (9.1)	1.18 (1.03,1.36)	0.017
Medium	285	26 (9.1)		
High	285	47 (16.5)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
842	1.13 (0.96,1.32)		0.144

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

The unadjusted Model 3 analysis of neurotic disorders showed a significant difference between Ranch Hands in the high dioxin category and Comparisons (Table 1-3(e): Est. RR=1.51, p=0.041). A higher prevalence of neurotic disorders was found among Ranch Hands in the high dioxin category than among the Comparisons (15.8% versus 10.9%). After adjusting for covariates, the results became nonsignificant (Table 1-3(f): p=0.115). All other unadjusted and adjusted Model 3 contrasts were nonsignificant (Table 1-3(e,f): p>0.17 for each contrast).

The unadjusted Model 4 analysis revealed a significant positive association between 1987 dioxin and neurotic disorders (Table 1-3(g): Est. RR=1.18, p=0.017). The prevalence of neurotic disorders among Ranch Hands in the low, medium, and high 1987 dioxin categories was 9.1 percent, 9.1 percent, and 16.5 percent, respectively. After adjusting for covariates, the results became nonsignificant (Table 1-3(h): p=0.144).

#### 1.2.2.2 Personality Disorder (ICD-9-CM 301)

All unadjusted and adjusted analyses in Models 1 through 4 showed no significant relation between group or dioxin and the prevalence of personality disorders (Table 1-4(a-h): p>0.15 for each analysis).

**Table 1-4. Analysis of Personality Disorders**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	<i>866</i>	<i>7 (0.8)</i>	<i>0.59 (0.24,1.43)</i>	<i>0.228</i>
	<i>Comparison</i>	<i>1,248</i>	<i>17 (1.4)</i>		
Officer	Ranch Hand	341	1 (0.3)	0.48 (0.05,4.64)	0.526
	Comparison	493	3 (0.6)		
Enlisted Flyer	Ranch Hand	151	1 (0.7)	0.41 (0.04,3.95)	0.438
	Comparison	186	3 (1.6)		
Enlisted Groundcrew	Ranch Hand	374	5 (1.3)	0.69 (0.24,1.99)	0.490
	Comparison	569	11 (1.9)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>0.56 (0.23,1.39)</i>	<i>0.198</i>
Officer	0.49 (0.05,4.78)	0.542
Enlisted Flyer	0.40 (0.04,3.94)	0.433
Enlisted Groundcrew	0.64 (0.21,1.88)	0.412

  

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
Initial Dioxin Category Summary Statistics			Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup>	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.) <sup>b</sup>	p-Value
Low	160	2 (1.3)	0.68 (0.27,1.74)	0.392
Medium	162	1 (0.6)		
High	156	1 (0.6)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

**Table 1-4. Analysis of Personality Disorders (Continued)**

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
471	0.60 (0.22,1.65)	0.287

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for occupation and education because of the sparse number of Ranch Hands with personality disorders.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,210	17 (1.4)		
Background RH	381	3 (0.8)	0.55 (0.16,1.90)	0.345
Low RH	239	2 (0.8)	0.59 (0.14,2.59)	0.488
High RH	239	2 (0.8)	0.60 (0.14,2.62)	0.496
Low plus High RH	478	4 (0.8)	0.60 (0.20,1.78)	0.355

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,195		
Background RH	374	0.71 (0.20,2.52)	0.594
Low RH	236	0.62 (0.14,2.78)	0.534
High RH	235	0.38 (0.08,1.74)	0.214
Low plus High RH	471	0.49 (0.16,1.49)	0.207

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 1-4. Analysis of Personality Disorders (Continued)**

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	3 (1.0)	0.75 (0.43,1.32)	0.307
Medium	287	2 (0.7)		
High	284	2 (0.7)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
845	0.67 (0.39,1.17)		0.159

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

### 1.2.2.3 Sexual Deviation and Disorder (ICD-9-CM 302)

Both the unadjusted and adjusted Model 1 analyses of sexual deviations and disorders revealed marginally significant overall group differences (Table 1-5(a,b): Est. RR=1.73, p=0.062; Adj. RR=1.65, p=0.093). After stratifying by occupation, unadjusted and adjusted analyses revealed marginally significant group differences within the enlisted flyer stratum (Table 1-5(a,b): Est. RR=6.37, p=0.093; Adj. RR=6.21, p=0.098). The prevalence of sexual deviations and disorders was higher among Ranch Hands (3.0%) than Comparisons (1.8%) over all occupations, as well as within the enlisted flyer stratum (3.3% versus 0.5%).

**Table 1-5. Analysis of Sexual Deviations and Disorders**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
<b>Occupational Category</b>	<b>Group</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<i>Ranch Hand</i>	<i>866</i>	<i>26 (3.0)</i>	<i>1.73 (0.97,3.07)</i>	<i>0.062</i>
	<i>Comparison</i>	<i>1,249</i>	<i>22 (1.8)</i>		
Officer	Ranch Hand	340	10 (2.9)	1.21 (0.52,2.84)	0.654
	Comparison	493	12 (2.4)		
Enlisted Flyer	Ranch Hand	151	5 (3.3)	6.37 (0.74,55.12)	0.093
	Comparison	187	1 (0.5)		
Enlisted Groundcrew	Ranch Hand	375	11 (2.9)	1.88 (0.77,4.58)	0.165
	Comparison	569	9 (1.6)		

**Table 1-5. Analysis of Sexual Deviations and Disorders (Continued)**

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
<b>Occupational Category</b>	<b>Adjusted Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<i>1.65 (0.92,2.96)</i>	<i>0.093</i>
Officer	1.18 (0.50,2.77)	0.704
Enlisted Flyer	6.21 (0.71,54.15)	0.098
Enlisted Groundcrew	1.74 (0.69,4.35)	0.238

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
<b>Initial Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>a</sup></b>	
<b>Initial Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>b</sup></b>	<b>p-Value</b>
Low	160	4 (2.5)	1.14 (0.73,1.77)	0.567
Medium	162	3 (1.9)		
High	157	4 (2.6)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
472	1.27 (0.73,2.21)	0.396

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for current parental status because of the sparse number of Ranch Hands with sexual deviations or disorders.

**Table 1-5. Analysis of Sexual Deviations and Disorders (Continued)**

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,211	22 (1.8)		
Background RH	380	14 (3.7)	2.05 (1.03,4.07)	0.040
Low RH	239	7 (2.9)	1.63 (0.69,3.87)	0.265
High RH	240	4 (1.7)	0.92 (0.31,2.71)	0.883
Low plus High RH	479	11 (2.3)	1.23 (0.58,2.60)	0.594

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

Background (Ranch Hand): 1987 Dioxin  $\leq$  10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin  $\leq$  94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
Comparison	1,196			
Background RH	373	1.95	(0.96,3.94)	0.065
Low RH	236	1.28	(0.51,3.23)	0.598
High RH	236	1.05	(0.35,3.21)	0.927
Low plus High RH	472	1.16	(0.53,2.54)	0.706

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

Background (Ranch Hand): 1987 Dioxin  $\leq$  10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin  $\leq$  94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	287	9 (3.1)	0.89 (0.67,1.18)	0.408
Medium	287	10 (3.5)		
High	285	6 (2.1)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low =  $\leq$  7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

**Table 1-5. Analysis of Sexual Deviations and Disorders (Continued)**

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
845	0.87 (0.63,1.21)	0.414

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

The unadjusted and adjusted analyses in Models 2 and 4 revealed no significant relation between dioxin and sexual deviations and disorders (Table 1-5(c,d,g,h):  $p > 0.39$  for each analysis).

The unadjusted and adjusted Model 3 analyses of sexual deviations and disorders revealed significant and marginally significant differences, respectively, between Ranch Hands in the background dioxin category and Comparisons (Table 1-5(e,f): Est. RR=2.05,  $p=0.040$ ; Adj. RR=1.95,  $p=0.065$ ). The prevalence of sexual deviations and disorders was higher among Ranch Hands in the background dioxin category than Comparisons (3.7% versus 1.8%). All other Model 3 contrasts in the unadjusted and adjusted analyses were nonsignificant (Table 1-5(e,f):  $p > 0.26$  for each contrast).

#### 1.2.2.4 Nondependent Abuse of Drugs (ICD-9-CM 305)

The unadjusted and adjusted Model 1 analyses did not disclose a significant overall difference in the nondependent use of drugs between Ranch Hands and Comparisons (Table 1-6(a,b):  $p > 0.46$  for each analysis). After stratifying by occupation, marginally significant differences between Ranch Hands and Comparisons were noted within the enlisted flyer stratum (Table 1-6(a,b): Est. RR=0.34,  $p=0.059$ ; Adj. RR=0.33,  $p=0.062$ ). Comparison enlisted flyers had a higher percentage of nondependent drug use than did Ranch Hand enlisted flyers (7.5% versus 2.6%).

