CHAPTER 12

PSYCHOLOGICAL ASSESSMENT

INTRODUCTION

Background

Although some epidemiologic studies in humans have associated chronic psychologic disorders with the perception of herbicide exposure (1), a direct causal relationship implicating 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD, or dioxin) has not been proven. Experimental animal studies provide little insight into potential psychological consequences of TCDD exposure in humans. Signs of toxicity in animals (lethargy, stupor, poor coordination, lack of feeding, and agitation) have been observed in multiple studies involving many species and have been attributed to the "wasting syndrome" of multi-organ toxicity rather than to primary central nervous system (CNS) toxicity (2). In rats exposed to high doses of TCDD (1,000 micrograms intraperitoneally), only slight differences were noted in spontaneous motor activity and maze performance relative to controls (3).

Experiments in monkeys exposed perinatally to TCDD may be more relevant to human experience. Several published reports have documented behavioral dysfunction and subtle cognitive impairment in monkeys exposed to TCDD (by maternal ingestion) while in utero and during nursing (4-6).

Studies attempting to defii human psychological and behavioral disorders related to TCDD exposure often are flawed by a number of limitations including the bias of self-reporting, the lack of confirmation by psychological testing, and unreliable indices of exposure. Using chloracne as a marker for high-level exposure, early studies of industrial chemical workers provided the first suggestion of psychological effects. Studies shortly after a Nitro, West Virginia, accident in 1949 documented nervousness, fatigue, irritability, cold intolerance, and decreased libido in many of the workers with chloracne. Most of these symptoms resolved over a 4-year period (7,8). Two followup studies of expanded plant cohorts in 1979 noted a strong association between chloracne and insomnia (9,10). None of the studies included validation by neurobehavioral testing.

Other industrial-based studies reported a wide range of acute and subacute subjective symptoms including fatigue, decreased libido, impotence, sleep disturbances, reduced emotional responses, sensory deficits, reading difficulties, memory loss, and emotional disorders (11-17). One study found a relationship between chloracne and hypomania as reflected in the Minnesota Multiphasic Personality Inventory (MMPI) (18). Another study noted that two of three chemists involved in the synthesis of TCDD developed marked personality changes (19). Although data interpretation problems exist, a Czechoslovakian 10-year followup study cited eight cases of severe dementia in exposed workers and reported that symptoms of anxiety and depression decreased over the followup period (17).

A contemporary cross-sectional morbidity study of residents of a mobile-home park environmentally contaminated with dioxin documented psychological changes in the exposed group (20). Significant abnormalities were recorded in the exposed group for the tension or anxiety scale and the anger or hostility scale of the Profile of Mood States Inventory as well as the vocabulary subtest of the Wechler Adult Intelligence Scale (WAIS). However, cerebral function, as assessed by the Halstead-Reitan Battery (HRB), revealed no significant group differences.

As one of the few epidemiologic studies in humans to incorporate serum dioxin data into psychometric analyses, the National Institute for Occupational Safety and Health (NIOSH) study of chemical plant workers deserves special mention (21). This cross-sectional study of 281 workers in two industrial plants investigated the association between exposure to chemicals (including TCDD) and symptoms of depression revealed by a well-established battery of psychologic screening tests (the Beck Depression Inventory and the depression subscale of the Symptom Checklist-90-Revised [SCL-90-R]). The mean serum TCDD level in the exposed cohort was 220 parts per trillion (ppt) versus 6 ppt in referents. By both scales the prevalence of depression was comparable in each group. Of interest and consistent with numerous other reports, the self-perception of TCDD exposure was significantly associated with depressive symptoms though the mean serum TCDD level in those thought to have been exposed (43 ppt) was significantly lower than that in the group reporting no such exposure (116 ppt).

The association of psychological symptoms with the self-perception of exposure to Agent Orange was reported in a Veterans' Administration study of 153 veterans undergoing treatment for substance abuse (22). Though no attempt was made to document actual exposure objectively, a subgroup of 58 patients self-reporting moderate to high herbicide exposure was compared to the remaining 95 patients reporting no or minimal exposure. When adjusted for age, education, and degree of combat experience, the self-perceived exposed group scored significantly higher in the MMPI scales of depression, poor morale, organic symptoms, family problems, and hypomania.

In addition to unreliable herbicide exposure estimates, the study of psychopathology in veterans is further complicated by the confounding effects of combat stress and post-traumatic stress disorder (PTSD) as defined by the American Psychiatric Association (23). Though the true prevalence of PTSD in Vietnam veterans is uncertain (24,25), 18 percent of the nearly 100,000 Vietnam veterans registered in the Veterans' Administration Agent Orange Registry in 1983 complained of "nervousness," and 10 percent reported personality disorders (26). In a group of 132 veterans included in the registry (most of whom were selected for inclusion in the study based on referral for psychotherapy), 53 percent met criteria for PTSD based on symptoms of sleep disorders (53%), mood depression (36%), suicidal thoughts (35%), and irritability (31%) (27). Many studies have attempted to investigate the relationship between PTSD and herbicide exposure in Vietnam veterans. The methods employed to determine exposure included self-reporting, use of chloracne symptoms (both self-reported and medically diagnosed), and various attempts to link the geographic location of a veteran during service in Vietnam to areas of herbicide use. All of these methods have questionable validity. Self-reporting has been shown to be highly inaccurate for most applications (28). One study in which chloracne was used as an index of exposure

examined six Vietnam veterans and 25 control subjects selected from the same sample group. Evidence was found for significant psychological disorders in the exposed subjects based on the results of a neuropsychological battery (29). Principal limitations of the study included the small sample size and lack of histologic confirmation of chloracne diagnosis.

Another large-scale study of 6,810 Vietnam-era veterans who are members of the American Legion found that, although perceived exposure to herbicides could not independently predict psychosocial outcomes, it was associated with such outcomes when combined with combat, indicating that a synergistic effect may have occurred (30). Principal limitations of the study include the lack of medical and psychological record review and exposure verification.

Although not specifically designed to investigate endpoints from Agent Orange exposure, the Vietnam Experience Study (VES) by the U.S. Centers for Disease Control, included comprehensive psychological testing in Vietnam and non-Vietnam veterans (31). Results revealed an increased incidence of psychological dysfunction related to service in Vietnam including depression (4.5 % of Vietnam veterans versus 3.2% in non-Vietnam veterans), anxiety (4.9 % versus 3.2 %), and alcohol abuse or dependence (13.7 % versus 9.2%).

Prior reports of the Air Force Health Study (AFHS) (32-34) have revealed few statistically significant differences in the psychologic indices between the Ranch Hand and Comparison cohorts. Furthermore, in the most recent analyses based on serum dioxin levels (35), psychological and psychosocial disorders in Ranch Hands appear unrelated to the body burden of TCDD.

Summary of Previous Analyses of the Air Force Health Study

1982 *Baseline Study Summary Results*

An extensive battery of psychological parameters was assessed on all participants during the 1982 Baseline questionnaire and physical examination. The expected high degree of concordance between education (college, high school) and military rank (officer, enlisted) was observed and validated the use of education as the sole covariate representing socioeconomic status for most analyses.

There were no questionnaire differences for past history of emotional or psychological illnesses between the Ranch Hand and Comparison groups. For the psychological indices of fatigue, anger, erosion, anxiety, and severity of depression (as determined by a modification of the Diagnostic Interview Schedule), no group differences were detected among the college-educated Ranch Hands. However, for the high-school-educated stratum, Ranch Hands demonstrated significantly more fatigue, anger, erosion, and anxiety. An unadjusted analysis of reported depression showed significantly more depression in the Ranch Hands, as did the isolation index adjusted for educational level.

At the time of the physical examination, additional self-reported data were collected with the Cornell Index and the MMPI. The CNS functional testing was conducted by a modified HRB, and intelligence was measured by the WAIS.

The Cornell Index showed a significant increase in psychophysiologic symptoms in the high school-educated Ranch Hands. In Ranch Hands, 6 of 10 parameters of the Cornell Index were abnormal (e.g., fear, startle, psychosomatic), as contrasted to the Comparisons, and all abnormal responses and parameters were inversely related to education to a statistically significant degree. MMPI results in the high-school-educated participants showed differences in the scales of denial, hypochondria, masculinity-femininity, and mania-hypomania as contrasted to the college-educated participants. Only the social introversion scale was significant in the college-educated participants. The effect of education was influential ($p < 0.01$) in all scales of the MMPI. Race was not a significant covariate. None of the self-reported data, including those from the in-home questionnaire, were adjusted for possible group differences in PTSD or combat experience and intensity.

Performance testing by the HRB showed no neuropsychiatric impairment in the Ranch Hands in contrast to the results of the self-administered MMPI and the Cornell Index. The effect of education on the HRB testing was strong ($p < 0.0001$). WAIS intelligence scores revealed very close group similarities in the full-scale and verbal and performance scales. As expected, the intelligence quotient (IQ) of college graduates was significantly higher than the IQ of high school graduates.

1985 ***Followup Study Summary Results***

Two of the psychological tests (MMPI, HRB) conducted at the 1982 Baseline examination were repeated at the first followup examination in 1985. An updated history of mental and emotional disorders and combat experience in Vietnam also was obtained on all participants. An indicator of PTSD was derived from a new MMPI subscale and was used for covariate adjustments of non-MMPI psychological data. The Cornell Medical Index (CMI) was substituted for the Cornell Index in the 1985 psychological assessment. Questionnaire data (verified by medical record reviews) for the lifetime events of psychotic illness, alcohol dependence, anxiety, or other neuroses disclosed no significant differences between groups for these conditions.

The similarity of the group distribution for the 14 MMPI variables, each stratified by the 3 occupational categories, was examined, and only 2 of the 42 tests approached statistical significance (masculinity-feminity for enlisted flyers and validity for officers). The group distributions of the total CMI score were simiiarly contrasted, with separate analyses performed with stratification by the five covariates of age, race, occupation, education, and current alcohol drinking status. For one stratum of each of these covariates (born in or after 1942, non-Black, enlisted groundcrew, high school education, and current alcohol drinker), a significant difference in the distribution of the Ranch Hand and Comparison scores was found. In all cases for the CMI, the Ranch Hand mean was greater than the Comparison mean.

The unadjusted analyses showed a significant difference for the MMPI scales of denial ($p<0.001$) and masculinity-femininity ($p=0.017$), the total CMI ($p<0.001$), and the Section A-H area subscore ($p=0.003$). A marginally significant difference was observed for the MMPI scales of hysteria ($p=0.067$) and social introversion ($p=0.069$). Comparisons had a greater percentage of abnormal scores for the denial and masculinity-femininity scales, whereas Ranch Hands showed adverse findings for the other four variables.

The adjusted analyses were generally quite similar to the unadjusted analyses with respect to group differences. The MMPI scales of denial and masculinity-femininity were statistically significant in both the adjusted and unadjusted analyses, where Comparisons showed an adverse effect over Ranch Hands. The A-H subscore of the CMI (suggesting diffise medical problems) also was significant, where Ranch Hands had higher mean scores than Comparisons, suggesting that Ranch Hands had more illness. The M-R subscore of the CMI, a broad indicator of emotional health, was not statistically different between the two groups.

The HRB impairment index, a measure of CNS functional integrity, did not differ significantly between the Ranch Hand and Comparison groups. Strong covariates in the adjusted analysis were age, race, and education.

Because of alternate statistical models and slightly different psychological testing parameters, a direct contrast between the psychological results of the Baseline and 1985 followup examinations was not always possible. However, several broad patterns were observed: the discordance between distributional tests and results from traditional statistical models of the MMPI variables was noted with data from both examinations; there was a narrowing of group differences at the 1985 followup examination for most subjective variables, either by a decrease in Ranch Hand reporting, or by an increase in Comparison reporting; and as at the Baseline, functional CNS testing, as measured by the HRB impairment index, showed no group differences, and did not support an organic basis for differences in self-reported symptomatology. The longitudinal analysis of two MMPI scales, depression and denial, showed a significant reversal of depression seen at Baseline in the high-school-educated Ranch Hands-the number of depression abnormalities decreased in Ranch Hands and increased in Comparisons.

The determination of PTSD in both Air Force cohorts by a relatively new MMPI scale showed a prevalence rate of less than 1 percent. This low rate is strongly influenced by characteristics of the study population (e.g., age, education, and officer ratio).

In conclusion, significant test results were present in both groups or were noted in specific subgroups of a covariate. Educational level, age, and alcohol use showed strong effects on the psychological scales and scores in this psychological assessment. Tests of the CNS by the HRB demonstrated an almost identical prevalence of abnormality in both groups.

1987 *Followup Study Summary Results*

The psychological assessment was based on verified psychological disorders, reported sleep disorders, and two clinical psychological tests-the SCL-90-R and the Millon Clinical

Multiaxial Inventory (MCMI). The verified data on lifetime psychological disorders showed no group differences for psychoses, drug dependence, and anxiety. However, marginally more Ranch Hands than Comparisons had a verified history of alcohol dependence and "other neuroses" based on unadjusted analyses. The Ranch Hands reported experiencing great or disabling fatigue during the day and talking in their sleep more frequently than the Comparisons. No group differences were detected in the other 13 sleep disorder variables in the unadjusted analyses. Although no significant differences between the Ranch Hands and the Comparisons were found in the unadjusted analyses of the 12 SCL-90-R variables, the Ranch Hands had marginally more abnormalities than the Comparisons for depression, somatization, and an index of the general severity of symptoms. The results of the unadjusted analyses of the MCMI scores revealed that the Ranch Hands had significantly higher mean antisocial and paranoid scores than the Comparisons. Marginally significant differences were identified on the narcissistic and psychotic delusion scores, where the mean score of the Ranch Hands exceeded that of the Comparisons. After adjustment for the covariates, a significant difference remained on the narcissistic score. The Comparisons had a significantly higher mean dependent score than the Ranch Hands.

Serum Dioxin Analysis of 1987 Followup Study Summary Results

In general, the results of the analyses of the verified psychological disorders, reported sleep disorders, and the SCL-90-R variables did not reveal significant associations with initial dioxin or current dioxin and time since tour of duty or find significant differences among the four current dioxin categories. In contrast, several of the analyses of the MCMI variables displayed significant results. However, there was a lack of consistency across similar variables included in the SCL-90-R, MCMI, and reported information. Additionally, the continuous scale of the MCMI variables allowed for a greater ability to detect small differences in the mean MCMI scores than the capability of the discrete analyses of the other three psychological abnormalities. In conclusion, the body burden of dioxin does not appear to be related to psychological or psychophysiological disorders.

Parameters of the Psychological Assessment

Dependent Variables

Data collected through the SCL-90-R were used in the psychological assessment. Additionally, psychological disorders, as verified through medical records review, were used to supplement the psychological evaluation for the 1992 followup.

Medical Records Data

At the face-to-face interview of the 1992 examination, each participant was asked whether he has had a mental or emotional disorder since the date of his last interview. Reported disorders for which treatment was obtained were subsequently verified by reviews of medical records. Information on verified psychological disorders from the 1992 examination was combined with information on verified disorders from the Baseline, 1985 followup, and 1987 followup examinations, and a series of dependent variables regarding verified history of psychological disorders were created. In particular, the verified histories

of psychoses, alcohol dependence, drug dependence, anxiety, and an International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM) diagnostic code-based category of "other neuroses" (ICD codes 300-302, 305-309, and 311) were studied.

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

Physical **Examination Data**

The SCL-90-R, used by the AFHS at the 1987 followup, was used again in the psychological assessment. The SCL-90-R is a multidimensional self-reported symptom inventory designed to measure symptomatic psychological distress in terms of nine primary symptom dimensions and three global indices of distress (36). Each participant was asked to respond to 90 questions in terms of a 5-point scale as follows: 0=not at all, 1 =a little bit, 2=moderately, 3 =quite a bit, and 4=extremely. Responses were grouped into the nine primary symptom categories, and a raw score for a participant for a category was determined by adding the scores of the answered questions in that category and dividing by the number of answered questions in that category. The raw scores then were converted to T-scores (reference scores for a given population norm) for analysis. These nine categories are anxiety, depression, hostility, interpersonal sensitivity, obsessive-compulsive behavior, paranoid ideation, phobic anxiety, psychoticism, and somatization. These symptom categories are defined in Appendix H- 1.

The following three global indices also were analyzed: the global severity index (GSI), the positive symptom total (PST), and the positive symptom distress index (PSDI). The GSI is defined as the sum of the scores of all answered questions divided by the number of answered questions on the entire test. This index combines information on the number of symptoms and the intensity of distress. The PST is the number of questions to which the participant responds positively (i.e., on the 5-point scale, responses 1, 2, 3, or 4). The PSDI is determined by adding the scores of all answered questions and dividing by the PST. This index describes the intensity of the positive symptoms. Each of these indices also were converted to a T-score. The T-scores for the nine primary symptom dimensions and the three global indices were then classified as high or normal, where high is defined as a T-score of 63 or greater (36). All participants were included in the analyses of the nine primary symptom dimensions and the three global indices of distress, including those participants who responded "not at all" to all 90 questions. These indices are described more fully in Appendix H-l.