**Table 1-6. Analysis of Nondependent Use of Drugs**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
<b>Occupational Category</b>	<b>Group</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<i>Ranch Hand</i>	<i>866</i>	<i>43 (5.0)</i>	<i>0.94 (0.63,1.39)</i>	<i>0.744</i>
	<i>Comparison</i>	<i>1,249</i>	<i>66 (5.3)</i>		
Officer	Ranch Hand	341	16 (4.7)	0.88 (0.47,1.67)	0.706
	Comparison	493	26 (5.3)		
Enlisted Flyer	Ranch Hand	151	4 (2.6)	0.34 (0.11,1.04)	0.059
	Comparison	187	14 (7.5)		
Enlisted Groundcrew	Ranch Hand	374	23 (6.1)	1.37 (0.77,2.44)	0.286
	Comparison	569	26 (4.6)		

**Table 1-6. Analysis of Nondependent Use of Drugs (Continued)**

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
<b>Occupational Category</b>	<b>Adjusted Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<b>0.86 (0.57,1.30)</b>	<b>0.462</b>
Officer	0.86 (0.45,1.65)	0.655
Enlisted Flyer	0.33 (0.10,1.06)	0.062
Enlisted Groundcrew	1.19 (0.64,2.21)	0.584

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
<b>Initial Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>a</sup></b>	
<b>Initial Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>b</sup></b>	<b>p-Value</b>
Low	160	11 (6.9)	1.06 (0.80,1.40)	0.679
Medium	162	7 (4.3)		
High	157	11 (7.0)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
472	0.90 (0.62,1.30)		0.562

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,211	66 (5.5)		
Background RH	380	13 (3.4)	0.60 (0.33,1.11)	0.104
Low RH	239	16 (6.7)	1.25 (0.71,2.20)	0.439
High RH	240	13 (5.4)	1.01 (0.55,1.87)	0.975
Low plus High RH	479	29 (6.1)	1.12 (0.71,1.77)	0.615

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 1-6. Analysis of Nondependent Use of Drugs (Continued)**

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,196		
Background RH	373	0.57 (0.30,1.07)	0.081
Low RH	236	1.23 (0.68,2.21)	0.499
High RH	236	0.84 (0.41,1.69)	0.618
Low plus High RH	472	1.01 (0.62,1.66)	0.962

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	287	10 (3.5)	1.19 (0.98,1.46)	0.088
Medium	287	15 (5.2)		
High	285	17 (6.0)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
845	1.11 (0.87,1.42)		0.388

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

The Model 2 unadjusted and adjusted analyses did not show an association between dioxin and nondependent use of drugs (Table 1-6(c,d): p>0.56 for each analysis).

The unadjusted Model 3 analysis did not reveal significant differences between Comparisons and any of the Ranch Hand categories (Table 1-6(e): p>0.10 for each contrast). After adjusting for covariates, a marginally significant difference was revealed between Ranch Hands in the background dioxin category and Comparisons (Table 1-6(f): Adj. RR=0.57, p=0.081). The nondependent use of drugs was more prevalent among the Comparisons than Ranch Hands (5.5% versus 3.4%). The remaining contrasts in the adjusted analysis were nonsignificant (Table 1-6(f): p>0.49 for each contrast).

The unadjusted Model 4 analysis showed a marginally significant positive association between 1987 dioxin and nondependent drug use (Table 1-6(g): Est. RR=1.19, p=0.088). The prevalence of nondependent drug use in the low, medium, and high 1987 dioxin categories was 3.5 percent, 5.2 percent, and 6.0 percent, respectively. After adjusting for covariates, the results became nonsignificant (Table 1-6(h): p=0.388).

#### 1.2.2.5 Physiological Malfunctioning Arising from Mental Factors (ICD-9-CM 306)

All unadjusted and adjusted analyses for Models 1 through 4 for physiological malfunctioning arising from mental factors were nonsignificant (Table 1-7(a-h): p>0.25 for each analysis).

**Table 1-7. Analysis of Physiological Malfunction Arising from Mental Factors**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	<i>865</i>	<i>116 (13.4)</i>	<i>1.03 (0.80,1.33)</i>	<i>0.821</i>
	<i>Comparison</i>	<i>1,247</i>	<i>163 (13.1)</i>		
Officer	Ranch Hand	340	33 (9.7)	1.15 (0.72,1.86)	0.557
	Comparison	493	42 (8.5)		
Enlisted Flyer	Ranch Hand	151	25 (16.6)	1.08 (0.60,1.94)	0.794
	Comparison	187	29 (15.5)		
Enlisted Groundcrew	Ranch Hand	374	58 (15.5)	0.95 (0.66,1.36)	0.769
	Comparison	567	92 (16.2)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>1.04 (0.80,1.35)</i>	<i>0.781</i>
Officer	1.18 (0.73,1.92)	0.500
Enlisted Flyer	0.94 (0.52,1.73)	0.853
Enlisted Groundcrew	1.00 (0.69,1.44)	0.997

  

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
Initial Dioxin Category Summary Statistics			Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup>	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.) <sup>b</sup>	p-Value
Low	160	21 (13.1)	0.94 (0.76,1.15)	0.516
Medium	162	25 (15.4)		
High	157	21 (13.4)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

**Table 1-7. Analysis of Physiological Malfunction Arising from Mental Factors (Continued)**

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
472	0.95 (0.75,1.21)	0.693

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,209	154 (12.7)		
Background RH	379	48 (12.7)	1.03 (0.73,1.47)	0.854
Low RH	239	31 (13.0)	1.01 (0.67,1.53)	0.958
High RH	240	36 (15.0)	1.17 (0.79,1.73)	0.441
Low plus High RH	479	67 (14.0)	1.09 (0.80,1.48)	0.599

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,194		
Background RH	372	1.22 (0.84,1.76)	0.294
Low RH	236	0.99 (0.65,1.52)	0.973
High RH	236	0.98 (0.64,1.48)	0.912
Low plus High RH	472	0.98 (0.71,1.36)	0.925

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 1-7. Analysis of Physiological Malfunction Arising from Mental Factors (Continued)**

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	286	37 (12.9)	0.99 (0.87,1.13)	0.907
Medium	287	35 (12.2)		
High	285	43 (15.1)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
844	0.92 (0.79,1.07)		0.256

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

#### *1.2.2.6 Special Symptoms or Syndromes Not Elsewhere Classified (ICD-9-CM 307)*

The unadjusted and adjusted analyses in Models 1, 3, and 4 did not show a significant relation between group or dioxin and the prevalence of special symptoms or syndromes not elsewhere classified (Table 1-8(a,b,e-h):  $p > 0.10$  in each analysis). The unadjusted Model 2 analysis of special symptoms or syndromes not elsewhere classified was nonsignificant (Table 1-8(c):  $p = 0.291$ ). The adjusted Model 2 analysis revealed a marginally significant association between initial dioxin and the prevalence of special symptoms or syndromes not elsewhere classified (Table 1-8(d): Adj. RR=0.64,  $p = 0.100$ ). The prevalence of Ranch Hands in the low, medium, and high initial dioxin categories was 3.1 percent, 3.1 percent, and 1.9 percent, respectively.

**Table 1-8. Analysis of Special Symptoms or Syndromes Not Elsewhere Classified**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	866	16 (1.8)	1.29 (0.65,2.54)	0.469
	<i>Comparison</i>	1,248	18 (1.4)		
Officer	Ranch Hand	341	2 (0.6)	0.48 (0.10,2.38)	0.368
	Comparison	492	6 (1.2)		
Enlisted Flyer	Ranch Hand	150	5 (3.3)	1.26 (0.36,4.42)	0.723
	Comparison	187	5 (2.7)		
Enlisted Groundcrew	Ranch Hand	375	9 (2.4)	1.97 (0.73,5.35)	0.181
	Comparison	569	7 (1.2)		

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>			
Occupational Category	Adjusted Relative Risk (95% C.I.)		p-Value
<i>All</i>	1.28 (0.65,2.54)		0.476
Officer	0.47 (0.09,2.34)		0.356
Enlisted Flyer	1.35 (0.38,4.78)		0.643
Enlisted Groundcrew	1.97 (0.73,5.35)		0.184

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
Initial Dioxin Category Summary Statistics			Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup>	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.) <sup>b</sup>	p-Value
Low	159	5 (3.1)	0.78 (0.49,1.26)	0.291
Medium	162	5 (3.1)		
High	157	3 (1.9)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
Analysis Results for Log <sub>2</sub> (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.) <sup>a</sup>	p-Value
471	0.64 (0.36,1.12)	0.100

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race and current marital status because of the sparse number of Ranch Hands with special symptoms or syndromes not elsewhere classified.

**Table 1-8. Analysis of Special Symptoms or Syndromes Not Elsewhere Classified (Continued)**

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,210	18 (1.5)		
Background RH	381	3 (0.8)	0.54 (0.16,1.84)	0.323
Low RH	238	7 (2.9)	2.00 (0.82,4.83)	0.126
High RH	240	6 (2.5)	1.67 (0.65,4.26)	0.287
Low plus High RH	478	13 (2.7)	1.82 (0.88,3.76)	0.105

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,195		
Background RH	374	0.60 (0.17,2.10)	0.425
Low RH	235	2.01 (0.82,4.92)	0.125
High RH	236	1.44 (0.55,3.79)	0.462
Low plus High RH	471	1.70 (0.82,3.54)	0.157

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	1 (0.4)	1.21 (0.88,1.66)	0.255
Medium	286	7 (2.5)		
High	285	8 (2.8)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

**Table 1-8. Analysis of Special Symptoms or Syndromes Not Elsewhere Classified (Continued)**

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>		
Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.) <sup>a</sup>	p-Value
845	1.04 (0.72,1.51)	0.819

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with special symptoms or syndromes not elsewhere classified.

### 1.2.2.7 Acute Reaction to Stress (ICD-9-CM 308)

The unadjusted and adjusted Model 1 analyses did not find a significant overall difference in acute reaction to stress between all Ranch Hands and all Comparisons (Table 1-9(a,b):  $p > 0.82$  for both analyses). After stratifying by occupation, marginally significant differences between Ranch Hands and Comparisons were noted within the officer stratum (Table 1-9(a,b): Est. RR=0.51,  $p=0.085$ ; Adj. RR=0.45,  $p=0.056$ ). Comparison officers had a higher prevalence of acute reaction to stress than did Ranch Hand officers (5.1% versus 2.6%).

**Table 1-9. Analysis of Acute Reaction to Stress**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	867	49 (5.7)	<b>0.96 (0.66,1.40)</b>	<b>0.848</b>
	<i>Comparison</i>	1,248	73 (5.8)		
Officer	Ranch Hand	341	9 (2.6)	0.51 (0.23,1.10)	0.085
	Comparison	492	25 (5.1)		
Enlisted Flyer	Ranch Hand	151	12 (8.0)	1.93 (0.77,4.86)	0.161
	Comparison	187	8 (4.3)		
Enlisted Groundcrew	Ranch Hand	375	28 (7.5)	1.07 (0.65,1.76)	0.800
	Comparison	569	40 (7.0)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	<b>0.96 (0.66,1.40)</b>	<b>0.825</b>
Officer	0.45 (0.20,1.02)	0.056
Enlisted Flyer	1.95 (0.77,4.94)	0.156
Enlisted Groundcrew	1.08 (0.65,1.79)	0.766

**Table 1-9. Analysis of Acute Reaction to Stress (Continued)**

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
<b>Initial Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>a</sup></b>	
<b>Initial Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>b</sup></b>	<b>p-Value</b>
Low	160	7 (4.4)	1.41 (1.11,1.79)	0.006
Medium	162	11 (6.8)		
High	157	17 (10.8)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
472	1.32 (0.98,1.78)		0.070

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,210	71 (5.9)		
Background RH	381	13 (3.4)	0.56 (0.31,1.03)	0.062
Low RH	239	12 (5.0)	0.85 (0.45,1.59)	0.611
High RH	240	23 (9.6)	1.71 (1.04,2.81)	0.033
Low plus High RH	479	35 (7.3)	1.21 (0.78,1.86)	0.396

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 1-9. Analysis of Acute Reaction to Stress (Continued)**

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,195		
Background RH	374	0.57 (0.30,1.08)	0.083
Low RH	236	0.89 (0.47,1.68)	0.718
High RH	236	1.51 (0.90,2.53)	0.121
Low plus High RH	472	1.16 (0.74,1.80)	0.517

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	9 (3.1)	1.42 (1.18,1.71)	<0.001
Medium	287	12 (4.2)		
High	285	27 (9.5)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
846	1.31 (1.05,1.64)		0.014

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

The unadjusted and adjusted Model 2 analyses revealed significant and marginally significant positive associations, respectively, between initial dioxin and the prevalence of acute reaction to stress (Table 1-9(c,d): Est. RR=1.41, p=0.006; Adj. RR=1.32, p=0.070). The prevalence of Ranch Hands in the low, medium, and high initial dioxin categories with an acute reaction to stress was 4.4 percent, 6.8 percent, and 10.8 percent, respectively.

The unadjusted Model 3 analysis of acute reaction to stress revealed a marginally significant decrease for Ranch Hands in the background dioxin category relative to Comparisons (Table 1-9(e): Est. RR=0.56,

p=0.062) and a significant increase for Ranch Hands in the high dioxin category (Table 1-9(e): Est. RR=1.71, p=0.033). The prevalence of acute reaction to stress among Ranch Hands in the background dioxin category, Ranch Hands in the high dioxin category, and Comparisons was 3.4 percent, 9.6 percent, and 5.9 percent, respectively. After adjusting for covariates, a marginally significant difference was seen between Ranch Hands in the background dioxin category and Comparisons (Table 1-9(f): Adj. RR=0.57, p=0.083).

Both the unadjusted and adjusted Model 4 analyses revealed significant positive associations between 1987 dioxin and acute reaction to stress (Table 1-9(g,h): Est. RR=1.42, p<0.001; Adj. RR=1.31, p=0.014). The prevalence of acute reaction to stress in the low, medium, and high 1987 dioxin categories was 3.1 percent, 4.2 percent, and 9.5 percent, respectively.

#### 1.2.2.8 Adjustment Reaction (ICD-9-CM 309)

The unadjusted and adjusted analyses of adjustment reaction in Models 1 and 2 did not reveal any significant results (Table 1-10(a-d): p>0.27 for each analysis).

**Table 1-10. Analysis of Adjustment Reaction**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	867	14 (1.6)	1.45 (0.69,3.05)	0.333
	<i>Comparison</i>	1,248	14 (1.1)		
Officer	Ranch Hand	341	4 (1.2)	0.96 (0.27,3.44)	0.954
	Comparison	493	6 (1.2)		
Enlisted Flyer	Ranch Hand	151	2 (1.3)	2.48 (0.22,27.65)	0.460
	Comparison	186	1 (0.5)		
Enlisted Groundcrew	Ranch Hand	375	8 (2.1)	1.75 (0.63,4.87)	0.284
	Comparison	569	7 (1.2)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	1.47 (0.69,3.10)	0.316
Officer	0.95 (0.27,3.39)	0.936
Enlisted Flyer	2.43 (0.22,27.18)	0.471
Enlisted Groundcrew	1.78 (0.64,4.96)	0.272

**Table 1-10. Analysis of Adjustment Reaction (Continued)**

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
<b>Initial Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>a</sup></b>	
<b>Initial Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>b</sup></b>	<b>p-Value</b>
Low	160	4 (2.5)	0.88 (0.50,1.53)	0.639
Medium	162	2 (1.2)		
High	157	3 (1.9)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
472	0.87 (0.44,1.71)	0.681

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,210	14 (1.2)		
Background RH	381	5 (1.3)	1.04 (0.37,2.92)	0.942
Low RH	239	6 (2.5)	2.24 (0.85,5.89)	0.102
High RH	240	3 (1.3)	1.17 (0.33,4.12)	0.807
Low plus High RH	479	9 (1.9)	1.62 (0.67,3.89)	0.283

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 1-10. Analysis of Adjustment Reaction (Continued)**

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,195		
Background RH	374	1.10 (0.38,3.16)	0.858
Low RH	236	2.40 (0.90,6.39)	0.079
High RH	236	1.05 (0.29,3.82)	0.945
Low plus High RH	472	1.59 (0.65,3.87)	0.312

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	2 (0.7)	1.09 (0.77,1.54)	0.646
Medium	287	8 (2.8)		
High	285	4 (1.4)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
846	0.96 (0.64,1.45)		0.860

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

No significant differences between Comparisons and any of the Ranch Hand dioxin categories were seen in the unadjusted Model 3 analysis (Table 1-10(e):  $p > 0.10$  for each contrast). After adjusting for covariates, a marginally significant difference was revealed between Ranch Hands in the low dioxin category and Comparisons (Table 1-10(f): Adj. RR=2.40,  $p=0.079$ ). The prevalence of adjustment reaction was higher among Ranch Hands in the low dioxin category (2.5%) than among Comparisons (1.2%).

The unadjusted and adjusted Model 4 analyses did not reveal any significant associations between 1987 dioxin and adjustment reaction (Table 1-10(g,h):  $p > 0.64$  for each analysis).

1.2.2.9 Depressive Disorder Not Elsewhere Classified (ICD-9-CM 311)

The unadjusted and adjusted Model 1 analyses of depressive disorders not elsewhere classified did not reveal a significant difference between Ranch Hands and Comparisons over all occupations or within each occupational stratum (Table 1-11(a,b):  $p > 0.18$  for each analysis).

**Table 1-11. Analysis of Depressive Disorders Not Elsewhere Classified**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	865	96 (11.1)	0.92 (0.70,1.21)	0.556
	<i>Comparison</i>	1,249	149 (11.9)		
Officer	Ranch Hand	341	31 (9.1)	0.74 (0.47,1.16)	0.189
	Comparison	493	59 (12.0)		
Enlisted Flyer	Ranch Hand	151	19 (12.6)	0.93 (0.49,1.77)	0.831
	Comparison	187	25 (13.4)		
Enlisted Groundcrew	Ranch Hand	373	46 (12.3)	1.09 (0.73,1.63)	0.672
	Comparison	569	65 (11.4)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	0.95 (0.72,1.25)	0.704
Officer	0.76 (0.48,1.21)	0.246
Enlisted Flyer	0.89 (0.46,1.72)	0.731
Enlisted Groundcrew	1.16 (0.77,1.75)	0.474

  

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
Initial Dioxin Category Summary Statistics			Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup>	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.) <sup>b</sup>	p-Value
Low	160	24 (15.0)	0.79 (0.63,1.00)	0.038
Medium	161	23 (14.3)		
High	156	12 (7.7)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

**Table 1-11. Analysis of Depressive Disorders Not Elsewhere Classified (Continued)**

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
470	0.68 (0.52,0.90)	0.005

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,211	143 (11.8)		
Background RH	381	37 (9.7)	0.81 (0.55,1.19)	0.280
Low RH	239	35 (14.6)	1.28 (0.86,1.91)	0.226
High RH	238	24 (10.1)	0.83 (0.53,1.32)	0.432
Low plus High RH	477	59 (12.4)	1.03 (0.74,1.43)	0.850

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,196		
Background RH	374	0.88 (0.59,1.30)	0.524
Low RH	236	1.36 (0.90,2.04)	0.145
High RH	234	0.77 (0.48,1.24)	0.289
Low plus High RH	470	1.03 (0.73,1.44)	0.884

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 1-11. Analysis of Depressive Disorders Not Elsewhere Classified (Continued)**

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	30 (10.4)	0.98 (0.85,1.14)	0.809
Medium	287	37 (12.9)		
High	283	29 (10.3)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
844	0.90 (0.77,1.07)		0.226

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Both the unadjusted and adjusted Model 2 analyses revealed significant inverse associations between the prevalence of depressive disorders not elsewhere classified and initial dioxin (Table 1-11(c,d): Est. RR=0.79, p=0.038; Adj. RR=0.68, p=0.005). The prevalence of depressive disorders among Ranch Hands in the low, medium, and high initial dioxin categories was 15.0 percent, 14.3 percent, and 7.7 percent, respectively.