Participants who tested positive for HIV were excluded from the analysis of the SCL-90-R variables.

Covariates

Covariates examined in the adjusted statistical analyses of the psychological assessment included age, race, military occupation, education level (high school, college), current alcohol *use* (drinks/day), lifetime alcohol history (drink-years), current total household income, current employment (yes, no), current marital status (married, not married), current parental status (currently having a child under the age of 18: yes, no), and combat service (number of days). Age, current alcohol use, lifetime alcohol history, current total household income, and combat service were used in the continuous form for modeling purposes for general linear models and logistic regression analyses. 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 $100,000 used for the $100,000 or more category. Educational level, current employment, current parental status, and marital status are all based on self-reported information from the questionnaire. Covariates were discretized as necessary for tabular presentations of covariate interactions with group or dioxin.

The lifetime alcohol history and current alcohol use covariates were based on self-reported information from the 1992 questionnaire and combined with similar information gathered at the 1987 followup. For lifetime alcohol history, the respondent's average daily alcohol consumption was determined for various drinking stages throughout his lifetime, and an estimate of the corresponding total number of drink-years (1 drink-year = 365 drinks) was derived. The current alcohol use covariate was based on the average number of drinks per day for the month prior to completing the questionnaire. These covariates were not used in adjusted analyses for the alcohol dependence variable.

For the historical dependent variables based on medical records data, the covariates based on current condition (current total household income, current employment, current marital status, and current parental status) are used as surrogate information to describe the participant's life experience. Current alcohol use was examined in the analyses of the psychological examination variables only. This covariate could not affect the results of a variable based on post-SEA history, and lifetime alcohol history is used to investigate the cumulative effects of alcohol.

Statistical Methods

Chapter 7, Statistical Methods describes the basic statistical methods used throughout this report. The modeling strategy was modified for the adjusted analyses of the psychological endpoints. For these variables, only the covariate main effects and group-by-covariate or dioxin-by-covariate interactions were examined; the pairwise covariate interactions were not investigated because of the large number of covariates.

Table 12-1 summarizes the statistical analyses performed for the 1992 psychological assessment. The first part of this table lists the dependent variables analyzed, data source, data form, cutpoints, candidate covariates, and statistical analysis methods. The second part of this table provides a description of candidate covariates examined. Abbreviations used in the body of the table are defined at the end of the table.

Table 12-1.
Statistical Analyses for the Psychological Assessment

Dependent Variables

Variable (Units)	Data Source	Data Form	Cutpoints	Candidate Covariates	Statistical Analyses
Psychoses	MR-V	D	Yes No	AGE,RACE,OCC, DRKYR,EDUC, INC,EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
Alcohol Dependence	MR-V	D	Yes No	AGE,RACE,OCC, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
Drug Dependence	MR-V	D	Yes No	AGE,RACE,OCC, DRKYR,EDUC, INC,EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
Anxiety	MR-V	D	Yes No	AGE,RACE,OCC, DRKYR,EDUC, INC,EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
Other Neuroses	MR-V	D	Yes No	AGE,RACE,OCC, DRKYR,EDUC, INC,EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Anxiety	PE	D	High: $T \geq 63$ Normal: $T < 63$	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Depression	PE	D	High: $T \geq 63$ Normal: $T < 63$	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR

Table 12-1. (Continued)
Statistical Analyses for the Psychological Assessment

Variable (Units)	Data Source	Data Form	Cutpoints	Candidate Covariates	Statistical Analyses
SCL-90-R Hostility	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Interpersonal Sensitivity	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Obsessive-Compulsive Behavior	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Paranoid Ideation	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Phobic Anxiety	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Psychoticism	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUC,INC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR

Table 12-1. (Continued)
Statistical Analyses for the Psychological Assessment

Variable (Units)	Data Source	Data Form	Cutpoints	Candidate Covariates	Statistical Analyses
SCL-90-R Somatization	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUC,INC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Global Severity Index (GSI)	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUC,INC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Positive Symptom Total (PST)	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUCJNC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR
SCL-90-R Positive Symptom Distress Index (PSDI)	PE	D	High: T≥63 Normal: T<63	AGE,RACE,OCC, ALC,DRKYR, EDUC,INC, EMPLOY, MARITAL, PARENT, COMBDAYS	U:LR,CS A:LR

Covariates

Variable (Abbreviation)	Data Source	Data Form	Cutpoints
Age (AGE)	MIL	D/C	Born ≥1942 Born <1942
Race (RACE)	MIL	D	Black Non-Black
Occupation (OCC)	MIL	D	Officer Enlisted Flyer Enlisted Groundcrew
Current Alcohol Use (ALC) (drinks/day)	Q-SR	D/C	o-1 >1-4 >4

Table 12-1. (Continued)
Statistical Analyses for the Psychological Assessment

Covariates

Variable (Abbreviation)	Data Source	Data Form	Cutpoints
Lifetime Alcohol History (DRKYR) (drink-years)	Q-SR	D/C	0 > O-40 >40
Education (EDUC)	Q-SR	D	College High School
Current Total Household Income (INC)	Q-SR	D/C	≤$55,000 >$55,000
Current Employment (EMPLOY)	Q-SR	D	Yes No
Current Marital Status (MARITAL)	Q-SR	D	Married Not Married
Current Parental Status (PARENT)	Q-SR	D	Child < 18 years old No child < 18 years old
Combat Service (COMBDAYS)	MIL	D/C	< 360 days ≥ 360 days

Abbreviations

Data Source:
- LAB = 1992 laboratory results
- MIL = Air Force military records
- MR-V = Medical records (verified)
- PE = 1992 physical examination
- Q-SR = Health questionnaire (self-reported)

Data Form:
- C = Continuous analysis only
- D = Discrete analysis only
- D/C = Appropriate form for analysis (either discrete or continuous)

Statistical Analyses:
- U = Unadjusted analyses
- A = Adjusted analyses
- L = Longitudinal analyses

Statistical Methods:
- CS = Chi-square contingency table analysis (continuity-adjusted for 2x2 tables)
- LR = Logistic regression analysis

Dependent variable data were missing for some participants. The number of participants with missing data and the number of participants excluded due to pre-SEA conditions or because they tested positive for HIV are provided in Table 12-2.

Analyses of data collected at the 1987 followup study indicated that dioxin was associated with military occupation. In general, enlisted personnel had higher levels of dioxin than officers, with enlisted groundcrew having higher levels than enlisted flyers. Consequently, adjustment for military occupation in statistical models using dioxin as a measure of exposure may improperly mask an actual dioxin effect. However, occupation also can be a surrogate for socioeconomic effects. Failure to adjust for occupation could overlook important risk factors related to lifestyle. If occupation was found to be significantly associated with a dependent variable in the 1992 followup analyses and was retained in the final statistical models using dioxin as a measure of exposure, the dioxin effect was evaluated in the context of two models. Analyses were performed with and without occupation in the final models to investigate whether conclusions regarding the association between the health endpoint and dioxin differed.

The results of the analyses without occupation are presented in Appendix H-3 and are only discussed in the text if the level of significance differs from the original final adjusted model (significant versus nonsignificant).

RESULTS

Dependent Variable-Covariate Associations

Tests of association between the psychological dependent variables and the candidate covariates were conducted, and results are presented in Appendix Table H-l-l. These associations are based on combined group data. Participants with a verified pre-SEA history of a psychological disorder were excluded from the analyses pertaining to that disorder. Additionally, participants who tested positive for the HIV virus were excluded from all analyses.

History of psychoses was found significantly associated only with current marital status ($p < 0.001$). The greater history was among participants who were not currently married at the time of the examination.

History of alcohol dependence was significantly associated with occupation ($p = 0.009$), with the highest percentage among the enlisted flyers. Participants with only a high school education displayed a higher history of alcohol dependence ($p = 0.007$), as did those participants with a current total household income less than or equal to $55,000 ($p < 0.001$). The higher history of alcohol dependence was among those participants not currently married ($p < 0.001$). Participants who were not married at the time of the examination also demonstrated a significantly higher history of drug dependence ($p = 0.022$).

Table 12-2.
Number of Participants with Missing Data for, or Excluded from, the Psychological Assessment

Variable	Variable Use	Group		Dioxin (Ranch Hands Only)		Categorized Dioxin	
		Ranch Hand	Comparison	Initial	Current	Ranch Hand	Comparison
12 SCL-90-R T-Scores	DEP	1	1	1	1	1	1
Current Alcohol Use	COV	10	18	7	9	9	16
Lifetime Alcohol History	COV	22	21	13	20	20	18
Current Total Household Income	COV	11	18	4	11	11	15
Current Employment	COV	0	2	0	0	0	2
Current Marital status	COV	0	2	0	0	0	0
Pre-SEA Alcohol Dependence	EXC	0	1	0	0	0	0
Pre-SEA Anxiety	EXC	5	3	2	4	4	3
Pre-SEA Other Neuroses	EXC	13	12	6	13	13	11
HIV Positive	EXC	3	1	2	3	3	1

Abbreviations: DEP = Dependent variable (missing data).
COV = Covariate (missing data).
EXC = Exclusion.

Note: 952 Ranch Hands and 1,281 Comparisons;
520 Ranch Hands for initial dioxin; 894 Ranch Hands for current dioxin;
894 Ranch Hands and 1,063 Comparisons for categorized dioxin.
One Ranch Hand missing total lipids for current dioxin.

The anxiety variable was significantly associated with age, indicating younger participants had a higher history of anxiety ($p=0.041$). Occupation also was significantly associated with anxiety ($p<0.001$), with the highest history of anxiety among enlisted groundcrew, followed by enlisted flyers and then officers. Additionally, education level and current total household income each demonstrated a significant inverse association with anxiety ($p<0.001$ for both associations). Those participants only a high-school education and those with an income of less than or equal to $55,000 had a higher incidence of anxiety. Participants who were currently unmarried at the time of the examination exhibited a significantly higher history of anxiety than participants who were currently married ($p=0.001$).

Tests for the other neuroses variable revealed several highly significant associations. Among the occupational strata, enlisted flyers exhibited the most history of other neuroses ($p<0.001$). Also, a significant association between other neuroses and lifetime alcohol history was found ($p<0.001$). The history of other neuroses increased as the number of drink-years increased. Significantly higher histories of other neuroses were found for the high-school-educated participants, those with a current total household income less than or equal to $55,000, those not currently employed, and participants not currently married ($p<0.001$, $p<0.001$, $p=0.040$, and $p<0.001$ respectively).

SCL-90-R anxiety and SCL-90-R depression scores displayed similar association test results. Enlisted groundcrew exhibited the greatest percentage of high SCL-90-R anxiety T-scores and enlisted flyers exhibited the greatest percentage of high SCL-90-R depression T-scores ($p<0.001$ for each of the associations with occupation). The greatest percentage of high T-scores for both SCL-90-R anxiety and SCL-90-R depression were among participants in the greater than 40 drink-years category ($p=0.005$ and $p=0.003$ respectively for associations with lifetime alcohol history). The 0 drink-years category was next highest for both variables, followed by the greater than 0 to 40 drink-years category. Both scores were highest for the high-school-educated participants ($p<0.001$ for each score), participants with a current total household income less than or equal to $55,000 ($p < 0.001$ for each), those not currently employed ($p=0.010$ and $p=0.001$ respectively), and participants not currently married ($p=0.002$ and $p<0.001$ respectively).

The SCL-90-R hostility score and occupation were found to be significantly associated with the largest percentage of high T-scores among the enlisted flyers($p<0.001$). The association with lifetime alcohol history was also significant($p=0.020$). The percentage of high T-scores increased as the number of drink-years increased. Significant associations also were found with each of education and current total household income ($p<0.001$ and $p=0.001$ respectively). T-scores were highest for the high-school-educated participants and those with a current total household income less than or equal to $55,000.

The percentages of SCL-90-R interpersonal sensitivity T-scores decreased with age ($p=0.009$) and occupation ($p<0.001$; enlisted groundcrew exhibited the highest percentage). Participants whose highest education level was high school, participants whose current total household income was less than or equal to $55,000, and participants who were not currently married each displayed the larger percentages of high SCL-90-R interpersonal sensitivity T-scores ($p<0.001$, $p<0.001$, and $p=0.001$ respectively).

Examination of SCL-90-R obsessive-compulsive behavior revealed a significant association with occupation ($p < 0.001$), with the greatest percentage of high T-scores among the enlisted flyers. Lifetime alcohol history also was associated with obsessive-compulsive behavior, with the largest percentage among participants with more than 40 drink-years ($p = 0.003$). Similar to other SCL-90-R measurements, the larger percentage of high obsessive-compulsive T-scores were for the high-school-educated participants ($p < 0.001$), participants with a current total household income less than or equal to $55,000 ($p < 0.001$), and those not currently employed ($p = 0.003$).

The percentage of high SCL-90-R paranoid ideation T-scores was greater for Blacks than non-Blacks and higher for enlisted groundcrew and enlisted flyers than for officers ($p = 0.016$ and $p < 0.001$ respectively). As the number of lifetime drink-years of alcohol increased, the percentage of high T-scores also increased ($p = 0.017$). Larger percentages of high T-scores were found among participants who were high-school educated only ($p < 0.001$) and among participants with a current total household income less than or equal to $55,000 ($p < 0.001$). Participants not currently married also displayed the higher percentage of high T-scores ($p = 0.005$).

Several covariates demonstrated a significant association with SCL-90-R phobic anxiety. Occupation was significantly associated ($p < 0.001$) and percentages of high T-scores increased from officers to enlisted flyers to enlisted groundcrew. The association with current alcohol use was also significant, with the heaviest current drinkers (greater than 4 drinks per day) having the largest percentage of high T-scores ($p = 0.010$). The lifetime alcohol history association also was significant and displayed the greatest percentage of high T-scores among participants in the 0 drink-years stratum ($p = 0.017$). Significantly higher percentages of high T-scores also were found for the high-school-educated participants, participants with a current total household income less than or equal to $55,000, those not currently employed, and those not currently married ($p < 0.001$ for education, current total household income, and current employment; $p = 0.009$ for current marital status).

Tests of association involving SCL-90-R psychoticism revealed significantly more Blacks than non-Blacks had a higher T-score ($p = 0.042$), and percentages of high T-scores increased from officers to enlisted flyers to enlisted groundcrew ($p < 0.001$). The lifetime alcohol history association also was significant ($p = 0.005$). Participants in the greater than 40 drink-years category displayed the largest percentage of high T-scores. Greater percentages of high T-scores were found for high-school-educated participants and among those with a current total household income less than or equal to $55,000 ($p < 0.001$ for both tests). Participants indicating that they were not currently employed, and those not currently married also displayed the larger percentage of high T-scores ($p = 0.001$ and $p = 0.004$ respectively).

SCL-90-R somatization was significantly associated with occupation ($p < 0.001$), education ($p < 0.001$), current total household income ($p < 0.001$), current'employment ($p = 0.001$), and current marital status ($p < 0.001$). Results were similar to the results observed for SCL-90-R psychoticism.

Results of association tests involving SCL-90-R global severity index and SCL-90-R positive symptom total were similar. Enlisted groundcrew and those participants with more than 40 lifetime drink-years of alcohol exhibited the greatest percentage of high T-scores for both variables ($p \leq 0.001$ for each test). Patterns of percentages of high T-scores for both variables for education, current total household income, current employment, and current marital status are similar in direction and significance to patterns for SCL-90-R psychoticism ($p < 0.001$ for education, current total household income, and current marital status; $p = 0.006$ and $p = 0.005$ respectively, for the associations between current employment and the SCL-90-R global severity index and SCL-90-R positive symptom total).

Occupation, current alcohol use, education, and current total household income were significantly associated with the SCL-90-R positive symptom distress index. The enlisted flyer stratum and the greater than 4 drinks per day stratum of current alcohol use demonstrated the largest percentages of high T-scores ($p < 0.001$ and $p = 0.017$ respectively). The high-school-educated participants exhibited a larger percentage of high T-scores than college graduates ($p = 0.004$), and participants with a current total household income less than or equal to $55,000 displayed a higher percentage of high T-scores than participants in the greater than $55,000 category ($p < 0.001$).

In summary, few variables were significantly associated with age, race, and current alcohol use, while most variables were associated with occupation, lifetime alcohol history, education, current total household income, current employment, and current marital status. No variables were found significantly associated with current parental status or combat service.

Exposure Analysis

The following section presents results of the statistical analyses of the dependent variables shown in Table 12-1. Dependent variables are grouped into two sections: those derived and verified from a review of medical records and data obtained during the 1992 psychological examination.