All unadjusted and adjusted Model 3 and Model 4 analyses were nonsignificant (Table 1-11(e-h): p>0.14 for each analysis).

### **1.3 SUMMARY**

#### **1.3.1 Model 1: Group Analysis**

In the Final Report (1) for the 1997 follow-up of the AFHS, the difference in the prevalence of other neuroses between Ranch Hand and Comparison officers was marginally significant (Est. RR=0.79, p=0.099) in the unadjusted analysis. Comparison officers had a larger percentage of other neuroses (46.0%) than Ranch Hand officers (40.2%). The difference was nonsignificant after adjustment for covariates (p=0.127). For enlisted groundcrew, Ranch Hands had a significantly greater prevalence of other neuroses than Comparisons (64.7% versus 57.1%) in both the unadjusted and adjusted analyses (Est. RR=1.38, p=0.021; Adj. RR=1.44, p=0.011).

The difference between all Ranch Hands and all Comparisons was marginally significant in the adjusted analysis of sexual deviations and disorders (p=0.093), with Ranch Hands exhibiting more sexual deviations and disorders than Comparisons. The difference between Ranch Hand and Comparison enlisted flyers was also marginally significant in the adjusted analysis of sexual deviations and disorders (p=0.098).

The difference between Ranch Hand and Comparison enlisted flyers was marginally significant in the adjusted analysis of nondependent abuse of drugs ( $p=0.062$ ), with Comparison enlisted flyers showing more drug abuse than Ranch Hand enlisted flyers.

The difference between Ranch Hand and Comparison officers was marginally significant in the adjusted analysis of acute reaction to stress ( $p=0.056$ ), with Comparison officers showing more reaction to stress than Ranch Hand officers.

Although no significant results were found in the adjusted analysis of Ranch Hand versus Comparison enlisted groundcrew, eight of the nine analyses of the categories of other neuroses showed an adjusted relative risk of 1.0 or greater, indicating more Ranch Hands than Comparisons with a neurosis. This observation may explain in part the significant relation between group and other neuroses in the Final Report (1) for the 1997 follow-up of the AFHS, although none of the analyses of the categories of other neuroses was significant.

### 1.3.2 Model 2: Initial Dioxin Analysis

Neither the unadjusted nor the adjusted analysis of other neuroses was significant in the Final Report (1) for the 1997 follow-up of the AFHS ( $p=0.743$  and  $p=0.164$  for the unadjusted and adjusted analyses, respectively).

Several adjusted analyses of the categories of other neuroses showed significant or marginally significant associations with initial dioxin, but the association was not consistently inverse or positive. A marginally significant inverse association was observed between initial dioxin and special symptoms or syndromes not elsewhere classified ( $p=0.100$ ). A marginally significant positive association was seen between initial dioxin and acute reaction to stress ( $p=0.070$ ). A significant inverse association between depressive disorders not elsewhere classified and initial dioxin was found ( $p=0.005$ ).

### 1.3.3 Model 3: Categorized Dioxin Analysis

In the Final Report (1) for the 1997 follow-up of the AFHS, the difference was significant in the unadjusted analysis of the prevalence of other neuroses between Comparisons and all the Ranch Hand dioxin categories. Significantly more Comparisons than Ranch Hands in the background dioxin category had other neuroses (Est. RR=0.75,  $p=0.018$ ). More Ranch Hands in the low dioxin category had other neuroses than Comparisons (Est. RR=1.34,  $p=0.041$ ), as did Ranch Hands in the high dioxin category (Est. RR=1.48,  $p=0.008$ ). Ranch Hands in the low plus high dioxin category had a significantly greater prevalence of other neuroses than did Comparisons (Est. RR=1.41,  $p=0.002$ ). The contrast of Ranch Hands in the low dioxin category and Ranch Hands in the low plus high dioxin category remained significant after adjustment for covariates (Adj. RR=1.37,  $p=0.036$ ; and Adj. RR=1.27,  $p=0.038$ , respectively).

Ranch Hands in the background dioxin category had a greater prevalence of sexual deviations and disorders, and the difference was marginally significant ( $p=0.065$ ). The difference between Ranch Hands in the background dioxin category and Comparisons was marginally significant for nondependent abuse of drugs ( $p=0.081$ ) and acute reaction to stress ( $p=0.083$ ), with more Comparisons than Ranch Hands exhibiting these neuroses.

The adjusted analysis of adjustment reaction between Ranch Hands in the low dioxin category and Comparisons was marginally significant ( $p=0.079$ ), with more Ranch Hands than Comparisons displaying an adjustment reaction.

All adjusted analyses of Ranch Hands in the high dioxin category, and Ranch Hands in the low plus high dioxin category, with Comparisons were nonsignificant. Although no significant results were found in the adjusted analysis of Ranch Hand in the low plus high dioxin category versus Comparison, seven of the nine analyses of the categories of other neuroses showed an adjusted relative risk greater than 1.0, indicating more Ranch Hands than Comparisons with a neurosis. As with Model 1 described above, this observation may explain, in part, the significant relation between group and other neuroses in the Final Report (1) for the 1997 follow-up of the AFHS.

#### 1.3.4 Model 4: 1987 Dioxin Level Analysis

The unadjusted analysis of other neuroses with 1987 dioxin was significant in the Final Report (1) for the 1997 follow-up of the AFHS (Est. RR=1.20,  $p<0.001$ ). After adjustment for covariates, the association was nonsignificant ( $p=0.763$ ).

The adjusted analysis of acute reaction to stress was significant ( $p=0.014$ ), indicating a positive association between reaction to stress and 1987 dioxin. All other adjusted analyses of 1987 dioxin were nonsignificant. Four of the nine adjusted analyses of the categories of other neuroses showed a positive association between the neurosis category and 1987 dioxin, whereas five adjusted analyses showed an inverse association with Comparisons. This observation may explain, in part, the significant result in the adjusted analysis of acute reaction to stress, but a nonsignificant relation between other neuroses and 1987 dioxin.

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## 2 OTHER LIVER DISORDERS ASSESSMENT

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### 2.1 INTRODUCTION

#### 2.1.1 Background

The Final Report (1) for the 1997 follow-up of the Air Force Health Study (AFHS) revealed a significant relation between a dependent variable named “other liver disorders” and herbicide or dioxin exposure. In particular, the difference between Ranch Hands and Comparisons was marginally significant in both the unadjusted Model 1 analysis (Est. RR=1.20, p=0.067) and the analysis adjusted for covariates (Adj. RR=1.19, p=0.090). Ranch Hands had a higher prevalence of other liver disorders than did Comparisons (28.8% versus 25.2%). The difference between Ranch Hands and Comparisons primarily was due to differences in enlisted groundcrew. The difference between Ranch Hand and Comparison enlisted groundcrew was marginally significant in both the unadjusted (Est. RR=1.32, p=0.062) and the adjusted Model 1 analysis (Adj. RR=1.31, p=0.073). Ranch Hand enlisted groundcrew had a higher prevalence of other liver disorders than did Comparisons (30.8% versus 25.2%).

The association between other liver disorders and initial dioxin in Ranch Hands was nonsignificant in the unadjusted Model 2 analysis (p=0.119), but was significant after adjustment for covariates (Adj. RR=1.23, p=0.022). The prevalence of Ranch Hands with other liver disorders in the low, medium, and high initial dioxin categories was 24.5 percent, 32.7 percent, and 34.4 percent, respectively.

Ranch Hands in the high dioxin category had a significantly greater prevalence of other liver disorders than did Comparisons (34.2% versus 24.9%). The difference was significant in both the unadjusted Model 3 analysis (Est. RR=1.49, p=0.009) and in the analysis adjusted for covariates (Adj. RR=1.52, p=0.009). This increase in other liver disorders for Ranch Hands in the high dioxin category relative to Comparisons also was illustrated in the contrast of Ranch Hands in the low plus high dioxin category and Comparisons (Est. RR=1.28, p=0.042; Adj. RR=1.27, p=0.055).

The association between other liver disorders and 1987 dioxin in Ranch Hands was marginally significant in both the unadjusted and adjusted Model 4 analyses (Est. RR=1.10, p=0.055 for the unadjusted analysis; Adj. RR=1.11, p=0.077 in the adjusted analysis). The prevalence of Ranch Hands with other liver disorders in the low, medium, and high 1987 dioxin categories was 25.5 percent, 26.7 percent, and 33.7 percent, respectively.

The purpose of this chapter is to categorize the “other liver disorders” dependent variable into International Classification of Diseases, 9<sup>th</sup> revision, Clinical Modification (ICD-9-CM) categories and subcategories, and to examine each of the ICD-9-CM categories separately.

#### 2.1.2 Parameters for the Other Liver Disorders Assessment

##### 2.1.2.1 *Dependent Variables*

During the 1997 health interview, each study participant was asked about the occurrence of other liver conditions. This self-reported information was elicited in the questionnaire and combined with information from the baseline, 1985, 1987, and 1992 follow-up examinations and verified by a medical

records review. The dependent variable “other disorders of the liver” included ICD-9-CM codes 573.0–573.9, 790.4, 790.5, and 794.8.

The “other liver disorders” dependent variable was divided into seven subcategories:

- Hepatitis in viral diseases classified elsewhere (ICD-9-CM 573.1)
- Unspecified hepatitis (ICD-9-CM 573.3)
- Other specified diseases of the liver (ICD-9-CM 573.8)
- Unspecified disorder of the liver (ICD-9-CM 573.9)
- Nonspecific elevation of levels of transaminase or lactic acid dehydrogenase (LDH) (ICD-9-CM 790.4)
- Other nonspecific abnormal serum enzyme levels (ICD-9-CM 790.5)
- Nonspecific abnormal results of liver studies (ICD-9-CM 794.8).

Because of a sparse number of abnormalities of hepatitis in viral diseases classified elsewhere (ICD-9-CM 573.1), unspecified hepatitis (ICD-9-CM 573.3), and other specified diseases of the liver (ICD-9-CM 573.8), these three subcategories, together with unspecified disorders of the liver (ICD-9-CM 573.9) were combined into one ICD-9-CM category (ICD-9-CM 573) called “viral and other unspecified disorders” for the purposes of statistical analysis. Approximately 2 percent of the participants had an unspecified disorder of the liver, and, consequently, this subcategory (ICD-9-CM code 573.9) also was analyzed as a separate dependent variable. The subcategories “nonspecific elevation of levels of transaminase or LDH” (ICD-9-CM 790.4), “other nonspecific abnormal serum enzyme levels” (ICD-9-CM 790.5), and “nonspecific abnormal results of liver studies” (ICD-9-CM 794.8) also were analyzed as separate dependent variables.

For each condition, participants with a pre-Southeast Asia (SEA) diagnosis were excluded from the analysis.

#### *2.1.2.2 Covariates*

Statistical analyses of all dependent variables were adjusted for age, race, military occupation, lifetime alcohol history, lifetime industrial chemical exposure, and lifetime degreasing chemical exposure. Age, race, and military occupation were determined from military records. Lifetime alcohol history was based on information from the 1997 questionnaire and combined with similar information gathered at the 1987 and 1992 follow-up examinations. Each participant was asked about his drinking patterns throughout his lifetime. When a participant’s drinking patterns changed, he was asked to describe how his alcohol consumption differed and the duration of time that the drinking pattern lasted. The participant’s average daily alcohol consumption was determined for each of the reported drinking pattern periods throughout his lifetime, and an estimate of the corresponding total number of drink-years was derived. One drink-year was the equivalent of drinking 1.5 ounces of an 80-proof alcoholic beverage, one 12-ounce beer, or one 5-ounce glass of wine per day for 1 year. The participants’ lifetime exposures through 1992 to degreasing and industrial chemicals were updated with information reported in the 1997 questionnaire.

Age and lifetime alcohol history were treated as continuous variables for all adjusted analyses. Degreasing chemical exposure and industrial chemical exposure were categorized as “yes” or “no” for all analyses.

### 2.1.3 Statistical Methods

Table 2-1 summarizes the statistical analyses performed for the assessment of the subcategorization of the dependent variable named “other liver disorders.” The first part of this table lists the dependent variables analyzed, data source, data form, cutpoints, covariates, and statistical analysis methods. The second part of this table provides a description of covariates examined. A covariate was used in its continuous form whenever possible for all adjusted analyses; if the covariate is inherently discrete, the covariate was categorized as shown in Table 2-1.

**Table 2-1. Statistical Analysis for the Subcategorization of Other Liver Disorders**

#### Dependent Variables

Variable (Units)	Data Source	Data Form	Cutpoints	Covariates <sup>a</sup>	Exclusions <sup>b</sup>	Statistical Analysis and Methods
Viral and Other Unspecified Disorders (ICD-9-CM 573)	MR-V	D	Yes	(1)	(a)	U:LR
			No			A:LR
Unspecified Disorders of the Liver (ICD-9-CM 573.9)	MR-V	D	Yes	(1)	(a)	U:LR
			No			A:LR
Nonspecific Elevation of Transaminase or LDH Levels (ICD-9-CM 790.4)	MR-V	D	Yes	(1)	(a)	U:LR
			No			A:LR
Other Nonspecific Abnormal Serum Enzyme Levels (ICD-9-CM 790.5)	MR-V	D	Yes	(1)	(a)	U:LR
			No			A:LR
Nonspecific Abnormal Results of Liver Studies (ICD-9-CM 794.8)	MR-V	D	Yes	(1)	(a)	U:LR
			No			A:LR

<sup>a</sup>Covariates:

(1): age, race, military occupation, lifetime alcohol history, industrial chemical exposure, degreasing chemical exposure.

<sup>b</sup>Exclusions:

(a): participants with a pre-SEA history of the disorder.

#### Covariates

Variable (Units)	Data Source	Data Form	Cutpoints
Age (years)	MIL	C	--
Race	MIL	D	Black Non-Black
Occupation	MIL	D	Officer Enlisted Flyer Enlisted Groundcrew
Lifetime Alcohol History (drink-years)	Q-SR	C	--
Industrial Chemical Exposure	Q-SR	D	Yes
			No
Degreasing Chemical Exposure	Q-SR	D	Yes
			No

**Table 2-1. Statistical Analysis for the Subcategorization of Other Liver Disorders (Continued)**

**Abbreviations**

Data Source: MIL: Air Force military records  
 MR-V: Medical records (verified)  
 Q-SR: Health questionnaires (self-reported)

Data Form: D: Discrete analysis  
 C: Continuous analysis

Statistical Analysis: U: Unadjusted analysis  
 A: Adjusted analysis

Statistical Methods: LR: Logistic regression analysis

**2.2 RESULTS**

2.2.1 Summary Statistics for Other Liver Disorders by ICD-9-CM Subcategory

Table 2-2 presents summary statistics for liver disorders classified by the seven ICD-9-CM subcategories. The summary statistics are further presented by group (Ranch Hand, Comparison) and military occupation (officer, enlisted flyer, enlisted groundcrew) and include sample size (n) and the number and percentage of participants with the specific liver disorder.

**Table 2-2. Frequencies of Other Liver Disorders by ICD-9-CM Classification**

Other Liver Disorder (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%) Yes
Hepatitis in Viral Diseases Classified Elsewhere (ICD-9-CM 573.1)	<i>All</i>	<i>Ranch Hand</i>	<b>869</b>	<b>1 (0.1)</b>
		<i>Comparison</i>	<b>1,246</b>	<b>5 (0.4)</b>
	Officer	Ranch Hand	340	0 (0.0)
		Comparison	491	2 (0.4)
	Enlisted Flyer	Ranch Hand	151	0 (0.0)
		Comparison	187	0 (0.0)
	Enlisted Groundcrew	Ranch Hand	378	1 (0.3)
		Comparison	568	3 (0.5)

**Table 2-2. Frequencies of Other Liver Disorders by ICD-9-CM Classification (Continued)**

Other Liver Disorder (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%) Yes
Unspecified Hepatitis (ICD-9-CM 573.3)	<i>All</i>	<i>Ranch Hand</i>	<b>867</b>	<b>7 (0.8)</b>
		<i>Comparison</i>	<b>1,246</b>	<b>12 (1.0)</b>
	Officer	Ranch Hand	339	2 (0.6)
		Comparison	489	4 (0.8)
	Enlisted Flyer	Ranch Hand	151	2 (1.3)
		Comparison	187	0 (0.0)
	Enlisted Groundcrew	Ranch Hand	377	3 (0.8)
		Comparison	570	8 (1.4)
Other Specified Diseases of Liver (ICD-9-CM 573.8)	<i>All</i>	<i>Ranch Hand</i>	<b>870</b>	<b>4 (0.5)</b>
		<i>Comparison</i>	<b>1,251</b>	<b>3 (0.2)</b>
	Officer	Ranch Hand	341	1 (0.3)
		Comparison	494	3 (0.6)
	Enlisted Flyer	Ranch Hand	151	1 (0.7)
		Comparison	187	0 (0.0)
	Enlisted Groundcrew	Ranch Hand	378	2 (0.5)
		Comparison	570	0 (0.0)
Unspecified Disorder of the Liver (ICD-9-CM 573.9)	<i>All</i>	<i>Ranch Hand</i>	<b>870</b>	<b>19 (2.2)</b>
		<i>Comparison</i>	<b>1,250</b>	<b>24 (1.9)</b>
	Officer	Ranch Hand	341	11 (3.2)
		Comparison	494	10 (2.0)
	Enlisted Flyer	Ranch Hand	151	3 (2.0)
		Comparison	187	4 (2.1)
	Enlisted Groundcrew	Ranch Hand	378	5 (1.3)
		Comparison	569	10 (1.8)
Nonspecific Elevation of Levels of Transaminase or LDH (ICD-9-CM 790.4)	<i>All</i>	<i>Ranch Hand</i>	<b>870</b>	<b>17 (2.0)</b>
		<i>Comparison</i>	<b>1,251</b>	<b>21 (1.7)</b>
	Officer	Ranch Hand	341	4 (1.2)
		Comparison	494	6 (1.2)
	Enlisted Flyer	Ranch Hand	151	2 (1.3)
		Comparison	187	6 (3.2)
	Enlisted Groundcrew	Ranch Hand	378	11 (2.9)
		Comparison	570	9 (1.6)

**Table 2-2. Frequencies of Other Liver Disorders by ICD-9-CM Classification (Continued)**

Other Liver Disorder (ICD-9-CM Classification)	Occupational Category	Group	n	Number (%) Yes
Other Nonspecific Abnormal Serum Enzyme Levels (ICD-9-CM 790.5)	<i>All</i>	<i>Ranch Hand</i>	<b>870</b>	<b>92 (10.6)</b>
		<i>Comparison</i>	<b>1,251</b>	<b>107 (8.6)</b>
	Officer	Ranch Hand	341	37 (10.9)
		Comparison	494	43 (8.7)
	Enlisted Flyer	Ranch Hand	151	15 (9.9)
		Comparison	187	15 (8.0)
	Enlisted Groundcrew	Ranch Hand	378	40 (10.6)
		Comparison	570	49 (8.6)
Nonspecific Abnormal Results of Liver Studies (ICD-9-CM 794.8)	<i>All</i>	<i>Ranch Hand</i>	<b>870</b>	<b>109 (12.5)</b>
		<i>Comparison</i>	<b>1,251</b>	<b>140 (11.2)</b>
	Officer	Ranch Hand	341	38 (11.1)
		Comparison	494	53 (10.7)
	Enlisted Flyer	Ranch Hand	151	17 (11.3)
		Comparison	187	23 (12.3)
	Enlisted Groundcrew	Ranch Hand	378	54 (14.3)
		Comparison	570	64 (11.2)

The largest subcategory of other liver disorders resulted from nonspecific abnormal results of liver studies (Ranch Hands: 12.5%, Comparisons: 11.2%). Abnormal results of liver studies included an abnormal liver scan. Nonspecific abnormal serum enzyme levels, which included abnormal serum levels of acid phosphatase, alkaline phosphatase, amylase, and lipase, also showed a high prevalence (Ranch Hands: 10.6%, Comparisons: 8.6%).