Unadjusted and adjusted analyses of six models are presented for each variable. Model 1 examines the relationship between the dependent variable and group (Ranch Hand or Comparison). Model 2 explores the relationship between the dependent variable and an extrapolated initial dioxin measure for Ranch Hands who had a 1987 dioxin measurement greater than 10 ppt, If a participant did not have a 1987 dioxin level, a 1992 level was used. A statistical adjustment for the percent of body fat at the participant's time of duty in SEA and the change in the percent of body fat from the time of duty in SEA to the date of the blood draw for dioxin is included in this model to account for body-fat-related difference in elimination rate (37). Model 3 dichotomizes the Ranch Hands in Model 2 based on their initial dioxin measures; these two categories of Ranch Hands are referred to as the "low Ranch Hand" category and the "high Ranch Hand" category. These participants are added to Ranch Hands and Comparisons with current serum dioxin levels (1987, if available; 1992, if the 1987 level was not available) at or below 10 ppt to create a total of four categories. Ranch Hands with current serum dioxin levels at or below 10 ppt are referred to as the "background Ranch Hand" category. The relationship between the dependent variable in

each of the three Ranch Hand categories and the dependent variable in the "Comparison" category is examined. A fourth contrast, exploring the relationship of the dependent variable in the low Ranch Hand category and the high Ranch Hand category combined, also is conducted. This combination is referred to in the text and tables as the "low plus high Ranch Hand" category. As in Model 2, a statistical adjustment is made for the percent of body fat at the participant's time of duty in SEA and the change in the percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

Models 4, 5, and 6 examine the relationship between the dependent variable and 1987 dioxin levels in all Ranch Hands with a dioxin measurement. If a participant did not have a 1987 dioxin measurement, a 1992 measurement was utilized in determining the current dioxin level. The measure of dioxin in Model 4 is lipid-adjusted, whereas whole-weight dioxin is used in Models 5 and 6. Model 6 differs from Model 5 in that a statistical adjustment for total lipids is included in Model 6. Details on dioxin and the modeling strategy are found in Chapters 2 and 7 respectively.

Results of investigations for group-by-covariate and dioxin-by-covariate interactions are referenced in the text, and tabular results are presented in Appendix H-2. As described previously, additional analyses are performed when occupation was retained in the final models for Models 2 through 6. Results excluding occupation from these models are shown in Appendix H-3, and dioxin-by-covariate interactions with occupation excluded from these models are presented in Appendix H-4. Results from analyses excluding occupation are discussed in the text only if a meaningful change in the results occurred (that is, changes between significant results, marginally significant results, and nonsignificant results).

Verified Medical Records Variables

Psychoses

All unadjusted and adjusted analyses of a history of psychoses for Models l-6 were nonsignificant (Table 12-3(a-f): $p > 0.24$ for all analyses). Current total household income and current marital status were significant covariates for each adjusted model. Model 1 also adjusted for the effects of race and lifetime alcohol history. Combat service was additionally significant for Models 2, 4, 5, and 6.

Alcohol Dependence

Results from the Model 1 unadjusted and adjusted analyses of a history of alcohol dependence were nonsignificant (Table 12-4(a,b): $p > 0.25$ for each contrast). Adjusted results were based on the final model after deletion of the significant group-by-current marital status interaction. Current total household income and current parental status also were significant in the final adjusted model. Appendix Table H-2-l presents results stratified by current marital status.

Table 12-3.
Analysis of Psychoses

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent Yes**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***949***	***2.9***	***0.98 (0.60,1.63)***	***0.999***
	Comparison	***1,280***	***2.9***		
Officer	Ranch Hand	367	1.9	0.96 (0.36,2.53)	0.999
	Comparison	501	2.0		
Enlisted Flyer	Ranch Hand	162	4.3	2.25 (0.65,7.81)	0.319
	Comparison	203	2.0		
Enlisted Groundcrew	Ranch Hand	420	3.1	0.77 (0.38,1.53)	0.563
	Comparison	576	4.0		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.04 (0.62,1.73)***	***0.888***	RACE (p=0.105) DRKYR (p=0.076) INC (p=0.009) MARITAL (p<0.001)
Officer	1.10 (0.40,3.01)	0.849	
Enlisted Flyer	2.10 (0.60,7.41)	0.247	
Enlisted Groundcrew	0.80 (0.40.1.63)	0.545	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-3. (Continued)
Analysis of Psychoses

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	174	5.2	0.91 (0.62,1.33)	0.604
Medium	173	1.2		
High	171	4.1		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
514	0.81 (0.54,1.22)	0.302	INC (p=0.090) MARITAL (p=0.009) COMBDAYS (p=0. 126)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-3. (Continued)
Analysis of Psychoses

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,062	3.0		
Background RI-I	373	1.9	0.67 (0.29,1.53)	0.336
Low RH	260	3.5	1.13 (0.53,2.42)	0.745
High RH	258	3.5	1.07 (0.50,2.28)	0.867
Low plus High RH	518	3.5	1.10 (0.61,1.99)	0.753

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,047			INC (p=0.097) MARITAL (p <0.001)
Background RH	366	0.76 (0.33,1.77)	0.525	
Low RH	256	1.21 (0.56,2.58)	0.631	
High RH	258	0.95 (0.44,2.06)	0.897	
Low plus High RH	514	1.07 (0.59,1.94)	0.834	

[a] Relative risk aud confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-3. (Continued)
Analysis of Psychoses

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent Yes/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	2.0	3.3	3.0	1.10 (0.84,1.43)	0.495
5	1.7 (299)	3.7 (297)	3.1 (295)	1.13 (0.89,1.42)	0.324
6[c]	1.7 (298)	3.7 (297)	3.1 (295)	1.06 (0.82,1.37)	0.650

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	880	1.00 (0.76,1.32)	0.983	INC (p=0.041) MARITAL (p=0.001) COMBDAYS (p=0. 113)
5	880	1.04 (0.82,1.32)	0.749	INC (p=0.048) MARITAL (p<0.001) COMBDAYS (p=0.122)
6[d]	879	0.98 (0.76,1.27)	0.881	INC (p=0.052) MARITAL (p=0.001) COMBDAYS (p=0. 107)

[a] Model 4: Log_2 (lipid-adjusted current dioxin + 1).
Model 5: Log_2 (whole-weight current dioxin + 1).
Model 6: Log, (whole-weight current dioxin + 1), adjusted for log, total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

Table 12-4.
Analysis of Alcohol Dependence

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent Yes**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***949***	***7.5***	***1.15 (0.83,1.60)***	***0.451***
	Comparison	***I,279***	***6.6***		
Officer	Ranch Hand	367	4.6	0.89 (0.47,1.66)	0.829
	Comparison	501	5.2		
Enlisted Flyer	Ranch Hand	162	9.9	1.20 (0.59,2.45)	0.754
	Comparison	203	8.4		
Enlisted Groundcrew	Ranch Hand	420	9.1	1.30 (0.82,2.05)	0.324
	Comparison	575	7.1		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.17 (0.84,1.64)*****	***0.355*****	GROUP*MARITAL (p=0.026) INC (p<0.001) PARENT (p=0.080)
Officer	0.92 (0.49,1.73)**	0.789**	
Enlisted Flyer	1.21 (0.58,2.53)**	0.621**	
Enlisted Groundcrew	1.32 (0.82,2.12)**	0.256**	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

** Group-by-covariate interaction (0.01 <p ~0.05); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-l for further analysis of this interaction.

Table 12-4. (Continued)
Analysis of Alcohol Dependence

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	174	8.6	1.05 (0.81,1.35)	0.722
Medium	173	4.6		
High	171	9.4		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
514	1.06 (0.81,1.40)	0.666	RACE (p=0.096) INC (p=0.016) PARENT (p=0.071)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-4. (Continued)
Analysis of Alcohol Dependence

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,062	6.4		
Background RH	373	7.5	1.18 (0.74,1.87)	0.484
Low RH	260	7.7	1.21 (0.72,2.03)	0.475
High RH	258	7.4	1.17 (0.69,1.99)	0.557
Low plus High RH	518	7.5	1.19 (0.79,1.79)	0.404

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,047			INC (p<0.001) MARITAL (p<0.001) PARENT (p=0.030)
Background RH	366	1.34 (0.83,2.16)	0.227	
Low RH	256	1.16 (0.67,1.98)	0.599	
High RH	258	1.04 (0.61,1.80)	0.879	
Low plus High RH	514	1.10 (0.72,1.67)	0.666	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin,

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" colmnn.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-4. (Continued)
Analysis of Alcohol Dependence

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent Yes/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	6.8	8.3	7.4	0.98 (0.83,1.17)	0.851
5	7.4 (299)	7.4 (297)	7.8 (295)	0.99 (0.85,1.14)	0.865
6[c]	7.4 (298)	7.4 (297)	7.8 (295)	0.95 (0.81,1.11)	0.511

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	880	0.86 (0.72,1.03)	0.097	EDUC (p=0.108) INC (p<0.001) COMBDAYS (p=0.059)
5	880	0.89 (0.77,1.03)	0.122	EDUC (p=0.115) INC (p<0.001) COMBDAYS (p=0.062)
6[d]	879	0.84 (0.72,0.99)	0.036	EDUC (p=0. 102) INC (p<0.001) COMBDAYS (p=0.053)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log_2 (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log_2 total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

Analysis of associations between a history of alcohol dependence and dioxin in Models 2 and 3 showed nonsignificant results (Table 12-4(c-f): $p > 0.22$ for all analyses). Current total household income and current parental status were each significant in both adjusted models. Model 2 also reflects the covariate effect of race and Model 3 additionally adjusted for current marital status.

Results were nonsignificant from the unadjusted analyses of a history of alcohol dependence for Models 4, 5, and 6 (Table 12-4(g): $p > 0.51$ for each analysis). After covariate adjustment, Model 4 displayed marginally significant results, while Model 6 showed a significant relationship (Table 12-4(h): $p = 0.097$, Adj. $RR = 0.86$; and $p = 0.036$, Adj. $RR = 0.84$ for Models 4 and 6 respectively). Model 5 remained nonsignificant after adjustment (Table 12-4(h): $p = 0.122$). Adjusted analyses of Models 4 and 6 revealed that a history of alcohol dependence decreased as current dioxin levels increased. Bach model adjusted for education, current total household income, and combat service.

Drug Dependence

Due to the sparse history of drug dependence among study participants, only selected analyses were possible and are discussed below. Only one Comparison and four Ranch Hands had a verified history of drug dependence.

Model 1 analyses of drug dependence contrasting Ranch Hands and Comparisons over all occupations and the within the enlisted groundcrew strata were nonsignificant for both the unadjusted and adjusted analyses (Table 12-5(a,b): $p > 0.31$ for each contrast). Age and current total household income were significant covariates. Differences between background Ranch Hands and Comparisons also were nonsignificant from Model 3 analysis (Table 12-5(e,f): $p > 0.68$ for both unadjusted and adjusted contrasts). Covariate adjustment included current total household income and current parental status. Only unadjusted analyses were possible for Models 4, 5, and 6 and each result was nonsignificant (Table 12-5(g): $p > 0.17$).

Anxiety

Model 1 contrasts examining differences of a history of anxiety between Ranch Hands and Comparisons were nonsignificant for the unadjusted and adjusted analyses (Table 12-6(a,b): $p > 0.49$ for each contrast). Race, occupation, current total household income, and current marital status displayed significant covariate effects in the final model.

Both Model 2 analyses were nonsignificant (Table 12-6(c,d): $p > 0.13$ for each analysis). Adjusted results were based on the final model after the deletion of the significant interaction between initial dioxin and occupation. Age, race, and current employment also were significant in the fiil model. Results stratified by occupation are presented in Appendix Table H-2-2.

The difference between high Ranch Hands and Comparisons was significant in the unadjusted analysis of Model 3 (Table 12-6(e): $p = 0.044$, Est. $RR = 1.43$), but was nonsignificant in the adjusted analysis (Table 12-6(f): $p = 0.915$). All other Model 3

Table 12-5.
Analysis of Drug Dependence

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent Yes**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***949***	***0.1***	***0.34 (0.04,3.02)***	***0.569***
	Comparison	***1,280***	***0.3***		
Officer	Ranch Hand	367	0.0	_	_
	Comparison	501	0.2		
Enlisted Flyer	Ranch Hand	162	0.0	_	_
	Comparison	203	0.0		
Enlisted Groundcrew	Ranch Hand	420	0.2	0.46 (0.05,4.40)	0.850
	Comparison	576	0.5		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***0.36 (0.04,3.23)***	***0.317***	AGE (p=0.023) INC (p=0.022)
Officer	_	--	
Enlisted Flyer	_	--	
Enlisted Groundcrew	0.49 (0.05,4.84)	0.517	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

--: Relative risk, confidence interval, and p-value not presented due to the sparse number of abnormalities.

Table 12-5. (Continued)
Analysis of Drug Dependence

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	174	0.0	_	_
Medium	173	0.0		
High	171	0.0		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
--	--	--	

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

--: Analysis not performed due to the sparse number of abnormalities.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-S. (Continued)
Analysis of Drug Dependence

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,062	0.3		
Background RH	373	0.3	0.62 (0.06,6.22)	0.684
Low RH	260	0.0	–	–
High RH	258	0.0	–	–
Low plus High RH	518	0.0	–	–

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,047			INC (p=0.015) PARENT (p=0.046)
Background RH	366	1.21 (0.11,13.45)	0.787	
Low RH	256	–	–	
High RH	258	--	–	
Low plus High RH	514	–	–	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

--: Relative risk, confidence interval, and p-value not presented due to the sparse number of abnormalities.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-5. (Continued)
Analysis of Drug Dependence

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent Yes/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	0.3	0.0	0.0	0.36 (0.08,1.54)	0.176
5	0.3 (299)	0.0 (297)	0.0 (295)	0.55 (0.25,1.21)	0.202
6[c]	0.3 (298)	0.0 (297)	0.0 (295)	0.58 (0.23,1.47)	0.320

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	--	–	–	
5	–	--	–	
6[c]	–	–	–	

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + I), adjusted for log_2 total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

--: Analyses not performed due to the sparse number of abnormalities.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

Table 12-6.
Analysis of Anxiety

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent Yes**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***944***	***14.8***	***1.06 (0.84,1.35)***	***0.670***
	Comparison	***I,277***	***14.1***		
0 fficer	Ranch Hand	366	6.8	1.08 (0.63,1.85)	0.903
	Comparison	501	6.4		
Enlisted Flyer	Ranch Hand	161	16.8	1.00 (0.58,1.74)	0.999
	Comparison	203	16.8		
Enlisted Groundcrew	Ranch Hand	417	21.1	1.08 (0.79,1.47)	0.700
	Comparison	573	19.9		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.09 (0.85,1.39)***	***0.499***	RACE (p=0.035)
Officer	1.07 (0.62,1.85)	0.809	OCC (p<0.001)
Enlisted Flyer	1.04 (0.59,1.82)	0.899	INC (p<0.001)
Enlisted Groundcrew	1.11 (0.81,1.52)	0.506	MARITAL (p=0.045)

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-6. (Continued)
Analysis of Anxiety

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	173	12.1	1.14 (0.96,1.35)	0.139
Medium	173	19.1		
High	170	18.2		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
516	0.94 (0.77,1.16)**	0.574**	INIT*OCC (p=0.037) AGE (p=0.028) RACE (p=0.037) EMPLOY (p=0.001)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Log_2 (initial dioxin)-by-covariate interaction ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-Z-2 for further analysis of this interaction.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.
INIT = Log, (initial dioxin).

Table 12-6. (Continued)
Analysis of Anxiety

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,059	14.8		
Background RH	371	13.5	0.91 (0.64,1.28)	0.585
Low RH	259	12.7	0.84 (0.56,1.26)	0.395
High RH	257	20.2	1.43 (1.01,2.04)	0.044
Low plus High RH	516	16.5	1.12 (0.84,1.50)	0.433

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1.044			RACE (p=0.055) OCC (p<0.001) INC (p=0.005) MARITAL (p=0.037)
Background RH	364	1.27 (0.88,1.84)	0.203	
Low RH	255	0.91 (0.60,1.37)	0.639	
High RH	257	1.02 (0.71,1.46)	0.915	
Low plus High RH	512	0.97 (0.72,1.31)	0.840	

[a] Relative risk aud confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-6. (Continued)
Analysis of Anxiety

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent Yes/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
	14.0 (292)	12.4 (299)	19.3 (296)	1.13 (1.00,1.28)	0.056
5	13.5 (297)	13.2 (296)	19.1 (294)	1.12 (1.00,1.25)	0.041
6[c]	13.5 (296)	13.2 (296)	19.1 (294)	1.09 (0.97,1.22)	0.154

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	887	0.94 (0.82,1.07)	0.343	RACE (p=0.010) OCC (p<0.001) EMPLOY (p=0.022) MARITAL (p=0.069)
5	887	0.96 (0.85,1.08)	0.495	RACE (p=0.011) occ (p<0.001) EMPLOY (p=0.021) MARITAL (p=0.069)
6[d]	886	0.92 (0.81,1.04)	0.197	RACE (p=0.015) occ (p<0.001) EMPLOY (p=0.021) MARITAL (p=0.081)

[a] Model 4: Log_2 (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log, total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

contrasts were nonsignificant (Table 12-6(e,f): $p > 0.20$ for all remaining contrasts). Significant covariates in the adjusted analysis included race, occupation, current total household income, and current marital status.

The Model 4 unadjusted analysis of anxiety revealed a marginally significant association between current dioxin and history of anxiety (Table 12-6(g): $p = 0.056$, Est. $RR = 1.13$). Results were significant from the Model 5 unadjusted analysis (Table 12-6(g): $p = 0.041$, Est. $RR = 1.12$). Both analyses suggest that the greater percentage of those reporting a history of anxiety among Ranch Hands were those with the highest levels of current dioxin. The test of association was nonsignificant for the Model 6 unadjusted analysis as well for the adjusted analysis for each of Models 4, 5, and 6 (Table 12-6(g,h): $p > 0.15$ for all remaining analyses). Bach model adjusted for the covariate effects of race, occupation, current employment, and current marital status. After exclusion of occupation from Models 4 and 5, results became significant (Appendix Table H-3-l(c): $p = 0.037$, Adj. $RR = 1.14$; and $p = 0.029$, Adj. $RR = 1.13$). However, education was not included in this auxiliary analysis. When education was added to the final model, the results of the analysis for Models 4, 5,and 6 were nonsignificant (Appendix Table H-3-2(a): $p = 0.276$, $p = 0.219$, and $p = 0.494$ for Models 4, 5, and 6 respectively).

Other Neuroses

Analysis of a history of other neuroses revealed significant differences between Ranch Hands and Comparisons from Model 1. The enlisted groundcrew unadjusted and adjusted contrasts were significant, with 47.6 percent of Ranch Hands and 40.8 percent of Comparisons having a history of other neuroses (Table 12-7(a,b): $p = 0.040$, Est. $RR = 1.32$; and $p = 0.017$, Adj. $RR = 1.39$, for the unadjusted and adjusted analyses). The adjusted contrast combining all occupations was significant also (Table 12-7(b): $p = 0.034$, Adj. RR= 1.22). All remaining contrasts were nonsignificant (Table 12-7(a,b): $p > 0.10$ for all remaining contrasts). Adjusted results are based on the final model after deletion of the significant interactions between group and education and between group and current total household income. Results presented for each level of education and current total household income are found in Appendix Table H-2-3. Age, occupation, lifetime alcohol history, current marital status, and current parental status were significant covariates in the adjusted model.

The Model 2 analysis of a history of other neuroses exhibited nonsignificant results for both the unadjusted and adjusted models (Table 12-7(c,d): $p > 0.51$ for both analyses). Covariates included in the final model were lifetime alcohol history, education, current employment, current marital status, and current parental status.

Unadjusted contrasts with Comparisons in Model 3 displayed a nonsignificant difference with background Ranch Hands, a marginally significant difference with low Ranch Hands, and significant differences with high Ranch Hands and with low plus high Ranch Hands (Table 12-7(e): $p = 0.293$ for background Ranch Hands versus Comparisons; $p = 0.056$, Est. $RR = 1.31$ for low Ranch Hands versus Comparisons; $p = 0.037$, Est. $RR = 1.34$ for high Ranch Hands versus Comparisons; and $p = 0.010$, Est. $RR = 1.33$ for low plus high Ranch

Table 12-7.
Analysis of Other Neuroses

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent Yes**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***936***	***40.3***	***1.16 (0.98,1.38)***	***0.101***
	Comparison	***1,268***	***36.8***		
0 fticer	Ranch **Hand**	364	28.6	0.96 **(0.71,1.29)**	0.836
	Comparison	499	29.5		
Enlisted Flyer	Ranch Hand	160	48.1	1.21 **(0.79,1.83)**	0.442
	comparison	200	43.5		
Enlisted Gronndcrew	Ranch Hand	412	47.6	1.32 **(1.02,1.70)**	0.040
	Comparison	569	40.8		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.22 (1.02,1.47)*****	***0.034*****	GROUP*EDUC **(p<0.001)** GROUP*INC **(p=0.032)**
Officer	1.00 **(0.73,1.36)****	0.999**	AGE **(p=0.052)** occ **(p <0.001)**
Enlisted Flyer	1.30 **(0.84,2.01)****	0.242**	DRKYR **(p<0.001)** MARITAL **(p<0.001)**
Enlisted Groundcrew	1.39 **(1.06,1.81)****	0.017**	PARENT **(p=0.028)**

[a] Covariates and associated p-values correspond to **final** model based on all participants with available data.

** Group-by-covariate interactions **(p≤0.05);** adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-3 for further analysis of these interactions.

Table 12-7. (Continued)
Analysis of Other Neuroses

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	172	42.4	1.04 (0.92,1.19)	0.518
Medium	171	48.0		
High	169	45.6		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
499	1.03 (0.89,1.19)	0.714	DRKYR (p=0.009) EDUC (p=0.002) EMPLOY (p=0.035) MARITAL (p=0.007) PARENT (p=0.077)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-7. (Continued)
Analysis of Other Neuroses

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED

Dioxin Category	n	Percent Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,051	38.3		
Background RH	366	34.7	0.87 (0.68,1.12)	0.293
Low RH	257	44.8	1.31 (0.99,1.73)	0.056
High RH	255	45.9	1.34 (1.02,1.77)	0.037
Low plus High RH	512	45.3	1.33 (1.07,1.64)	0.010

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED

Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,022			DXCAT*DRKYR (p=0.011) DXCAT*EDUC (p<0.001) DXCAT*INC (p=0.035) DXCAT*COMBDAYS (p=0.029) OCC (p<0.001) EMPLOY (p=0.038) MARITAL (p<0.001)
Background RH	352	1.09 (0.81,1.46)**	0.574**	
Low RH	247	1.27 (0.92,1.75)**	0.142**	
High RH	248	1.08 (0.78,1.51)**	0.630**	
Low plus High RH	495	1.18 (0.90,1.54)**	0.222**	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA aud change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Categorized dioxin-by-wvariate interaction ($p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-3 for further analysis of these interactions.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.
DXCAT = Categorized Dioxin.

Table 12-7. (Continued)
Analysis of Other Neuroses

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent Yes/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	33.0 (288)	43.1 (297)	46.4 (293)	1.12 (1.02,1.23)	0.013
5	32.8 (293)	42.5 (294)	47.4 (291)	1.12 (1.03,1.21)	0.005
6[c]	32.5 (292)	42.5 (294)	47.4 (291)	1.07 (0.98,1.17)	0.139

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	858	0.98 (0.88,1.10)**	0.777**	CURR*DRKYR (p=0.038) OCC (p=0.026) EDUC (p=0.003) EMPLOY (p=0.029) MARITAL (p=0.002) PARENT (p=0.100)
5	858	1.01 (0.92,1.11)**	0.816**	CURR*DRKYR (p=0.013) occ (p=0.043) EDUC (p=0.002) EMPLOY (p=0.027) MARITAL (p=0.002) PARENT (p =O. 103)
6[d]	857	0.95 (0.85,1.05)**	0.301**	CURR*DRKYR (p=0.014) occ (p=0.020) EDUC (p=0.004) EMPLOY (p=0.020) MARITAL (p=0.002) PARENT (p=0.068)

[a] Model 4: Log_2 (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log, (whole-weight current dioxin + 1), adjusted for log_2 total lipids.

[b] Relative risk for a twofold increase in current dioxin.
[c] Adjusted for log, total' lipids.
[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log, (current dioxin + I)-by-covariate interaction ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-3 for further analysis of this interaction.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.
CURR = Log, (current dioxin + 1).

Hands versus Comparisons). The analyses indicated that a history of other neuroses increased with dioxin. Adjusted contrasts were nonsignificant (Table 12-7(f): $p > 0.14$ for each adjusted contrast). Adjusted results are based on the final model after the deletion of the significant categorized dioxin interactions with each of the following covariates: lifetime alcohol history, education, current total household income, and combat service. Appendix Table H-2-3 presents analysis stratified by each level the covariates involved in the interactions. Occupation, current employment, and current marital status also were significant in the final model. Exclusion of occupation from the final model changed nonsignificant results to marginally significant results for the high Ranch Hands and low plus high Ranch Hands contrasts (Appendix Table H-3-2(a): $p=0.093$, Adj. RR=1.25; and $p=0.063$, Adj. RR=1.28 respectively).

Significant relative risk estimates resulted from the unadjusted analyses of other neuroses for Models 4 and 5 (Table 12-7(g): $p=0.013$, Est. RR=1.12 and $p=0.005$, Est. RR= 1.12). The percentage of Ranch Hands having a history of other neuroses increased as current dioxin levels increased. Results from the unadjusted Model 6 analysis and the adjusted Models 4, 5, and 6 analyses were each nonsignificant (Table 12-7(g,h): $p>0.13$ for each analysis). All adjusted results are based on each final model after the deletion of the significant current dioxin-by-lifetime alcohol history interaction. Results stratified by each category of lifetime alcohol history are presented in Appendix Table H-2-3. Occupation, education, current employment, current marital status, and current parental status were each additionally included as significant covariates in each final model.

Psychological Examination Variables

SCL-90-R Anxiety

Marginally significant differences in the prevalence of high SCL-90-R anxiety T-scores were found between Ranch Hands and Comparisons from the Model 1 unadjusted contrast combining all occupations (Table 12-8(a): $p=0.071$, Est. RR=1.38). Results became significant after covariate adjustment (Table 12-8(b): $p=0.039$, Adj. RR=1.44). Adjusted analysis also revealed a marginally significant difference within the enlisted flyer stratum (Table 12-8(b): $p=0.098$, Adj. RR= 1.92). All other Model 1 contrasts were nonsignificant (Table 12-8(a,b): $p>0.21$ for all remaining contrasts). Significant covariates in the final adjusted model were occupation, lifetime alcohol history, current total household income, and current employment.

Associations between SCL-90-R anxiety and initial dioxin were nonsignificant for both the Model 2 unadjusted and adjusted analyses (Table 12-8(c,d): $p > 0.33$ for both analyses). Significant covariate effects in the final adjusted model 'included lifetime alcohol history, education, current total household income, current marital status, and combat service. Initial dioxin-by-occupation and initial dioxin-by-current alcohol use interactions also were significant in the analysis. Adjusted results are based on the final model after deletion of the interactions. Results stratified by occupation and current alcohol use category are presented in Appendix Table H-2-4.

Table 12-S.
Analysis of SCL-90-R Anxiety

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	Group	n	Percent High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***948***	***7.8***	***1.38 (0.99,1.93)***	***0.071***
	Comparison	***1,279***	***5.8***		
Officer	Ranch Hand	367	3.5	1.50 (0.68,3.32)	0.428
	Comparison	501	2.4		
Enlisted Flyer	Ranch Hand	161	11.2	1.70 (0.82,3.53)	0.212
	Comparison	203	6.9		
Enlisted Groundcrew	Ranch Hand	420	10.2	1.25 (0.81,1.93)	0.363
	Comparison	575	8.4		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks[a]
All	***1.44 (1.02,2.05)***	***0.039***	***occ*** (p=0.014)
Officer	1.62 (0.73,3.62)	0.238	DRKYR (p=0.010)
			INC (p<0.001)
Enlisted Flyer	1.92 (0.89,4.16)	0.098	EMPLOY (p=0.095)
Enlisted Groundcrew	1.26 (0.81.1.98)	0.306	

[a] Covariates and associated p-values correspond to fmal model based on all participants with available data.

Table 12-8. (Continued)
Analysis of SCL-90-R Anxiety

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	173	7.5	1.11 (0.90,1.39)	0.335
Medium	173	9.3		
High	171	11.1		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
500	1.04 (0.81,1.35)**	0.740**	INIT*OCC (p=0.031) INIT*ALC (p=0.029) DRKYR (p=0.018) EDUC (p=0.127) INC (p=0.005) MARITAL (p=0.069) COMBDAYS (p=0. 140)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Log, (initial dioxin)-by-wvariate interactions ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-4 for further analysis of these interactions.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-S. (Continued)
Analysis of SCL-90-R' Anxiety

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	5.6		
Background RH	373	5.1	0.94 (0.55,1.60)	0.812
Low RH	259	7.3	1.32 (0.77,2.26)	0.309
High RH	258	11.2	2.11 (1.32,3.38)	0.002
Low plus High RH	517	9.3	1.71 (1.14,2.54)	0.009

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			OCC (p=0.022) DRKYR (p=0.012)
Background RH	359	1.33 (0.76,2.34)	0.318	INC (p<0.001)
Low RH	249	1.30 (0.73,2.31)	0.373	EMPLOY (p=0.089)
High RH	251	1.67 (1.02,2.73)	0.041	
Low plus High RH	500	1.50 (0.99,2.29)	0.056	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: RI-I = 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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-S. (Continued)
Analysis of SCL-90-R Anxiety

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	4.8 (294)	7.0 (299)	10.8 (297)	1.26 (1.07,1.49)	0.005
5	4.4 (299)	8.1 (296)	10.2 (295)	1.26 (1.09,1.46)	0.002
6[c]	4.4 (298)	8.1 (296)	10.2 (295)	1.22 (1.04,1.43)	0.013

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	1.13 (0.96,1.34)**	0.146**	CURR*ALC (p=0.022) DRKYR (p=0.018) EDUC (p=0.040) INC (p=0.004)
5	859	1.15 (0.99,1.34)**	0.069**	CURR*ALC (p=0.036) DRKYR (p=0.021) EDUC (p=0.046) INC (p=0.004)
6[d]	858	1.10 (0.94,1.30)**	0.240**	CURR*ALC (p=0.039) DRKYR (p=0.023) EDUC (p=0.046) INC (p=0.003)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log, (whole-weight current dioxin + 1), adjusted for logs total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log, (current dioxin + l)-by-covsriate interaction ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-4 for further analysis of this interaction.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

Significant Model 3 results were found from the unadjusted and adjusted analysis of SCL-90-R anxiety contrasting high Ranch Hands and Comparisons (Table 12-8(e,f): p=0.002, Est. RR=2.11 and p=0.041, Adj. RR=1.67 respectively). The unadjusted low plus high Ranch Hand contrast also was significant but became marginally significant after covariate adjustment (Table 12-8(e,f): p=0.009, Est. RR=1.71 and p=0.056, Adj. RR= 1.50 for the unadjusted and adjusted analyses). Occupation, lifetime alcohol history, current total household income, and current employment were significant in the final adjusted model. However, after exclusion of occupation from the final model, the low plus high Ranch Hands contrast became significant (Appendix Table H-3-4(b): p=0.022, Adj. RR=1.62). Other Model 3 contrasts were nonsignificant (Table 12-8(e,f): p>0.30 for all remaining contrasts).

Models 4, 5, and 6 each displayed a significant association between SCL-90-R anxiety and current dioxin in the unadjusted analysis (Table 12-8(g): p=0.005, Est. RR= 1.26; p=0.002, Est. RR=1.26; and p=0.013, Est. RR=1.22 respectively). The relative risk estimates that were greater than one indicate the prevalence of high SCL-90-R anxiety T-scores increased as current dioxin levels increased. The Model 5 association became marginally significant after covariate adjustment (Table 12-8(h): p=0.069, Adj. RR= 1.15). Models 4 and 6 became nonsignificant after covariate adjustment (Table 12-8(h): p > 0.14 for both'analyses). All adjusted results are based on the final model after deletion of the significant current dioxin-by-current alcohol use interaction. Results stratified by each category of current alcohol use are presented in Appendix Table H-2-4. Other significant covariates present in the final model were lifetime alcohol history, education, and current total household income.

SCL-90-R Depression

All differences examined between Ranch Hands and Comparisons from the Model 1 unadjusted and adjusted analyses of SCL-90-R depression were nonsignificant (Table 12-9(a,b): p > 0.18 for all contrasts). Lifetime alcohol history, education, current total household income, current employment, and current marital status were significant covariates in the final adjusted model.

Results from the Model 2 unadjusted analysis of SCL-90-R depression also were nonsignificant (Table 12-9(a): p=0. 148). Adjusted analysis revealed a significant interaction between initial dioxin and lifetime alcohol history. Results stratified by each category of lifetime alcohol history are presented in Appendix Table H-2-5. After deleting the initial dioxin-by-lifetime alcohol history interaction, the adjusted analysis also showed a nonsignificant association between SCL-90-R depression and initial dioxin (Table 12-9(d): p = 0.115). Education, current employment, and current marital status were other significant covariates in the final model.