### 2.2.2 Exposure Analysis

As described above, the subcategories corresponding to ICD-9-CM codes 573.1, 573.3, 573.8, and 573.9 were combined into one dependent variable named “viral and other unspecified disorders” for the purposes of statistical analysis. The subcategory of “unspecified disorders of the liver” (ICD-9-CM code 573.9) was analyzed as a separate dependent variable. The subcategories “nonspecific elevation of levels of transaminase or LDH” (ICD-9-CM 790.4), “other nonspecific abnormal serum enzyme levels” (ICD-9-CM 790.5), and “nonspecific abnormal results of liver studies” (ICD-9-CM 794.8) also were analyzed as separate dependent variables, which resulted in statistical analysis of five dependent variables. The following section presents results of the statistical analyses of the dependent variables shown in Table 2-1.

Four models were examined for each dependent variable given in Table 2-1. The analyses of these models are presented below. Further details on dioxin and the modeling strategy are found in Chapters 2 and 7 of the Final Report (1) for the 1997 follow-up of the AFHS, respectively. These analyses were performed both unadjusted and adjusted for relevant covariates. Model 1 examined the relation between the dependent variable and group (i.e., Ranch Hand or Comparison). In this model, herbicide exposure was defined as “yes” for Ranch Hands and “no” for Comparisons without regard to the magnitude of the herbicide exposure. As an attempt to quantify exposure, three contrasts of Ranch Hands and

Comparisons were performed along with the overall Ranch Hand versus Comparison contrast. These three contrasts compared Ranch Hands and Comparisons within each occupational category (i.e., officers, enlisted flyers, and enlisted groundcrew). As described in previous reports and Table 2-8 of the Final Report (1) for the 1997 follow-up of the AFHS, the average levels of dioxin were highest for enlisted groundcrew, followed by enlisted flyers, then officers.

Model 2 explored the relation between the dependent variable and an extrapolated initial dioxin measure for Ranch Hands who had a 1987 dioxin measurement greater than 10 parts per trillion (ppt). If a participant did not have a 1987 dioxin level, the 1992 level was used to estimate the initial dioxin level. If a participant did not have a 1987 or a 1992 dioxin level, the 1997 level was used to estimate the initial dioxin level. A statistical adjustment for the percentage of body fat at the time of the participant's blood measurement of dioxin was included in this model to account for body-fat-related differences in elimination rate (2).

Model 3 divided the Ranch Hands examined in Model 2 into two categories based on their initial dioxin measures. These two categories are referred to as "low Ranch Hand" and "high Ranch Hand." Two additional categories, Ranch Hands with 1987 serum dioxin levels at or below 10 ppt and Comparisons with 1987 serum dioxin levels at or below 10 ppt, were formed and included in the model. Ranch Hands with 1987 serum dioxin levels at or below 10 ppt are referred to as the "background Ranch Hand" category. Dioxin levels in 1992 were used if the 1987 level was not available, and dioxin levels in 1997 were used if the 1987 and 1992 levels were not available. These four categories—Comparisons, background Ranch Hands, low Ranch Hands, and high Ranch Hands—were used in Model 3 analyses. The relation between the dependent variable in each of the three Ranch Hand categories and the dependent variable in the Comparison category was examined. A fourth contrast, exploring the relation of the dependent variable in the combined low and high Ranch Hand categories relative to Comparisons, also was conducted. This combination is referred to in the tables as the "low plus high Ranch Hand" category. As in Model 2, a statistical adjustment for the percentage of body fat at the time of the participant's blood measurement of dioxin was included in this model.

Model 4 examined the relation between the dependent variable and 1987 lipid-adjusted dioxin levels in all Ranch Hands with a dioxin measurement. If a participant did not have a 1987 dioxin measurement, the 1992 measurement was used to determine the dioxin level. If a participant did not have a 1987 or a 1992 dioxin measurement, the 1997 measurement was used to determine the dioxin level.

#### *2.2.2.1 Viral and Other Unspecified Disorders (ICD-9-CM 573)*

All unadjusted and adjusted analyses in Models 1, 3, and 4 were nonsignificant (Table 2-3(a,b,e-h):  $p > 0.10$  for each analysis). The unadjusted Model 2 analysis did not reveal a significant association between viral and other unspecified disorders and initial dioxin (Table 2-3(c):  $p = 0.267$ ). After adjusting for covariates, the results became significant (Table 2-3(d): Adj. RR=1.73,  $p = 0.013$ ). The prevalence of viral and other unspecified disorders among Ranch Hands in the low, medium, and high initial dioxin categories was 3.1 percent, 4.3 percent, and 4.4 percent, respectively.

**Table 2-3. Analysis of Viral and Other Unspecified Disorders**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	866	31 (3.6)	<i>1.01 (0.63,1.61)</i>	<i>0.970</i>
	<i>Comparison</i>	1,240	44 (3.5)		
Officer	Ranch Hand	338	14 (4.1)	1.06 (0.52,2.15)	0.867
	Comparison	486	19 (3.9)		
Enlisted Flyer	Ranch Hand	151	6 (4.0)	1.89 (0.52,6.83)	0.330
	Comparison	187	4 (2.1)		
Enlisted Groundcrew	Ranch Hand	377	11 (2.9)	0.78 (0.37,1.64)	0.514
	Comparison	567	21 (3.7)		

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>1.01 (0.63,1.61)</i>	<i>0.973</i>
Officer	1.10 (0.54,2.23)	0.796
Enlisted Flyer	1.86 (0.51,6.73)	0.346
Enlisted Groundcrew	0.75 (0.36,1.58)	0.453

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
Initial Dioxin Category Summary Statistics			Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup>	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.) <sup>b</sup>	p-Value
Low	159	5 (3.1)	1.20 (0.87,1.65)	0.267
Medium	162	7 (4.3)		
High	160	7 (4.4)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
Analysis Results for Log <sub>2</sub> (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.) <sup>a</sup>	p-Value
478	1.73 (1.11,2.70)	0.013

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with viral and other unspecified disorders.

**Table 2-3. Analysis of Viral and Other Unspecified Disorders (Continued)**

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,202	43 (3.6)		
Background RH	378	12 (3.2)	1.01 (0.52,1.94)	0.986
Low RH	238	9 (3.8)	1.02 (0.49,2.12)	0.968
High RH	243	10 (4.1)	1.03 (0.51,2.09)	0.939
Low plus High RH	481	19 (4.0)	1.02 (0.59,1.78)	0.940

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood draw for dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,201		
Background RH	375	0.94 (0.48,1.83)	0.853
Low RH	237	1.03 (0.49,2.17)	0.934
High RH	241	1.10 (0.52,2.32)	0.812
Low plus High RH	478	1.06 (0.60,1.88)	0.832

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin Category Summary Statistics</b>			<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>p-Value</b>	
Low	286	10 (3.5)	1.13 (0.90,1.43) 0.301	
Medium	285	9 (3.2)		
High	288	12 (4.2)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

**Table 2-3. Analysis of Viral and Other Unspecified Disorders (Continued)**

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>		
Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.) <sup>a</sup>	p-Value
853	1.28 (0.95,1.74)	0.102

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

2.2.2.2 *Unspecified Disorders of the Liver (ICD-9-CM 573.9)*

The unadjusted and adjusted Model 1 analyses of unspecified liver disorders did not show significant differences between Ranch Hands and Comparisons over all occupations or within each occupational stratum (Table 2-4(a,b): p>0.20 for each analysis).

**Table 2-4. Analysis of Unspecified Disorders of the Liver**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	870	19 (2.2)	<i>1.14 (0.62,2.10)</i>	<i>0.673</i>
	<i>Comparison</i>	1,250	24 (1.9)		
Officer	Ranch Hand	341	11 (3.2)	1.61 (0.68,3.84)	0.280
	Comparison	494	10 (2.0)		
Enlisted Flyer	Ranch Hand	151	3 (2.0)	0.93 (0.20,4.21)	0.922
	Comparison	187	4 (2.1)		
Enlisted Groundcrew	Ranch Hand	378	5 (1.3)	0.75 (0.25,2.21)	0.601
	Comparison	569	10 (1.8)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>1.12 (0.61,2.08)</i>	<i>0.709</i>
Officer	1.76 (0.73,4.22)	0.207
Enlisted Flyer	0.84 (0.18,3.85)	0.819
Enlisted Groundcrew	0.67 (0.23,2.02)	0.482

**Table 2-4. Analysis of Unspecified Disorders of the Liver (Continued)**

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
Initial Dioxin Category Summary Statistics			Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup>	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.) <sup>b</sup>	p-Value
Low	160	4 (2.5)	1.10 (0.74,1.64)	0.640
Medium	162	4 (2.5)		
High	160	4 (2.5)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
Analysis Results for Log <sub>2</sub> (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.) <sup>a</sup>	p-Value
479	2.01 (1.03,3.90)	0.036

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with unspecified disorders of the liver.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.) <sup>ab</sup>	p-Value
Comparison	1,212	23 (1.9)		
Background RH	381	7 (1.8)	1.13 (0.48,2.67)	0.783
Low RH	239	6 (2.5)	1.26 (0.50,3.15)	0.619
High RH	243	6 (2.5)	1.13 (0.45,2.84)	0.790
Low plus High RH	482	12 (2.5)	1.19 (0.59,2.44)	0.625

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 2-4. Analysis of Unspecified Disorders of the Liver (Continued)**

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,211		
Background RH	378	0.97 (0.40,2.33)	0.942
Low RH	238	1.30 (0.51,3.29)	0.583
High RH	241	1.20 (0.43,3.31)	0.731
Low plus High RH	479	1.24 (0.59,2.63)	0.566

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	6 (2.1)	1.14 (0.85,1.53)	0.387
Medium	287	7 (2.4)		
High	288	6 (2.1)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
857	1.61 (1.04,2.52)		0.029

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with unspecified disorders of the liver.

The unadjusted Model 2 analysis did not reveal a significant association between initial dioxin and unspecified liver disorders (Table 2-4(c): p=0.640). After adjusting for covariates, a significant positive association was revealed (Table 2-4(d): Adj. RR=2.01, p=0.036). The prevalence of unspecified liver disorders among Ranch Hands in the low, medium, and high initial dioxin categories was 2.5 percent in each category. Further investigations were conducted to examine the effect of each covariate on the adjusted analysis. These investigations showed the change in significance between the unadjusted and adjusted analyses to be due primarily to the effect of military occupation. Among Ranch Hands, officers had the highest percentage of unspecified liver disorders (5.8%), followed by enlisted flyers (1.9%), then enlisted groundcrew (1.5%).

In Model 3, the unadjusted and adjusted analyses of unspecified liver disorders did not reveal significant differences between Comparisons and any of the Ranch Hand dioxin categories (Table 2-4(e,f):  $p > 0.56$  for each contrast).

The unadjusted Model 4 analysis did not uncover a significant association between 1987 dioxin and unspecified liver disorders (Table 2-4(g):  $p = 0.387$ ). After covariate adjustment, the results became significant (Table 2-4(h): Adj. RR=1.61,  $p = 0.029$ ). The prevalence of Ranch Hands with unspecified liver disorders in the low, medium, and high 1987 dioxin category was 2.1 percent, 2.4 percent, and 2.1 percent, respectively. As in Model 2, further investigation showed the change in significance between the unadjusted and adjusted Model 4 analyses to be due primarily to the effect of military occupation. Among Ranch Hands, officers had the highest percentage of unspecified liver disorders (3.3%), followed by enlisted flyers (2.0%), then enlisted groundcrew (1.3%).

### 2.2.2.3 Nonspecific Elevation of Transaminase or LDH Levels (ICD-9-CM 790.4)

All unadjusted and adjusted analyses in Models 1, 2, and 4 showed no significant relations between dioxin and nonspecific elevated transaminase or LDH levels (Table 2-5(a-d,g,h):  $p > 0.16$  for each analysis). The unadjusted Model 3 analyses revealed a significant higher prevalence of nonspecific elevated transaminase or LDH levels between Ranch Hands in the high dioxin category and Comparisons (Table 2-5(e,f): Est. RR=2.45,  $p = 0.030$ ). The increase in prevalence was marginally significant in the adjusted analysis (Adj. RR=2.25,  $p = 0.064$ ). The prevalence of nonspecific elevated transaminase or LDH levels among Ranch Hands in the high dioxin category was 3.7 percent, versus 1.6 percent among Comparisons.

**Table 2-5. Analysis of Nonspecific Elevated Transaminase or LDH Levels**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	<i>870</i>	<i>17 (2.0)</i>	<i>1.17 (0.61,2.23)</i>	<i>0.640</i>
	<i>Comparison</i>	<i>1,251</i>	<i>21 (1.7)</i>		
Officer	Ranch Hand	341	4 (1.2)	0.97 (0.27,3.45)	0.957
	Comparison	494	6 (1.2)		
Enlisted Flyer	Ranch Hand	151	2 (1.3)	0.40 (0.08,2.04)	0.273
	Comparison	187	6 (3.2)		
Enlisted Groundcrew	Ranch Hand	378	11 (2.9)	1.86 (0.77,4.55)	0.169
	Comparison	570	9 (1.6)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>1.14 (0.59,2.17)</i>	<i>0.701</i>
Officer	1.01 (0.28,3.61)	0.990
Enlisted Flyer	0.39 (0.08,1.98)	0.257
Enlisted Groundcrew	1.78 (0.72,4.35)	0.209

**Table 2-5. Analysis of Nonspecific Elevated Transaminase or LDH Levels (Continued)**

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
<b>Initial Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>a</sup></b>	
<b>Initial Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>b</sup></b>	<b>p-Value</b>
Low	160	2 (1.3)	1.17 (0.77,1.79)	0.462
Medium	162	6 (3.7)		
High	160	4 (2.5)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
479	1.30 (0.78,2.17)	0.319

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,213	19 (1.6)		
Background RH	381	4 (1.1)	0.66 (0.22,1.95)	0.448
Low RH	239	3 (1.3)	0.80 (0.24,2.73)	0.724
High RH	243	9 (3.7)	2.45 (1.09,5.51)	0.030
Low plus High RH	482	12 (2.5)	1.41 (0.63,3.14)	0.401

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 2-5. Analysis of Nonspecific Elevated Transaminase or LDH Levels (Continued)**

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,212		
Background RH	378	0.68 (0.23,2.07)	0.502
Low RH	238	0.76 (0.22,2.62)	0.663
High RH	241	2.25 (0.95,5.33)	0.064
Low plus High RH	479	1.31 (0.58,2.97)	0.514

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	4 (1.4)	1.22 (0.89,1.67)	0.224
Medium	287	2 (0.7)		
High	288	10 (3.5)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
857	1.10 (0.77,1.57)		0.608

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

#### 2.2.2.4 Other Nonspecific Abnormal Serum Enzyme Levels (ICD-9-CM 790.5)

All unadjusted and adjusted analyses in Models 1 through 4 showed no significant association between herbicide or dioxin exposure and the prevalence of nonspecific abnormal serum enzyme levels (Table 2-6(a-h): p>0.11 for each analysis).

**Table 2-6. Analysis of Other Nonspecific Abnormal Serum Enzyme Levels**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
<i>All</i>	<i>Ranch Hand</i>	870	92 (10.6)	1.26 (0.94,1.70)	0.118
	<i>Comparison</i>	1,251	107 (8.6)		
Officer	Ranch Hand	341	37 (10.9)	1.28 (0.80,2.03)	0.301
	Comparison	494	43 (8.7)		
Enlisted Flyer	Ranch Hand	151	15 (9.9)	1.26 (0.60,2.68)	0.540
	Comparison	187	15 (8.0)		
Enlisted Groundcrew	Ranch Hand	378	40 (10.6)	1.26 (0.81,1.95)	0.306
	Comparison	570	49 (8.6)		

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	1.25 (0.93,1.69)	0.140
Officer	1.26 (0.79,2.00)	0.335
Enlisted Flyer	1.22 (0.57,2.62)	0.602
Enlisted Groundcrew	1.26 (0.80,1.97)	0.320

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
Initial Dioxin Category Summary Statistics			Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup>	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.) <sup>b</sup>	p-Value
Low	160	17 (10.6)	0.86 (0.68,1.09)	0.196
Medium	162	19 (11.7)		
High	160	14 (8.8)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
Analysis Results for Log <sub>2</sub> (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.) <sup>a</sup>	p-Value
479	0.90 (0.68,1.19)	0.459

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

**Table 2-6. Analysis of Other Nonspecific Abnormal Serum Enzyme Levels (Continued)**

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,213	105 (8.7)		
Background RH	381	41 (10.8)	1.29 (0.88,1.90)	0.188
Low RH	239	28 (11.7)	1.39 (0.90,2.17)	0.140
High RH	243	22 (9.1)	1.03 (0.64,1.68)	0.889
Low plus High RH	482	50 (10.4)	1.20 (0.84,1.72)	0.318

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
Comparison	1,212			
Background RH	378	1.30 (0.88,1.93)		0.192
Low RH	238	1.23 (0.78,1.94)		0.375
High RH	241	1.13 (0.68,1.87)		0.639
Low plus High RH	479	1.18 (0.81,1.70)		0.384

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	30 (10.4)	0.95 (0.82,1.10)	0.505
Medium	287	34 (11.9)		
High	288	27 (9.4)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

**Table 2-6. Analysis of Other Nonspecific Abnormal Serum Enzyme Levels (Continued)**

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
857	0.95 (0.80,1.14)	0.602

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

**2.2.2.5 Nonspecific Abnormal Results of Liver Studies (ICD-9-CM 794.8)**

The unadjusted and adjusted Model 1 analyses of nonspecific abnormal results of liver studies revealed no significant differences between Ranch Hands and Comparisons over all occupations or within each occupational stratum (Table 2-7(a,b): p>0.15 for each contrast).