The Model 3 unadjusted analysis revealed a significant difference between high Ranch Hands and Comparisons (Table 12-9(e): p=0.031, Est. RR=1.58), where 13.6 percent of high Ranch Hands and 8.8 percent of Comparisons exhibited a high SCL-90-R depression T-score. All other unadjusted and adjusted Model 3 contrasts indicated no significant differences (Table 12-9(e,f): p>0.10 for all remaining contrasts). Adjusted analysis

Table 12-9.
Analysis of SCL-90-R Depression

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent High**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***948***	***IO.1***	***1.16 (0.87,1.55)***	***0.337***
	Comparison	***1,279***	***8.8***		
Officer	Ranch Hand	367	6.5	1.28 (0.72,2.27)	0.487
	Comparison	501	5.2		
Enlisted Flyer	Ranch Hand	161	14.9	1.37 (0.74,2.53)	0.393
	Comparison	203	11.3		
Enlisted Groundcrew	Ranch Hand	420	11.4	1.03 (0.69,1.53)	0.964
	Comparison	575	11.1		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.21 (0.90,1.63)***	***0.210***	DRKYR (p=0.028) EDUC (p=0.003) INC (p=0.001) EMPLOY (p=0.030) MARITAL (p=0.001)
Officer	1.38 (0.77,2.47)	0.282	
Enlisted Flyer	1.55 (0.81,2.97)	0.184	
Enlisted Groundcrew	1.02 (0.67,1.55)	0.927	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-9. (Continued)
Analysis of SCL-90-R Depression

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	173	8.1	1.16 (0.95,1.42)	0.148
Medium	173	10.4		
High	171	13.5		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
504	1.20 (0.96,1.50)**	0.115**	INIT*DRKYR (p=0.001) EDUC (p=0.026) EMPLOY (p=0.066) MARITAL (p=0.003)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Log, (initial dioxin)-by-covariate interaction ($p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-5 for further analysis of this interaction.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-9. (Continued)
Analysis of SCL-90-R Depression

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	8.8		
Background RH	373	9.1	1.09 (0.72,1.65)	0.684
Low RH	259	7.7	0.85 (0.51,1.41)	0.527
High RH	258	13.6	1.58 (1.04,2.40)	0.031
Low plus High RH	517	10.6	1.20 (0.85,1.71)	0.303

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1.031			ALC (p=0.129)
Background RH	359	1.35 (0.87,2.09)	0.177	DRKYR (p=0.010) EDUC (p=0.006) INC (p=0.021)
Low RH	249	0.75 (0.43,1.30)	0.309	EMPLOY (p=0.024)
High RH	251	1.43 (0.92,2.22)	0.108	MARITAL (p<0.001)
Low plus High RH	500	1.10 (0.75,1.59)	0.629	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-9. (Continued)
Analysis of SCL-90-R Depression

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	8.8 (299)	8.7 (296)	12.5 (297)	1.10 (0.95,1.27)	0.207
5	9.4 (299)	7.8 (296)	12.9 (295)	1.11 (0.97,1.26)	0.125
6[c]	9.4 (298)	7.8 (296)	12.9 (295)	1.04 (0.90,1.19)	0.613

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	1.00 (0.86,1.18)**	0.961**	CURR*INC (p=0.032) DRKYR (p=0.028) EDUC (p=0.047) EMPLOY (p=0.038) MARITAL (p=0.022)
5	859	1.02 (0.89,1.17)**	0.783**	CURR*RACE (p=0.028) CURR*INC (p=0.008) DRKYR (p=0.041) EDUC (p=0.057) EMPLOY (p=0.036) MARITAL (p=0.010)
6[d]	858	0.95 (0.82,1.10)**	0.507**	CURR*RACE (p=0.023) cuRR*INc (p=0.010) DRKYR (p=0.053) EDUC (p=0.045) EMPLOY (p=0.043) MARITAL (p=0.016)

[a] Model 4: Log_2 (Lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log, (whole-weight current dioxin + 1), adjusted for log_2 total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log, (current dioxin + 1)-by-covariate interaction ($p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-5 for further analysis of these interactions.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

displayed the significant covariate effects of current alcohol use, lifetime alcohol history, education, current total household income, current employment, and current marital status.

All results from the unadjusted and adjusted analyses of XL-90-R depression for Models 4, 5, and 6 were nonsignificant (Table 12-9(g,h): $p > 0.12$ for each analysis). Adjusted results displayed in Table 12-9(h) are based on the final models of Models 4, 5, and 6 after deletion of significant interactions involving current dioxin. Model 4 results stratified by each level of current total household income are found in Appendix Table H-2-5, as are Model 5 and 6 results stratified by race and by current total household income. Covariates significant for each model were lifetime alcohol history, education, current employment, and current marital status.

SCL-90-R Hostility

The Model 1 unadjusted analysis of SCL-90-R hostility revealed a significant group difference from the contrast combining all occupations. Results indicated a greater percentage of high T-scores for Ranch Hands (6.1%) than for Comparisons (4.1 %) (Table 12-10(a): $p=0.044$, Est. $RR=1.51$). After covariate adjustment, the overall contrast presented a marginally significant difference (Table 12-10(b): $p=0.078$, Adj. RR= 1.43). The unadjusted contrast within the enlisted groundcrew stratum and the adjusted contrast within the enlisted flyer stratum also displayed marginally significant differences between Ranch Hands and Comparisons (Table 12-10(a,b): $p=0.064$, Est. $RR=1.65$ and $p=0.091$, Adj. $RR=2.04$ respectively). All other Model 1 contrasts were nonsignificant (Table 12-10(a,b): $p > 0.10$ for each remaining contrast). Lifetime alcohol history, current total household income, the group-by-current alcohol use interaction, and the group-by-education interaction were significant in the final adjusted model. All adjusted results are based on the fiil model after deletion of the group-by-covariate interactions. Appendix Table H-2-6 presents contrasts stratified by current alcohol use and education.

Model 2 unadjusted analysis of SCL-90-R hostility displayed a marginally significant positive association between initial dioxin and a high SCL-90-R hostility T-score (Table 12-10(c): $p=0.067$, Est. $RR=1.26$). After covariate adjustment for age, lifetime alcohol history, education, and current marital status, the association was nonsignificant (Table 12-10(d): $p=0.310$).

Model 3 contrasts involving background Ranch Hands and low Ranch Hands with Comparisons were nonsignificant for both the unadjusted and adjusted analyses of SCL-90-R hostility (Table 12-10(e,f): $p > 0.10$ for each contrast). The high and the low plus high Ranch Hand contrasts revealed significant differences in the unadjusted analyses (Table 12-10(e): $p=0.008$, Est. $RR=2.04$ and $p=0.032$, Est. $RR=1.64$ respectively). Unadjusted analysis revealed a greater tendency of a high SCL-90-R hostility T-score among Ranch Hands with higher dioxin levels than Comparisons. After covariate adjustment for occupation, current alcohol use, lifetime alcohol history, and current total household income, the high Ranch Hand contrast became marginally significant and the low plus high contrast became nonsignificant (Table 12-10(f): $p=0.093$, Adj. $RR=1.60$ and $p=0.194$ respectively). Exclusion of occupation from the fii model shifted the significance of the high contrast from marginally significant to significant (Appendix Table H-3-4(a): $p=0.027$,

Table 12-10.
Analysis of SCL-90-R Hostility

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	Group	n	Percent High	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*948*	*6.1*	*1.51 (1.03,2.21)*	***0.044***
	Comparison	*1,279*	*4.1*		
Officer	Ranch Hand	367	1.6	0.68 (0.25,1.82)	0.592
	Comparison	501	2.4		
Enlisted Flyer	Ranch Hand	161	9.9	2.13 (0.94,4.83)	0.101
	Comparison	203	4.9		
Enlisted Groundcrew	Ranch Hand	420	8.6	1.65 (1.00,2.71)	0.064
	Comparison	575	5.4		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks[a]
All	*1.43 (0.96,2.14)***	***0.078****	GROUP*ALC (p=0.047) GROUP*EDUC (p=0.047) DRKYR (p<0.001) INC (p=0.009) OCC (p=0.061)
Officer	0.64 (0.22,1.86)**	0.411**	
Enlisted Flyer	2.04 (0.89,4.67)**	0.091**	
Enlisted Groundcrew	1.53 (0.91,2.57)**	0.106**	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

** Group-by-covariate interactions (0.01 <p≤0.05); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-6 for further analysis of these interactions.

Table 1210. (Continued)
Analysis of SCL-90-R Hostility

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	173	5.8	1.26 (0.99,1.60)	0.067
Medium	173	5.2		
High		10.5		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
504	1.16 (0.87,1.53)	0.310	AGE (p=0.073) DRKYR (p=0.002) EDUC (p=0.017) MARITAL (p=0.026)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-10. (Continued)
Analysis of SCL-90-R Hostility

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	4.2		
Background RH	373	4.8	1.26 (0.71,2.21)	0.429
Low RH	259	5.4	1.25 (0.67,2.32)	0.484
High RH	258	8.9	2.04 (1.21,3.46)	0.008
Low plus High RH	517	7.2	1.64 (1.05,2.58)	0.032

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			occ (p=0.020) ALC (p=0.025) DRKYR (p<0.001) INC (p=0.027)
Background RH	359	1.64 (0.89,3.02)	0.109	
Low RH	249	1.07 (0.54,2.14)	0.843	
High RH	251	1.60 (0.93,2.78)	0.093	
Low plus High RH	500	1.37 (0.85,2.21)	0.194	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-10. (Continued)
Analysis of SCL-90-R Hostility

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	4.4 (294)	5.4 (299)	8.8 (297)	1.28 (1.07,1.53)	0.008
5	4.0 (299)	6.4 (296)	8.1 (295)	1.27 (1.08,1.49)	0.004
6[c]	4.0 (298)	6.4 (296)	8.1 (295)	1.23 (1.04,1.46)	0.019

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	870	1.08 (0.89,1.33)	0.431	AGE (p=0.071) occ (p=0.074) DRKYR (p<0.001) EDUC (p=0.061) EMPLOY (p=0.095)
5	870	1.10 (0.92,1.32)	0.275	AGE (p=0.069) OCC (p=0.082) DRKYR (p<0.001) EDUC (p=0.062) EMPLOY (p=0.090)
6[d]	869	1.05 (0.86,1.27)	0.645	AGE (p=0.054) occ (p=0.066) DRKYR (p<0.001) EDUC (p=0.076) EMPLOY (p=0.074)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log, total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = >128 ppq.

Adj. RR= 1.84). The low plus high contrast changed from norisignificant to marginally significant (Appendix Table H-3-5(a): p=0.098, Adj. RR=1.49). However, education was not included in this auxiliary analysis. When education was added to the fiil model, the results of the contrast between low plus high Ranch Hands and Comparisons for the SCL-90-R hostility T-scores were nonsignificant (Table H-3-6(a): p=0. 144).

Positive associations between high SCL-90-R hostility T-scores and current dioxin were significant in the unadjusted analysis of Models 4, 5, and 6 (Table 12-10(g): p=0.008, Est. RR=1.28; p=0.004, Est. RR=1.27; and p=0.019, Est. RR=1.23, respectively). However, adjusted analyses were nonsignificant for each model (Table 12-10(h): p > 0.27 for each analysis). Age, occupation, lifetime alcohol history, education, and current employment were significant in each fii adjusted model.

SCL-90-R Interpersonal Sensitivity

Unadjusted and adjusted contrasts between Ranch Hands and Comparisons were each nonsignificant from the Model 1 analysis of SCL-90-R'interpersonal sensitivity (Table 12-ll(a,b): p>0.22 for each contrast). Occupation, lifetime alcohol history, education, and current total household income were each significant in the final adjusted model.

Results from the Model 2 analysis of SCL-90-R interpersonal sensitivity also were nonsignificant for both the unadjusted and adjusted analyses (Table 12-11(c,d): p>0.38 for both analyses). Adjusted results are based on the final model after deletion of the significant interactions of initial dioxin with occupation and lifetime alcohol history. Appendix Table H-2-7 presents analysis stratified by each category of occupation and lifetime alcohol history. Education, current total household income, current marital status, and current parental status were significant covariates in the final adjusted model.

The unadjusted analysis of Model 3 identified significantly more high Ranch Hands than Comparisons with a high SCL-90-R interpersonal sensitivity T-score (Table 12-11(e): p=0.024, Est. RR= 1.62). Also, results were marginally significant for the unadjusted low plus high Ranch Hands contrast (Table 12-11(e): p=0.083, Est. RR=1.36). All remaining unadjusted contrasts and all adjusted contrasts were nonsignificant (Table 12-11(e,f): p>0.23 for all remaining contrasts). Occupation, lifetime alcohol history, current total household income, and current marital status were significant covariates in the final adjusted model. Exclusion of occupation from the adjusted model revealed a marginally significant difference between high Ranch Hands and Comparisons (Appendix Table H-3-5@): p=0.075, Adj. RR=1.48). However, education was not included in this auxiliary analysis. When education was added to the final model, the results of the contrast between high Ranch Hands and Comparisons for the SCL-90-R interpersonal sensitivity T-scores were nonsignificant (Table H-3-8(a): p=0. 121).

Unadjusted analysis of SCL-90-R interpersonal sensitivity from Models 4 and 5 revealed a significant association between current dioxin and SCL-90-R interpersonal sensitivity T-scores (Table 12-11(g): p=0.022, Est. RR=1.19 and p=0.012, Est. RR=1.18 for Models 4 and 5). Results from the Model 6 unadjusted analysis were marginally significant (p=0.058, Est. RR=1.15). Each analysis showed increases in the percentages of high

Table 12-11.
Analysis of SCL-90-R Interpersonal Sensitivity

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	Group	n	Percent High	Est. Relative Risk (95% C.I.)	p-Value
AU	*Ranch Hand*	*948*	*10.4*	*1.16 (0.87,1.54)*	*0.343*
	Comparison	*1,279*	*9.2*		
Officer	Ranch Hand	367	4.4	0.91 (0.47,1.73)	0.892
	Comparison	501	4.8		
Enlisted Flyer	Ranch Hand	161	13.7	1.37 (0.73,2.60)	0.417
	Comparison	203	10.3		
Enlisted Groundcrew	Ranch Hand	420	14.5	i.19 (0.82,1.71)	0.411
	Comparison	575	12.5		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks[a]
All	*1.20 (0.90,1.61)*	*0.223*	*occ* (p=0.034)
Officer	1.00 (0.52,1.92)	*0.994*	DRKYR (p=0.070)
Enlisted Flyer	1.44 (0.74,2.81)	0.280	EDUC (p=0.128)
Enlisted Groundcrew	1.21 (0.82,1.76)	0.337	INC (p<0.001)

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-11. (Continued)
Analysis of SCL-90-R Interpersonal Sensitivity

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	173	11.0	1.09 (0.90,1.33)	0.381
Medium	173	9.8		
High	171	14.0		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
500	1.00 (0.79,1.27)**	0.996**	INIT*OCC (p=0.003) INIT*DRKYR (p=0.028) EDUC (p=0.057) INC (p=0.014) MARITAL (p=0.019) PARENT (p=0.060)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in Initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Log_2 (initial dioxin)-by-covariate interactions ($p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-7 for further analysis of these interactions.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-11. (Continued)
Analysis of SCL-90-R Interpersonal Sensitivity

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	8.7		
Background RH	373	7.5	0.88 (0.57,1.37)	0.575
Low RH	259	9.7	1.11 (0.70,1.77)	0.662
High RH	258	13.6	1.62 (1.06,2.45)	0.024
Low plus High RH	517	11.6	1.36 (0.96,1.92)	0.083

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			OCC (p=0.012) DRKYR (p=0.029) INC (p<0.001) MARITAL (p=0.094)
Background RH	359	1.25 (0.79,2.00)	0.342	
LOWRH	249	1.11 (0.68,1.84)	0.673	
High RH	251	1.30 (0.84,2.01)	0.234	
Low plus High RH	500	1.22 (0.85,1.75)	0.286	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in *percent* body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-11. (Continued)
Analysis of SCL-90-R Interpersonal Sensitivity

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	6.8 (299)	9.7 (296)	13.1 (297)	1.19 (1.03,1.37)	0.022
5	7.0 (299)	9.8 (296)	12.9 (295)	1.18 (1.04,1.35)	0.012
6[c]	7.1 (298)	9.8 (296)	12.9 (295)	1.15 (1.00,1.32)	0.058

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	1.05 (0.90,1.22)	0.560	DRKYR (p=0.010) EDUC (p=0.035) INC (p=0.003) MARITAL (p=0.088) PARENT (p=0.038)
5	859	1.06 (0.93,1.21)	0.381	DRKYR (p=0.010) EDUC (p=0.038) INC (p=0.004) MARITAL (p=0.088) PARENT (p=0.040)
6[d]	858	1.02 (0.88,1.18)	0.813	DRKYR (p=0.013) EDUC (p=0.036) INC (p=0.003) MARITAL (p=0.111) PARENT (p=0.031)

[a] Model 4: Log_2 (lipid-adjusted current dioxin + 1).
Model 5: Log_2 (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log_2 total lipids.

[b] Relative risk for a twofold increase in cm-rem dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

T-scores with increases in current dioxin. Results were nonsignificant for each model after adjustment for lifetime alcohol history, education, current total household income, current marital status, and current parental status (Table 12-11(h): $p > 0.38$ for each model).

SCL-90-R Obsessive-Compulsive Behavior

The Model 1 unadjusted group contrast combining all occupations displayed a marginally significant difference in the presence of a high SCL-90-R obsessive-compulsive T-score (Table 12-12(a): $p=0.082$, Est. RR=1.30). Of the Ranch Hands, 11.0 percent displayed a high T-score, in contrast to 8.7 percent of the Comparisons. The difference was significant in the adjusted analysis (Table 12-12(b): $p=0.047$, Adj. RR= 1.35). Significant covariates in the final model were age, occupation, lifetime alcohol history, and current total household income. Contrasts examined within each occupation yielded nonsignificant differences for the unadjusted and adjusted analyses (Table 12-12(a,b): $p > 0.14$ for each contrast).