**Table 2-7. Analysis of Nonspecific Abnormal Results of Liver Studies**

<b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b>					
<b>Occupational Category</b>	<b>Group</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<i>Ranch Hand</i>	870	109 (12.5)	<i>1.14 (0.87,1.48)</i>	<i>0.348</i>
	<i>Comparison</i>	1,251	140 (11.2)		
Officer	Ranch Hand	341	38 (11.1)	1.04 (0.67,1.62)	0.850
	Comparison	494	53 (10.7)		
Enlisted Flyer	Ranch Hand	151	17 (11.3)	0.90 (0.46,1.76)	0.768
	Comparison	187	23 (12.3)		
Enlisted Groundcrew	Ranch Hand	378	54 (14.3)	1.32 (0.89,1.94)	0.164
	Comparison	570	64 (11.2)		

  

<b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b>		
<b>Occupational Category</b>	<b>Adjusted Relative Risk (95% C.I.)</b>	<b>p-Value</b>
<i>All</i>	<i>1.13 (0.86,1.48)</i>	<i>0.385</i>
Officer	1.04 (0.67,1.62)	0.855
Enlisted Flyer	0.82 (0.41,1.65)	0.584
Enlisted Groundcrew	1.33 (0.90,1.96)	0.155

**Table 2-7. Analysis of Nonspecific Abnormal Results of Liver Studies (Continued)**

<b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b>				
<b>Initial Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>a</sup></b>	
<b>Initial Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>b</sup></b>	<b>p-Value</b>
Low	160	15 (9.4)	1.24 (1.03,1.50)	0.026
Medium	162	21 (13.0)		
High	160	30 (18.8)		

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

Note: Low = 27-63 ppt; Medium = >63-152 ppt; High = >152 ppt.

<b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b>		
<b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)</b>		
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
479	1.27 (1.01,1.60)	0.043

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

<b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b>				
<b>Dioxin Category</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Est. Relative Risk (95% C.I.)<sup>ab</sup></b>	<b>p-Value</b>
Comparison	1,213	132 (10.9)		
Background RH	381	42 (11.0)	1.08 (0.75,1.57)	0.667
Low RH	239	24 (10.0)	0.90 (0.57,1.42)	0.645
High RH	243	42 (17.3)	1.62 (1.11,2.37)	0.013
Low plus High RH	482	66 (13.7)	1.21 (0.87,1.67)	0.254

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

**Table 2-7. Analysis of Nonspecific Abnormal Results of Liver Studies (Continued)**

<b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b>			
<b>Dioxin Category</b>	<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Comparison	1,212		
Background RH	378	1.08 (0.73,1.58)	0.707
Low RH	238	0.94 (0.59,1.49)	0.790
High RH	241	1.54 (1.03,2.31)	0.035
Low plus High RH	479	1.21 (0.87,1.68)	0.269

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: Current Dioxin ≤ 10 ppt.

Background (Ranch Hand): Current Dioxin ≤ 10 ppt.

Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

<b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b>				
<b>1987 Dioxin Category Summary Statistics</b>			<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>	
<b>1987 Dioxin</b>	<b>n</b>	<b>Number (%) Yes</b>	<b>Estimated Relative Risk (95% C.I.)<sup>a</sup></b>	<b>p-Value</b>
Low	288	29 (10.1)	1.16 (1.02,1.33)	0.029
Medium	287	31 (10.8)		
High	288	48 (16.7)		

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

<b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>			
<b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b>			
<b>n</b>	<b>Adjusted Relative Risk (95% C.I.)<sup>a</sup></b>		<b>p-Value</b>
857	1.15 (0.98,1.34)		0.082

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Both the unadjusted and adjusted Model 2 analyses revealed significant positive associations between initial dioxin and the prevalence of nonspecific abnormal results of liver studies (Table 2-7(c,d): Est. RR=1.24, p=0.026; Adj. RR=1.27, p=0.043). The prevalence of nonspecific abnormal results of liver studies among Ranch Hands in the low, medium, and high initial dioxin categories was 9.4 percent, 13.0 percent, and 18.8 percent, respectively.

In Model 3, a significant difference between Ranch Hands in the high dioxin category and Comparisons was seen in both the unadjusted and adjusted analyses of nonspecific abnormal results of liver studies (Table 2-7(e,f): Est. RR=1.62, p=0.013; Adj. RR=1.54, p=0.035). The prevalence of nonspecific abnormal results of liver studies among Ranch Hands in the high dioxin category was 17.3 percent, versus 10.9 percent among Comparisons.

A significant positive association between 1987 dioxin and nonspecific abnormal results of liver studies was seen in both the unadjusted and adjusted Model 4 analyses (Table 2-7(g,h): Est. RR=1.16, p=0.029; Adj. RR=1.15, p=0.082). The prevalence of Ranch Hands in the low, medium, and high 1987 dioxin category with nonspecific abnormal results of liver studies was 10.1 percent, 10.8 percent, and 16.7 percent, respectively.

## **2.3 SUMMARY**

### 2.3.1 Model 1: Group Analysis

The Final Report (1) for the 1997 follow-up of the AFHS revealed a marginally significant increase in the prevalence of other liver disorders in Ranch Hands relative to Comparisons (28.8% versus 25.2%) in both the unadjusted analysis (Est. RR=1.20, p=0.067) and the analysis adjusted for covariates (Adj. RR=1.19, p=0.090). The increase in Ranch Hands relative to Comparisons primarily was due to differences in enlisted groundcrew (30.8% versus 25.2%). The increase in other liver disorders in Ranch Hand enlisted groundcrew was marginally significant in both the unadjusted analysis (Est. RR=1.32, p=0.062) and the adjusted analysis (Adj. RR=1.31, p=0.073).

When other liver disorders was subcategorized into the five dependent variables described in Table 2-1, no significant results were found, either when analyzed by occupation or when all occupations were combined. Although no significant results were found in the unadjusted and adjusted analyses of Ranch Hands versus Comparisons, the relative risk was greater than 1.0 for all five dependent variables, indicating more Ranch Hands than Comparisons with a liver disorder. When the unadjusted and adjusted analyses were performed for enlisted groundcrew, three of the five dependent variables showed a relative risk greater than 1.0. Although nonsignificant, the relative risk for nonspecific elevation of levels of transaminase or LDH in enlisted groundcrew was 1.86 for the unadjusted analysis (p=0.169) and 1.78 for the adjusted analysis (p=0.209). These observations may explain, in part, the significant relation between group and other liver disorders in the Final Report (1) for the 1997 follow-up of the AFHS.

### 2.3.2 Model 2: Initial Dioxin Analysis

In the Final Report (1) for the 1997 follow-up of the AFHS, the association between other liver disorders and initial dioxin in Ranch Hands was nonsignificant in the unadjusted analysis (p=0.119), but was significant after adjustment for covariates (Adj. RR=1.23, p=0.022). The prevalence of Ranch Hands with other liver disorders in the low, medium, and high initial dioxin categories was 24.5 percent, 32.7 percent, and 34.4 percent, respectively.

The adjusted analysis of the subcategorization of other liver disorders into the five dependent variables described in Table 2-1 showed significant positive associations with initial dioxin for three dependent variables. Viral and other unspecified disorders (Adj. RR=1.73, p=0.013), unspecified disorders of the liver (Adj. RR=2.01, p=0.036), and nonspecific abnormal results of liver studies (Adj. RR=1.27, p=0.043) were significantly related to initial dioxin.

### 2.3.3 Model 3: Categorized Dioxin Analysis

In the Final Report (1) for the 1997 follow-up of the AFHS, Ranch Hands in the high dioxin category had a significantly greater prevalence of other liver disorders than did Comparisons (34.2% versus 24.9%) in both the unadjusted analysis (Est. RR=1.49, p=0.009) and in the adjusted analysis (Adj. RR=1.52, p=0.009). This increase in other liver disorders for Ranch Hands in the high dioxin category relative to

Comparisons also was illustrated in the contrast of Ranch Hands in the low plus high dioxin category and Comparisons (Est. RR=1.28, p=0.042; Adj. RR=1.27, p=0.055).

The adjusted analysis of the subcategorization of other liver disorders into the five dependent variables described in Table 2-1 showed a significant increase in nonspecific abnormal results of liver studies for Ranch Hands in the high dioxin category (Adj. RR=1.54, p=0.035). A marginally significant increase in nonspecific elevation of transaminase or LDH levels for Ranch Hands in the high dioxin category (Adj. RR=2.25, p=0.064) was also observed.

#### 2.3.4 Model 4: 1987 Dioxin Level Analysis

In the Final Report (1) for the 1997 follow-up of the AFHS, the association between other liver disorders and 1987 dioxin in Ranch Hands was marginally significant in both the unadjusted and adjusted analyses (Est. RR=1.10, p=0.055 for the unadjusted analysis; Adj. RR=1.11, p=0.077 in the adjusted analysis). The prevalence of Ranch Hands with other liver disorders in the low, medium, and high 1987 dioxin categories was 25.5 percent, 26.7 percent, and 33.7 percent, respectively.

The adjusted analysis of the subcategorization of other liver disorders into the five dependent variables described in Table 2-1 showed a significant positive association with 1987 dioxin for unspecified disorders of the liver (Adj. RR=1.61, p=0.029). A marginally significant positive association between nonspecific abnormal results of liver studies and 1987 dioxin (Adj. RR=1.15, p=0.082) also was observed.

## REFERENCES

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