Unadjusted and adjusted analyses of SCL-90-R obsessive-compulsive behavior for Model 2 were nonsignificant (Table 12-12(a,b): $p > 0.30$ for both analyses). Current alcohol use, lifetime alcohol history, combat service, and the initial dioxin-by-occupation and initial dioxin-by-current total household income interactions were significant in the final adjusted model. Adjusted results were based on the final model after deletion of the initial dioxin interactions. Results stratified by occupation and current total household income are presented separately in Appendix Table H-2-8.

Significant differences were found between high Ranch Hands and Comparisons in the unadjusted Model 3 analysis of SCL-90-R obsessive-compulsive behavior (Table 12-12(e): $p=0.049$, Est. RR=1.54). The adjusted contrast between background Ranch Hands and Comparisons also was significant (Table 12-12(f): $p=0.007$, Adj. RR=1.79). Both analyses revealed that a larger percentage of Ranch Hands had high SCL-90-R obsessive-compulsive T-scores than Comparisons (background Ranch Hands: 10.7%; high Ranch Hands: 12.8%; Comparisons: 8.6%). Other Model 3 contrasts were nonsignificant (Table 12-12(e,f): $p > 0.17$ for all remaining contrasts). The adjusted analysis displayed the significant covariate effects of occupation, lifetime alcohol history, current total household income, and current employment.

Results from the unadjusted and adjusted analysis of SCL-90-R obsessive-compulsive behavior from Models 4, 5, and 6 indicated that the association between current dioxin and the prevalence of a high T-score was nonsignificant (Table 12-12(g,h): $p > 0.29$ for each analysis). Adjusted results for each model are based on the final model after the deletion of the significant interactions of current dioxin-by-current alcohol use and current dioxin-by-current total household income. Other covariates displaying significance in each final model were lifetime alcohol history, education, and current employment. Results stratified by each combination of categories of current alcohol use and current total household income are presented in Appendix Table H-2-8 for each model.

Table 12-12.
Analysis of SCL-90-R Obsessive-Compulsive Behavior

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	Group	n	Percent High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***948***	***II.0***	***1.30 (0.98,1.72)***	***0.082***
	Comparison	***1,279***	***8.7***		
Officer	Ranch Hand	367	6.3	1.22 (0.69,2.18)	0.596
	Comparison	501	5.2		
Enlisted Flyer	Ranch Hand	161	14.9	1.37 (0.74,2.53)	0.393
	Comparison	203	11.3		
Enlisted Groundcrew	Ranch Hand	420	13.6	1.30 (0.89,1.91)	0.215
	Comparison	575	10.8		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks[a]
All	***1.35 (1.00,1.80)***	***0.047***	AGE (p=0.023) OCC (p=0.018) DRKYR (p=0.003) INC (p<0.001)
Officer	1.28 (0.71,2.28)	0.412	
Enlisted Flyer	1.45 (0.76,2.74)	0.258	
Enlisted Groundcrew	1.34 (0.90,1.99)	0.149	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-12. (Continued)
Analysis of SCL-90-R Obsessive-Compulsive Behavior

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	173	11.6	1.11 (0.91,1.36)	0.304
Medium	173	8.1		
High	171	12.9		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
500	1.05 (0.83,1.34)**	0.674**	INIT*OCC (p=0.017) INIT*INC (p=0.013) ALC (p=0.052) DRKYR (p=0.002) COMBDAYS (p=0.018)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Log, (initial dioxin)-by-covariate interactions ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-8 for further analysis of these interactions.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-12. (Continued)
Analysis of SCL-90-R Obsessive-Compulsive Behavior

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED

Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	8.6		
Background RH	373	10.7	1.32 (0.89,1.96)	0.171
Low RH	259	8.9	1.01 (0.62,1.63)	0.982
High RH	258	12.8	1.54 (1.00,2.36)	0.049
Low plus High RH	517	10.8	1.26 (0.89,1.80)	0.196

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED

Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			OCC (p=0.006) DRKYR (p=0.005) INC (p=0.007) EMPLOY (p=0.030)
Background RH	359	1.79 (1.17,2.73)	0.007	
Low RH	249	0.97 (0.58,1.62)	0.908	
High RH	251	1.26 (0.81,1.97)	0.307	
Low plus High RH	500	1.13 (0.78,1.63)	0.530	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt. Initial Dioxin > 143 ppt.

Table 12-12. (Continued)
Analysis of SCL-90-R Obsessive-Compulsive Behavior

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	10.2 (294)	10.4 (299)	11.8 (297)	1.02 (0.88,1.18)	0.766
5	10.7 (299)	9.5 (296)	12.2 (295)	1.02 (0.90,1.15)	0.809
6[c]	10.4 (298)	9.5 (296)	12.2 (295)	0.99 (0.87,1.13)	0.893

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	0.94 (0.81,1.10)**	0.456**	CURR*ALC (p<0.001) CURR*INC (p=0.013) DRKYR (p=0.005) EDUC (p=0.020) EMPLOY (p=0.077)
5	859	0.95 (0.84,1.08)**	0.461**	CURR*ALC (p<0.001) CURR*INC (p=0.002) DRKYR (p=0.005) EDUC (p=0.022) EMPLOY (p=0.070)
6[d]	858	0.93 (0.81,1.07)**	0.295**	cuRR*ALc (p<0.001) CURR*INC (p=0.009) DRKYR (p=0.004) EDUC (p-0.022) EMPLOY (p=0.065)

[a] Model 4: Log_2 (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log, total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log, (current dioxin + 1)-by-covariate interactions ($p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-8 for further analysis of these interactions.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High =>20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

SCL-90-R Paranoid Ideation

Both Model 1 unadjusted and adjusted analyses displayed a significant group difference in the prevalence of high SCL-90-R paranoid ideation T-scores from the contrast combining all occupations (Table 12-13(a,b): p=0.022, Est. RR=1.55 and p=0.010, Adj. RR=1.65). Marginally significant differences were found in the unadjusted and adjusted enlisted groundcrew contrasts, as well as the adjusted enlisted flyer contrast (Table 12-13(a,b): p=0.073, Est. RR=1.58; p=0.078, Adj. RR=1.55; and p=0.070, Adj. RR=2.23 respectively). Other Model 1 contrasts were nonsignificant (Table 12-13(a,b): p >0.21 for each remaining contrast). Ranch Hands had a greater percentage of high T-scores than Comparisons combining all occupations (Table 12-13(a): 7.0% vs. 4.6%), as well as within each occupation (Table 12-13(a): 3.0% vs. 2.4% for officers, 9.3% vs. 5.4% for enlisted flyers, and 9.5 % vs. 6.3 % for enlisted groundcrew). Significant covariates present in the fii model were occupation, lifetime alcohol history, current total household income, and the group-by-race interaction. Adjusted results are based on the fiil model after deletion of the interaction, and results stratified by race are presented in Appendix Table H-2-9.

Tests of association between SCL-90-R paranoid ideation and initial dioxin were nonsignificant for both unadjusted and adjusted Model 2 analyses (Table 12-13(c,d): p>0.65 for both analyses). Lifetime alcohol history, education, current total household income, current marital status, current parental status, and combat service were significant covariates in the fiil adjusted model.

The Model 3 unadjusted analysis revealed significant differences in the prevalence of high SCL-90-R paranoid ideation T-scores when the high Ranch Hands and low plus high Ranch Hands each were contrasted with Comparisons (Table 12-13(e): p=0.010, Est. RR=2.00 and p=0.029, Est. RR=1.64). The percentage of high Ranch Hands, low plus high Ranch Hands, and Comparisons with high T-scores were 8.5, 7.2, and 4.4 percent respectively. The background Ranch Hand contrast was significant and the high Ranch Hand contrast was marginally significant in the adjusted analysis (Table 12-13(f): p=0.007, Adj. RR=2.16 and p=0.090, Adj. RR=1.62). Adjusted results are based on the final model after deletion of the significant interaction between categorized dioxin and current marital status. Other covariates significant in the final model were race, occupation, lifetime alcohol history, and current total household income. After exclusion of occupation from the final model, the high Ranch Hands versus Comparisons contrast was significant, similar to the unadjusted analysis (Appendix Table H-3-7(a): p=0.031, Adj. RR= 1.83).

Unadjusted and adjusted analyses of SCL-90-R paranoid ideation for Models 4, 5, and 6 were nonsignificant for tests of association between current dioxin and prevalence of high SCL-90-R paranoid ideation T-scores (Table 12-13(g,h): p 10.28 for each analysis). Each adjusted model reflected covariate effects of occupation, lifetime alcohol history, current total household income, and current dioxin-by-covariate interactions involving education, current marital status, and combat service. Adjusted results are based on the final models after deletion of the significant current dioxin interactions. Results stratified by education, current marital status, and combat service are presented in Appendix Table H-2-9.

Table 12-13.
Analysis of SCL-90-R Paranoid Ideation

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent High**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***948***	***7.0***	***1.55 (1.08,2.22)***	***0.022***
	Comparison	***1,279***	***4.6***		
Officer	Ranch Hand	367	3.0	1.26 (0.55,2.89)	0.740
	Comparison	501	2.4		
Enlisted Flyer	Ranch Hand	161	9.3	1.79 (0.80,4.02)	0.219
	Comparison	203	5.4		
Enlisted Groundcrew	Ranch Hand	420	9.5	1.58 (0.99,2.52)	0.073
	Comparison	575	6.3		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.65 (1.13,2.41)*****	***0.010*****	GROUP*RACE (p=0.044) occ (p=0. 129) DRKYR (p<0.001) INC (p<0.001)
Officer	1.46 (0.62,3.42)**	0.386**	
Enlisted Flyer	2.23 (0.94,5.31)**	0.070**	
Enlisted Groundcrew	1.55 (0.95,2.53)**	0.078**	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

** Group-by-covariate interaction (0.01 $< p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-9 for further analysis of this interaction.

Table 12-13. (Continued)
Analysis of SCL-90-R Paranoid Ideation

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	173	5.8	1.06 (0.82,1.36)	0.652
Medium	173	8.1		
High	171	7.6		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
500	0.98 (0.74,1.31)	0.914	DRKYR (p=0.002) EDUC (p=0.111) INC (p=0.035) MARITAL (p=0.012) PARENT (p=0.065) COMBDAYS (p=0.017)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-13. (Continued)
Analysis of SCL-90-R Paranoid Ideation

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED

Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	4.4		
Background RH	373	6.2	1.44 (0.86,2.41)	0.170
Low RH	259	5.8	1.31 (0.72,2.38)	0.380
High RH	258	8.5	2.00 (1.18,3.39)	0.010
Low plus High RH	517	7.2	1.64 (1.05,2.57)	0.029

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED

Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			DXCAT*MARITAL (p=0.032) RACE (p=0.106) occ (p=0.049) DRKYR (p<0.001) INC (p=0.001)
Background RH	359	2.16 (1.24,3.78)**	0.007**	
Low RH	249	1.29 (0.67,2.47)**	0.451**	
High RH	251	1.62 (0.93,2.82)**	0.090**	
Low plus High RH	500	1.47 (0.92,2.36)**	0.110**	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Categorized dioxin-by-covariate interaction ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-9 for further analysis of this interaction.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-13. (Continued)
Analysis of SCL-90-R Paranoid Ideation

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	6.1 (6.0)	5.4 (6.4)	8.8 (7.8)	1.08 (0.90,1.28)	0.420
5	(299)	(296)	(295)	1.09 (0.93,1.27)	0.280
6[c]	6.0 (298)	6.4 (296)	7.8 (295)	1.06 (0.90,1.25)	0.506

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	0.92 (0.76,1.12)**	0.405**	CURR*EDUC (p=0.027) CURR*MARITAL (p=0.012) CURR*COMBDAYS (p<0.001) occ (p=0.044) DRKYR (p=0.001) INC (p=0.013)
5	859	0.96 (0.82,1.13)**	0.639**	CURR*EDUC (p=0.017) CURR*MARITAL (p=0.016) CURR*COMBDAYS (p<0.001) occ (p=0.053) DRKYR (p=0.003) INC (p=0.015)
6[d]	858	0.92 (0.77,1.10)**	0.378**	CURR*EDUC (p=0.023) CURR*MARITAL (p=0.015) CURR*COMBDAYS (p<0.001) OCC (p=0.048) DRKYR (p=0.003) INC (p=0.014)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log_2 (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log, total lipids.
[b] Relative risk for a twofold increase in current dioxin.
[c] Adjusted for log, total lipids.
[d] Adjusted for log_2 total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log, (current dioxin + l)-by-covariate interactions ($p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-9 for further analysis of these interactions.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

SCL-90-R Phobic Anxiety

All contrasts performed from the unadjusted and adjusted analyses of SCL-90-R phobic anxiety displayed nonsignificant results for Model 1 (Table 12-14(a,b): $p > 0.53$ for all contrasts). Occupation, lifetime alcohol history, education, current total household income, current employment, and current parental status were significant in the final adjusted model.

The Model 2 unadjusted analysis of SCL-90-R phobic anxiety revealed a significant association between initial dioxin and prevalence of a high SCL-90-R phobic anxiety T-score (Table 12-14(c): $p=0.036$, Est. $RR=1.27$). Results were marginally significant after covariate adjustment of current alcohol use, lifetime alcohol history, education, current employment, and current marital status (Table 12-14(d): $p=0.051$, Adj. $RR=1.27$).

The Model 3 unadjusted analysis of SCL-90-R phobic anxiety revealed a marginally significant difference between high Ranch Hands and Comparisons (Table 12-14(e): $p=0.094$, Est. RR= 1.47). Adjusted analysis displayed a marginally significant difference between background Ranch Hands and Comparisons (Table 12-14(f): $p=0.094$, Adj. $RR=1.52$). All remaining Model 3 contrasts were nonsignificant (Table 12-14(e,f): $p > 0.41$ for all remaining contrasts). Adjustment for covariates included age, occupation, lifetime alcohol history, education, current total household income, current employment, and current parental status in the fiil model. When occupation was removed from the final model, the background Ranch Hand versus Comparison contrast became nonsignificant (Appendix Table H-3-11(a): $p=0.229$).

Marginally significant associations between SCL-90-R phobic anxiety and current dioxin were found in the unadjusted analyses of Models 4 and 5 (Table 12-14(g): $p=0.089$, Est. $RR=1.15$ and $p=0.080$, Est. $RR=1.13$). The percentage of high SCL-90-R phobic anxiety T-scores increased as current dioxin levels increased. Model 6 unadjusted and adjusted analyses were both nonsignificant, as well as the Model 4 and 5 adjusted analyses (Table 12-14(g,h): $p > 0.29$ for each analysis). Occupation, lifetime alcohol history, education, current employment, and current marital status were significant covariates in each adjusted model.

SCL-90-R Psychoticism

All results were nonsignificant for all models analyzed for SCL-90-R psychoticism (Table 12-15(a-h): $p > 0.12$ for each analysis). Models 1 and 3 adjusted for age, race, occupation, lifetime alcohol history, and current total household income. Model 3 also adjusted for effects of current employment and the categorized dioxin-by-current alcohol use interaction. Lifetime alcohol history, education, and current marital status were significant covariates in the Model 2 adjusted analysis. Significant in Model 4, 5, and 6 adjusted analyses were occupation, lifetime alcohol history, current total household income, and current employment. Current alcohol use also was significant in Model 5, while the current dioxin-by-current alcohol use interaction was significant in Model 4. Model 3 and 4 results stratified by each category of current alcohol use are presented in Appendix Table H-2-10. Adjusted Model 3 and 4 results are based on the final models after deletion of the significant interaction.

Table 12-14.
Analysis of SCL-90-R Phobic Anxiety

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	Group	n	Percent High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***948***	***8.4***	***1.06 (0.78,1.44)***	***0.751***
	Comparison	***1,279***	***8.0***		
Officer	Ranch Hand	367	2.5	0.88 (0.37,2.04)	0.923
	Comparison	501	2.8		
Enlisted Flyer	Ranch Hand	161	10.6	1.21 (0.60,2.44)	0.715
	Comparison	203	8.9		
Enlisted Groundcrew	Ranch Hand	420	12.9	1.06 (0.73,1.56)	0.822
	Comparison	575	12.2		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks[a]
All	***1.10 (0.80,1.52)***	***0.563***	OCC ($p<0.001$) DRKYR ($p=0.148$) EDUC ($p=0.044$) INC ($p<0.001$) EMPLOY ($p=0.011$) PARENT ($p=0.118$)
Officer	***0.99*** (0.42,2.36)	0.982	
Enlisted Flyer	1.19 (0.58,2.43)	0.642	
Enlisted Groundcrew	1.10 (0.74,1.63)	0.638	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-14. (Continued): Analysis of SCL-90-R Phobic Anxiety

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	173	5.8	1.27 (1.02,1.58)	0.036
Medium	173	8.7		
High	171	12.3		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
504	1.27 (1.00,1.61)	0.051	ALC (p=0.119) DRKYR (p=0.070) EDUC (p=0.003) EMPLOY (p=0.041) MARITAL (p=0.033)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-14. (Continued)
Analysis of SCL-90-R Phobic Anxiety

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	7.8		
Background RH	373	7.5	0.98 (0.63,1.54)	0.933
Low RH	259	6.6	0.80 (0.46,1.37)	0.413
High RI-I	258	11.2	1.47 (0.94,2.31)	0.094
Low plus High RI-I	517	8.9	1.12 (0.77,1.64)	0.560

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			AGE (p=0.078) OCC (p=0.001) DRKYR (p=0.095) EDUC (p=0.050) INC (p=0.001) EMPLOY (p=0.008) PARENT (p=0.031)
Background RI-I	359	1.52 (0.93,2.47)	0.094	
Low RH	249	0.79 (0.45,1.42)	0.434	
High RH	251	1.02 (064,164)	0.922	
Low plus High RH	500	0.93 (0.62,1.38)	0.706	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: RI-I = 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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-14. (Continued)
Analysis of SCL-90-R Phobic Anxiety

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	6.5 (299)	7.7 (296)	10.8 (297)	1.15 (0.98,1.35)	0.089
5	6.0 (298)	8.5 (296)	10.5 (295)	1.13 (0.99,1.30)	0.080
6[c]			10.5 (295)	1.08 (0.93,1.26)	0.293

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	870	0.96 (0.81,1.14)	0.635	OCC (p=0.001) DRKYR (p=0.060) EDUC (p=0.039) EMPLOY (p=0.002) MARITAL (p=0.058)
5	870	0.98 (0.84,1.13)	0.731	OCC (p=0.002) DRKYR (p=0.061) EDUC (p=0.038) EMPLOY (p=0.001) MARITAL (p=0.058)
6[d]	869	0.92 (0.78,1.08)	0.297	OCC (p<0.001) DRKYR (p=0.073) EDUC (p=0.049) EMPLOY (p=0.001) MARITAL (p=0.072)

[a] Model 4: Log_2 (lipid-adjusted current dioxin + 1).
Model 5: Log_2 (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for logs total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

Table 12-15.
Analysis of SCL-90-R Psychoticism

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent High**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***948***	***9.6***	***1.10 (0.82,1.46)***	***0.587***
	Comparison	***1,279***	***8.8***		
Officer	Ranch Hand	367	5.2	1.09 (0.59,2.01)	0.920
	Comparison	501	4.8		
Enlisted Flyer	Ranch Hand	161	11.8	1.38 (0.70,2.72)	0.456
	Comparison	203	8.9		
Enlisted Groundcrew	Ranch Hand	420	12.6	1.03 (0.70,1.50)	0.975
	Comparison	575	12.4		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.16 (0.86,1.58)***	***0.329***	AGE (p=0.005) RACE (p=0. 133) OCC (p=0.009) DRKYR (p=0.021) INC (p<0.001)
Officer	1.08 (0.57,2.03)	0.815	
Enlisted Flyer	1.57 (0.77,3.19)	0.210	
Enlisted Groundcrew	1.09 (0.73,1.63)	0.674	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-15. (Continued]
Analysis of SCL-90-R Psychoticism

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log$_2$ (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	173	9.8	1.06 (0.86,1.32)	0.587
Medium	173	8.7		
High	171	10.5		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log$_2$ (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
504	1.07 (0.85,1.35)	0.555	DRKYR (p=0.052) EDUC (p=0.084) MARITAL (p=0.051)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-15. (Continued)
Analysis of SCL-90-R Psychoticism

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	8.7		
Background RH	373	8.9	1.05 (0.69,1.60)	0.809
Low RH	259	8.5	0.96 (059,156)	0.852
High RH	258	10.9	1.26 (0.80,1.97)	0.317
Low plus High RH	517	9.7	1.10 (0.77,1.59)	0.598

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			DXCAT*ALC (p=0.019) AGE (p=0.050) RACE (p=0.047) occ (p =0.005) DRKYR (p=0.026) INC (p=0.005) EMPLOY (p=0.148)
Background RH	359	1.43 (0.91,2.25)**	0.122**	
Low RH	249	0.90 (0.53,1.54)**	0.704**	
High RH	251	1.12 (0.70,1.80)**	0.636**	
Low plus High RH	500	1.02 (0.69,1.50)**	0.928**	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin,, and covariates specified under "Covariate Remarks" column.

** Categorized dioxin-by-covariate interaction ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, aud p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-10 for further analysis of this interaction.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-15. (Continued)
Analysis of SCL-90-R Psychoticism

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	8.2 (294)	9.4 (299)	10.4 (297)	1.07 (0.92,1.25)	0.371
5	8.7 (299)	8.8 (296)	10.5 (295)	1.08 (0.94,1.23)	0.275
6[c]	8.7 (298)	8.8 (296)	10.5 (295)	1.05 (0.91,1.21)	0.526

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	0.95 (0.80,1.13)**	0.559**	CURR*ALC (p=0.036) OCC (p=0.045) DRKYR (p=0.012) INC (p=0.113) EMPLOY (p=0.061)
5	859	0.98 (0.84,1.13)	0.747	OCC (p=0.072) ALC (p=0.150) DRKYR (p=0.027) INC (p=0.103) EMPLOY (p=0.057)
6[d]	858	0.94 (0.81,1.10)	0.471	OCC (p=0.076) DRKYR (p=0.007) INC (p=0.090) EMPLOY (p=0.080)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log, (whole-weight current dioxin + 1), adjusted for log, total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log_2 (current dioxin + l)-by-covariate interaction (0.01 $<p$ ~0.05); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-10 for further analysis of this interaction.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

SCL-90-R Somatization

Significant group differences were found in the Model 1 unadjusted and adjusted analyses of SCL-90-R somatization contrast combining all occupations (Table 12-16(a,b): $p=0.048$, Est. $RR=1.36$ and $p=0.018$, Adj. $RR=1.45$ for the unadjusted and adjusted analyses). More Ranch Hands (10.2%) than Comparisons (7.7%) had a high SCL-90-R somatization T-score. The adjusted enlisted groundcrew contrast was marginally significant (Table 12-16(b): $p=0.081$, Adj. $RR=1.43$). All other contrasts were nonsignificant (Table 12-16(a,b): $p \geq 0.15$ for all remaining contrasts). Covariates in the final adjusted model included occupation, lifetime alcohol history, current total household income, and current employment.

Model 2 analyses of SCL-90-R somatization exhibited a shift from a nonsignificant association with initial dioxin in the unadjusted analysis to a marginally significant association after adjustment for effects of current alcohol use and current marital status (Table 12-16(c,d): $p=0.158$ and $p=0.087$, Adj, $RR=1.20$ respectively).

Unadjusted Model 3 contrasts identified significant differences between high Ranch Hands and Comparisons and between low plus high Ranch Hands and Comparisons (Table 12-16(e): $p=0.011$, Est. $RR=1.75$ and $p=0.024$, Est. $RR=1.51$ respectively). A greater percentage of Ranch Hands than Comparisons had a high SCL-90-R somatization T-score within each category of Ranch Hands. The background Ranch Hand adjusted contrast revealed that significantly more Ranch Hands than Comparisons exhibited a high SCL-90-R somatization T-score (Table 12-16(f): $p=0.031$, Adj. $RR=1.67$). Remaining Model 3 contrasts were nonsignificant (Table 12-16(e,f): $p>0.10$ for each remaining contrast). Occupation, lifetime alcohol history, current total household income, current employment, and current marital status exhibited significant covariate effects in the final adjusted model. Significance levels of contrasts changed considerably after exclusion of occupation from the final model. The background Ranch Hand contrast became marginally significant (Appendix Table H-3-10(a): $p=0.099$, Adj. $RR=1.47$). Nonsignificant results in the original adjusted final model changed to significant results for each of the high and low plus high Ranch Hand contrasts (Appendix Table H-3-13(a): $p=0.029$, Adj. $RR=1.65$ and $p=0.043$, Adj. RR= 1.47 respectively). However, education was not included in this auxiliary analysis. When education was added to the final model, the results of the contrasts between high Ranch Hands and Comparisons and between low plus high Ranch Hands and Comparisons for the SCL-90-R somatization T-scores were marginally significant (Appendix Table H-3-14(a): $p=0.056$, Adj. $RR=1.55$ and $p=0.076$, Adj. $RR=1.41$ respectively).

Unadjusted analysis of SCL-90-R somatization for Models 4 and 5 indicated that high somatization T-scores increased as current dioxin levels increased. Tests of association were marginally significant and significant for Models 4 and 5 respectively (Table 12-16(g): $p=0.064$, Est. $RR=1.15$ and $p=0.023$, Est. $RR=1.16$ for Models 4 and 5). Results from the adjusted analysis for Models 4 and 5 and both the unadjusted and adjusted analyses for Model 6 were nonsignificant (Table 12-16(g,h): $p>0.22$ for each analysis). Significant covariates present in each final model include lifetime alcohol history, current total household income, and current marital status, as well as the current dioxin-by-current alcohol use interaction. Education also was significant in Model 5, as was the interaction between

Table 12-16.
Analysis of SCL-90-R Somatization

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	Group	n	Percent High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***948***	***10.2***	***1.36 (1.01,1.82)***	***0.048***
	Comparison	***1,279***	***7.7***		
Officer	Ranch Hand	367	5.2	1.47 (0.76,2.83)	0.331
	Comparison	501	3.6		
Enlisted Flyer	Ranch Hand	161	12.4	1.30 (0.67,2.51)	0.542
	Comparison	203	9.9		
Enlisted Groundcrew	Ranch Hand	420	13.8	1.35 (0.92,1.98)	0.150
	Comparison	575	10.6		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks[a]
All	***1.45 (1.07,1.98)***	***0.018***	OCC (p=0.006) DRKYR (p=0.079) INC (p<0.001) EMPLOY (p=0.025)
Officer	1.59 (0.80,3.15)	0.183	
Enlisted Flyer	1.39 (0.70,2.76)	0.349	
Enlisted Groundcrew	1.43 (0.96.2.14)	0.081	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-16. (Continued)
Analysis of SCL-90-R Somatization

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	173	8.7	1.16 (0.95,1.41)	0.158
Medium	173	12.1		
High	171	12.9		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
510	1.20 (0.98,1.47)	0.087	ALC (p=0.129) MARITAL (p<0.001)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-16. (Continued)
Analysis of SCL-90-R Somatization

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	7.6		
Background RI-I	373	8.6	1.16 (0.75,1.78)	0.505
Low RH	259	9.7	1.27 (0.80,2.04)	0.315
High RI-I	258	12.8	1.75 (1.14,2.70)	0.011
Low plus High RH	517	11.2	1.51 (1.05,2.15)	0.024

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			OCC (p=0.005) DRKYR (p=0.077)
Background RI-I	359	1.67 (1.05,2.67)	0.031	INC (p<0.001)
Low RH	249	1.27 (0.76,2.11)	0.369	EMPLOY (p=0.023) MARITAL (p=0.100)
Low plus High RH	500	1.37 (0.94,1.99)	0.102	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-16. (Continued)
Analysis of SCL-90-R Somatization

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	8.2 (299)	9.4 (296)	12.8 (297)	1.15 (0.99,1.33)	0.064
5	7.7 (299)	9.5 (296)	13.2 (295)	1.16 (1.02,1.32)	0.023
6[c]	7.7 (298)	9.5 (296)	13.2 (295)	1.09 (0.95,1.25)	0.227

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	1.05 (0.90,1.22)**	0.545**	CURR*ALC (p=0.037) CURR*EDUC (p=0.040) DRKYR (p=0.015) INC (p=0.026) MARITAL (p=0.009)
5	859	1.08 (0.94,1.23)**	0.283**	CURR*ALC (p=0.045) DRKYR (p=0.021) EDUC (p=0.008) INC (p=0.012) MARITAL (p=0.012)
6[d]	858	1.00 (0.87,1.16)**	0.996**	CURR*ALC (p=0.038) CURR*EDUC (p=0.038) DRKYR (p=0.019) INC (p=0.019) MARITAL (p=0.015)

[a] Model 4: Log_2 (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log, (whole-weight current dioxin + 1), adjusted for logs total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log, (current dioxin + 1)-by-covariate interactions ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-l 1 for further analysis of these interactions.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

current dioxin and education in Models 4 and 6. All adjusted results were based on each final model after deletion of the significant current dioxin-by-covariate interactions present in the final models. Results stratified by current alcohol use and education are presented in Appendix Table H-2- 11.

SCL-90-R Global Severity Index

Marginally significant differences in the prevalence of high SCL-90-R global severity index T-scores between Ranch Hands and Comparisons in Model 1 were found in the unadjusted overall contrast (Table 12-17(a): $p=0.100$, Est. $RR=1.30$). Of the Ranch Hands, 9.8 percent exhibited a high T-score, whereas 7.7 percent of the Comparisons exhibited high T-scores. Adjusted analysis produced significant results for the contrast combining all occupations (Table 12-17(b): $p=0.044$, Adj. $RR=1.38$). Differences were nonsignificant when examined within each occupational strata for both the unadjusted and adjusted analyses (Table 12-17(a,b): $p>0.12$ for each strata). Lifetime alcohol history, education, current total household income, and current marital status were significant covariates in the final adjusted model.

The Model 2 results were nonsignificant for both the unadjusted and adjusted analyses of SCL-90-R global severity index (Table 12-17(c,d): $p>0.12$ for both analyses). Lifetime alcohol history, education, current marital status, and the initial dioxin-by-current alcohol use interaction were significant in the final model. The adjusted results are based on the final model after deletion of the initial dioxin-by-current alcohol use interaction. Results stratified by each current alcohol use category are presented in Appendix Table H-2-12.

The high and low plus high Ranch Hand categories each demonstrated a greater percentage of high global severity index T-scores than Comparisons in the Model 3 unadjusted analyses (Table 12-17(e): $p=0.006$, Est. $RR=1.82$ and $p=0.035$, Est. $RR=1.47$ respectively). The high Ranch Hand contrast was marginally significant in the adjusted analysis (Table 12-17(f): $p=0.094$, Adj. $RR=1.47$). Results for other Model 3 contrasts were nonsignificant (Table 12-17(e,f): $p>0.13$ for each remaining contrast). Occupation, lifetime alcohol history, education, current total household income, current employment, and current marital status were significant covariates in the final adjusted model. The high Ranch Hand versus Comparison contrast became significant after occupation was removed from the final model (Appendix Table H-3-15(a): $p=0.047$, Adj. $RR=1.57$).

Significant associations between current dioxin and the SCL-90-R global severity index were revealed from the unadjusted analysis of Models 4 and 5 (Table 12-17(g): $p=0.024$, Est. $RR=1.19$ and $p=0.014$, Est. $RR=1.18$ respectively). Both analyses indicated that the percentage of high global severity index T-scores increased as current dioxin levels increased. Adjusted analyses of Models 4 and 5 were nonsignificant as were both unadjusted and adjusted analyses of Model 6 (Table 12-17(g,h): $p>0.11$ for all remaining analyses). Models 4, 5, and 6 adjusted for lifetime alcohol use, education, current marital status, and the current dioxin-by-current alcohol use interaction. Current total household income was significant in Model 4 and the interaction between current dioxin and current household income was significant in Models 5 and 6. All adjusted results are based on deletion of the

Table 12-17.
Analysis of SCL-90-R Global Severity Index

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	Group	n	Percent High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***948***	***9.8***	***1.30 (0.96,1.74)***	***0.100***
	Comparison	***1,279***	***7.7***		
Officer	Ranch Hand	367	4.6	1.17 (0.60,2.26)	0.771
	Comparison	501	4.0		
Enlisted Flyer	Ranch Hand	161	13.0	1.54 (0.79,3.00)	0.267
	Comparison	203	8.9		
Enlisted Groundcrew	Ranch Hand	420	13.1	1.27 (0.86,1.87)	0.268
	Comparison	575	10.6		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks[a]
AU	***1.38 (1.01,1.88)***	***0.044***	DRKYR (p=0.002) EDUC (p<0.001) INC (p<0.001) MARITAL (p=0.020)
Officer	1.30 (0.66,2.55)	0.445	
Enlisted Flyer	1.73 (0.86,3.48)	0.124	
Enlisted Groundcrew	1.31 (0.87,1.95)	0.195	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-17. (Continued)
Analysis of SCL-90-R Global Severity Index

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
LOW	173	9.3	1.17 (0.96,1.43)	0.121
Medium	173	10.4		
High	171	14.0		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
504	1.16 (0.94,1.43)**	0.182**	INIT*ALC (p=0.004) DRKYR (p<0.001) EDUC (p=0.038) MARITAL (p=0.002)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Log_2 (initial dioxin)-by-covariate interaction ($p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-12 for further analysis of this interaction.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-17. (Continued)
Analysis of SCL-90-R Global Severity Index

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	7.7		
Background RH	373	1.5	1.01 (0.64,1.58)	0.967
Low RH	259	8.9	1.13 (0.70,1.84)	0.615
High RI-I	258	13.6	1.82 (1.19,2.78)	0.006
Low plus High RI-I	517	11.2	1.47 (1.03,2.09)	0.035

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			OCC (p=0.118) DRKYR (p=0.004) EDUC (p=0.091) INC (p=0.010) EMPLOY (p=0.118) MARITAL (p=0.003)
Background RH	359	1.45 (0.90,2.34)	0.131	
Low RH	249	1.14 (0.68,1.92)	0.615	
High RH	251	1.47 (0.94,2.30)	0.094	
Low plus High RI-I	500	1.32 (0.91,1.92)	0.148	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-17. (Continuedj
Analysis of SCL-90-R Global Severity Index

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	7.5 (294)	8.4 (299)	13.1 (297)	1.19 (1.02,1.38)	0.024
5	7.4 (299)	8.8 (296)	12.9 (295)	1.18 (1.03,1.35)	0.014
6[c]	7.4 (298)	8.8 (296)	12.9 (295)	1.12 (0.97,1.29)	0.118

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	1.08 (0.92,1.26)**	0.354**	CURR*ALC (p=0.012) DRKYR (p=0.001) EDUC (p=0.008) INC (p=0.042) MARITAL (p=0.013)
5	859	1.08 (0.95,1.24)**	0.242**	CURR*ALC (p=0.026) CURR*INC (p=0.037) DRKYR (p=0.003) EDUC (p=0.019) MARITAL (p=0.016)
6[d]	858	1.02 (0.88,1.18)**	0.779**	cuRR*ALc (p=0.028) CURR*INC (p=0.044) DRKYR (p=0.003) EDUC (p=0.016) MARITAL (p=0.023)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log, (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log, total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

** Log, (current dioxin + 1)-by-covariate interaction ($0.01 < p \leq 0.05$); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of this interaction; refer to Appendix Table H-2-12 for further analysis of this interaction.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

significant interactions from the final models. Appendix Table H-2-12 presents results stratified by current alcohol use and current total household income.

SCL-90-R Positive Symptom Total

Model 1 SCL-90-R positive symptom total results were nonsignificant for both the unadjusted and adjusted analyses (Table 12-18(a,b): $p > 0.13$ for all analyses). Occupation, lifetime alcohol history, current total household income, current employment, and current marital status displayed significant covariate effects in the final adjusted model.

Results from both the unadjusted and adjusted analyses of the SCL-90-R positive symptom total were nonsignificant for Model 2 (Table 12-18(c,d): $p > 0.17$ for both analyses). Adjusted results are based on the final model after the deletion of the significant initial dioxin-by-occupation and initial dioxin-by-current total household income interactions. Other significant covariates included current alcohol use, lifetime alcohol history, education, current marital status, and current parental status. Results stratified by occupation and current total household income category are presented in Appendix Table H-2-13.

Model 3 unadjusted contrasts revealed a significantly greater prevalence of high SCL-90-R positive symptom total T-scores among high Ranch Hands (14.3 %) than Comparisons (9.4%) (Table 12-18(e): $p=0.033$, Est. $RR=1.56$). This contrast was nonsignificant after adjustment, as were the other Model 3 contrasts both before and after covariate adjustment for occupation, lifetime alcohol history, current total household income, current employment, and current marital status (Table 12-18(e,f): $p > 0.11$ for all remaining contrasts). However, exclusion of occupation from the final model revealed a marginally significant difference between high Ranch Hands and Comparisons (Appendix Table H-3-16(b): $p=0.072$, Adj. $RR=1.47$). However, education was not included in this auxiliary analysis. When education was added to the final model, the results of the contrast between high Ranch Hands and Comparisons for the SCL-90-R positive symptom total T-scores were nonsignificant (Appendix Table H-3-17(a): $p = 0.126$).

Significant positive associations between current dioxin and SCL-90-R positive symptom total were found in the unadjusted analysis of Models 4 and 5 (Table 12-18(g): $p=0.027$, Est. $RR=1.17$ and $p=0.013$, Est. $RR=1.17$ respectively). Tests of association from the adjusted analyses from Models 4 and 5 and both unadjusted and adjusted analyses of Model 6 were nonsignificant (Table 12-18(g,h): $p > 0.14$ for all remaining analyses). Each adjusted model included lifetime alcohol history, education, current total household income, and current marital status. Model 6 additionally adjusted for current alcohol use.

SCL-90-R Positive Symptom Distress Index

All analyses conducted for SCL-90-R positive symptom distress index produced nonsignificant results, except for the Model 5 unadjusted analyses (Table 12-19(a-h): $p > 0.11$ for all analyses except Model 5 unadjusted analysis). A marginally significant positive association between current dioxin and a high SCL-90-R positive symptom distress index T-score resulted for the Model 5 unadjusted analysis (Table 12-19(g): $p=0.059$, Est. RR= 1.15). Occupation, current total household income, and current parental status were

Table 12-18.
Analysis of SCL-90-R Positive Symptom Total

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent High**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***948***	***11.0***	***1.16 (0.88,1.53)***	***0.331***
	Comparison	***1,279***	***9.6***		
Officer	Ranch Hand	367	5.5	0.97 (0.54,1.76)	0.929
	Comparison	501	5.6		
Enlisted Flyer	Ranch Hand	161	13.7	1.37 (0.73,2.60)	0.330
	Comparison	203	10.3		
Enlisted Groundcrew	Ranch Hand	420	14.8	1.17 (0.82,1.69)	0.392
	Comparison	575	12.9		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.25 (0.93,1.66)***	***0.135***	*occ* (p =0.009)
Officer	1.06 (0.58,1.93)	0.850	DRKYR (p=0.002) INC (p=0.001)
Enlisted Flyer	1.49 (0.76,2.89)	0.244	EMPLOY (p=0.044) MARITAL (p=0.029)
Enlisted Groundcrew	1.26 (0.86,1.84)	0.241	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-18. (Continued)
Analysis of SCL-90-R Positive Symptom Total

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	173	12.1	1.14 (0.94,1.38)	0.177
Medium	173	9.8		
High	171	15.2		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
500	1.03 (0.82,1.30)**	0.778**	INIT*OCC (p-0.001) INIT*INC (p=0.004) ALC (p=0.059) DRKYR (p=0.003) EDUC (p=0.044) MARITAL (p=0.015) PARENT (p=0.113)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

** Log, (initial dioxin)-by-covariate interactions (p 50.05); adjusted relative risk, confidence interval, and p-value derived from a model fitted after deletion of these interactions; refer to Appendix Table H-2-13 for further analysis of these interactions.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-18. (Continued)
Analysis of SCL-90-R Positive Symptom Total

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	9.4		
Background RH	373	8.6	0.95 (0.62,1.44)	0.791
Low RH	259	10.4	1.08 (0.69,1.70)	0.732
High RH	258	14.3	1.56 (1.04,2.34)	0.033
Low plus High RH	517	12.4	1.31 (0.94.1.84)	0.110

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,031			OCC (p=0.028) DRKYR (p=0.003) INC (p=0.003) EMPLOY (p=0.062) MARITAL (p=0.012)
Background RH	359	1.32 (0.84,2.06)	0.224	
Low RH	249	1.13 (0.70,1.82)	0.614	
High RH	251	1.32 (0.86,2.03)	0.207	
Low plus High RH	500	1.23 (0.87,1.75)	0.247	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-18. (Continued)
Analysis of SCL-90-R Positive Symptom Total

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	8.8 (299)	9.4 (299)	14.1 (297)	1.17 (1.02,1.35)	0.027
5	8.7 (299)	10.1 (296)	13.6 (295)	1.17 (1.03,1.33)	0.013
6[c]	8.7 (298)	10.1 (296)	13.6 (295)	1.10 (0.97,1.27)	0.149

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	1.05 (0.91,1.22)	0.494	DRKYR (p=0.011) EDUC (p=0.013) INC (p=0.004) MARITAL (p=0.025)
5	859	1.07 (0.94,1.21)	0.330	DRKYR (p=0.012) EDUC (p=0.014) INC (p=0.004) MARITAL (p=0.025)
6[d]	858	1.00 (0.87,1.15)	0.984	ALC (p=0.130) DRKYR (p=0.006) EDUC (p=0.012) INC (p=0.004) MARITAL (p=0.033)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log_2 (whole-weight current dioxin + 1).
Model 6: Log_2 (whole-weight current dioxin + 1), adjusted for log_2 total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

Table 12-19.
Analysis of SCL-90-R Positive Symptom Distress Index

a) MODEL 1: RANCH HANDS VS. COMPARISONS — UNADJUSTED					
Occupational Category	**Group**	**n**	**Percent High**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	***Ranch Hand***	***948***	***7.8***	***1.04 (0.76,1.43)***	***0.855***
	Comparison	***1,279***	***7.5***		
Officer	Ranch Hand	367	4.6	1.11 (0.58,2.14)	0.884
	Comparison	501	4.2		
Enlisted Flyer	Ranch Hand	161	9.9	0.91 (0.46,1.79)	0.915
	Comparison	203	10.8		
Enlisted Groundcrew	Ranch Hand	420	9.8	1.07 (0.69,1.64)	0.857
	Comparison	575	9.2		

b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Adj. Relative Risk (95% C.I.)**	**p-Value**	**Covariate Remarks[a]**
All	***1.02 (0.74,1.41)***	***0.881***	*OCC* (p=0.006) INC (p=0.002) PARENT (p=0.016)
Officer	1.07 (0.55,2.08)	*0.847*	
Enlisted Flyer	0.90 (0.45,1.80)	0.775	
Enlisted Groundcrew	1.06 (0.69,1.63)	0.797	

[a] Covariates and associated p-values correspond to final model based on all participants with available data.

Table 12-19. (Continued)
Analysis of SCL-90-R Positive Symptom Distress Index

c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Percent High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	173	7.5	1.14 (0.91,1.43)	0.248
Medium	173	9.3		
High	171	9.4		

d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED			
Analysis Results for Log_2 (Initial Dioxin)[c]			
n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
517	1.18 (0.94,1.48)	0.169	EMPLOY (p=0. 115) MARITAL (p=0.062)

[a] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[b] Relative risk for a twofold increase in initial dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

Note: Low = 39-98 ppt; Medium = >98-232 ppt; High = >232 ppt.

Table 12-19. (Continued)
Analysis of SCL-90-R Positive Symptom Distress Index

e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED				
Dioxin Category	n	Percent High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,061	7.2		
Background RH	373	6.2	0.91 (0.56,1.47)	0.691
Low RH	259	7.7	1.06 (0.63,1.77)	0.836
High RH	258	9.7	1.32 (0.82,2.13)	0.249
Low plus High RH	517	8.7	1.19 (0.81,1.75)	0.380

f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — ADJUSTED				
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[ac]	p-Value	Covariate Remarks
Comparison	1,046			OCC (p=0.007) INC (p=0.030) PARENT (p=0.004)
Background RH	366	1.07 (0.64,1.78)	0.793	
Low RH	255	1.07 (0.63,1.80)	0.808	
High RH	258	1.04 (0.64,1.70)	0.865	
Low plus High RH	513	1.05 (0.71,1.56)	0.793	

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of duty in SEA and change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin.

[c] Adjusted for percent body fat at the time of duty in SEA, change in percent body fat from the time of duty in SEA to the date of the blood draw for dioxin, and covariates specified under "Covariate Remarks" column.

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 ≤ 143 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 143 ppt.

Table 12-19. (Continued)
Analysis of SCL-90-R Positive Symptom Distress Index

g) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — UNADJUSTED					
	Current Dioxin Category Percent High/(n)			Analysis Results for Log_2 (Current Dioxin + 1)	
Model[a]	Low	Medium	High	Est. Relative Risk (95% C.I.)[b]	p-Value
4	6.1	7.7	9.1	1.14 (0.97,1.35)	0.118
	5.7	7.4	9.8		
5	(299)	(296)	(295)	1.15 (0.99,1.33)	0.059
6[c]	5.7	7.4	9.8	1.08 (0.92,1.26)	0.359
	(298)	(296)	(295)		

h) MODELS 4, 5, AND 6: RANCH HANDS — CURRENT DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Current Dioxin + 1)			
Model[a]	n	Adj. Relative Risk (95% C.I.)[b]	p-Value	Covariate Remarks
4	859	1.10 (0.92,1.30)	0.302	DRKYR (p=0.103) INC (p=0.019)
5	859	1.11 (0.95,1.29)	0.172	DRKYR (p=0.105) INC (p=0.022)
6[d]	858	1.03 (0.88,1.22)	0.683	DRKYR (p=0.125) INC (p=0.016)

[a] Model 4: Log, (lipid-adjusted current dioxin + 1).
Model 5: Log_2 (whole-weight current dioxin + 1).
Model 6: Log, (whole-weight current dioxin + I), adjusted for log, total lipids.

[b] Relative risk for a twofold increase in current dioxin.

[c] Adjusted for log, total lipids.

[d] Adjusted for log, total lipids in addition to covariates specified under "Covariate Remarks" column.

Note: Model 4: Low = ≤ 8.1 ppt; Medium = >8.1-20.5 ppt; High = >20.5 ppt.
Models 5 and 6: Low = ≤ 46 ppq; Medium = >46-128 ppq; High = > 128 ppq.

significant covariates for Models 1 and 3. Model 2 adjusted for current employment and current marital status. Lifetime alcohol history and current total household income were each included in Models 4, 5, and 6.

DISCUSSION

Prior to the AFHS 1982 Baseline study, little scientifically validated information existed regarding the relationship between dioxin exposure and disturbances of cognition and emotion in man. The Baseline and 1985 followup studies attempted to explore these possible relationships using well-established questionnaires, personality inventories, and neuropsychological assessment techniques. These instruments included the CMI, the MMPI, and the HRB.

Analysis of extensive data generated by the CMI, MMPI and the HRB revealed very few statistically significant differences between those Air Force veterans who sustained dioxin exposure (Ranch Hands) and their unexposed Comparison group. More specifically, the two groups did not differ significantly on tests of cognitive (cerebral) function. The Ranch Hand group reported a moderately greater number of diffuse medical (somatic) complaints on the CMI. They also registered moderately higher (but not statistically significant) scores on those MMPI scales that are influenced most heavily by physical complaints such as generalized feelings of malaise, energy loss, and mental and physical slowing. The herbicide-exposed enlisted groundcrew cohort, which reported the highest levels of exposure, had significantly higher scores than other Ranch Hand group members only on the MMPI depression scale.

Factors contributing to the modest differences between groups were not clearly indicated by estimated dioxin exposure data. It was suspected that observed differences in psychological dependent variables might be related to some combination of negative expectations, anxiety, and increased somatic sensitivity on the part of exposed personnel. As the 1985 followup concluded, the possibility existed that subjectively experienced and reported exposure levels and symptoms were more accurate than exposure data at that time. Subsequently, this exposure data was found to correlate poorly with objectively determined TCDD levels.

A limited number of previous dioxin exposure studies reported findings similar to those described above. Investigations of both military and civilian groups failed to reveal evidence for organic brain dysfunction. However, at least one civilian study reported significantly elevated levels of tension-anxiety and anger-hostility. Psychological tests employed by some of these previous studies were relatively limited. However, the existence of independent data that potentially corroborated the previous AFHS findings indicated the importance of continuing appropriate psychological assessment for the 1987 followup. As the 1985 followup study concluded, participant complaints regarding the lengthy and repetitious psychometric evaluation were noted. Concern regarding potential loss of subjects for the 1987 followup prompted specific changes in the psychometric component of the study. Previously unrevealing and lengthy tests of cognition (i.e., HRB) were suspended. The issue of test-retest boredom was addressed by selecting two new psychometric instruments that

would provide ongoing assessment of important psychological variables while requiring much less time than the MMPI.

The new psychological instruments included the SCL-90-R. This 90-item checklist of physical and mental symptoms provided a reasonable measure of health-related concerns and associated anxiety, depression, and general emotional discomfort. The second test selected was the MCMI. This test provided back-up measures of depression, anxiety, and somatization while also screening for personality disorders and major psychiatric syndromes including psychosis. Both the SCL-90-R and the MCMI were previously employed in clinical and research settings requiring economical assessment of psychiatric disorders, physical disability status, and response to specific therapy. Furthermore, factor analysis and correlational studies indicated that specific scales and factors included in the two new tests correlated reasonably well with comparable elements in the MMPI. Therefore, acceptable continuity of psychological dependent variables was assured.

The addition of data concerning sleep disorders and the 20 scales and 3 indices comprising the SCL-90-R and the MCMI produced a substantial increase in the number of psychological dependent variables requiring analysis for the 1987 followup. Similarly, the number of dependent variable-covariate associations requiring examination increased, as did the probability of a proliferation of statistically significant interactions.

Examination of these psychological dependent variable-covariate associations indicated a host of statistically significant relationships. For example, previously well-known relationships between advancing age and disturbed sleep were noted, as was the well-known phenomena of sleep disturbance following excessive consumption of alcohol. A strong relationship between the presence of PTSD and a disturbance of numerous sleep and psychological variables also was observed. While the number of participants with PTSD was small (approximately 1% of each group), the effects of this condition were striking and made this an important finding. Given logistical difficulties inherent to the study, it was determined that a more efficient assessment of PTSD could be accomplished using a recently developed subscale of the MMPI. While this scale tends to be less precise than the structured psychiatric interview, it was significantly associated with expected psychological endpoints in the covariate adjusted analyses, and it appears to be a useful technique in the assessment of PTSD in population-based studies.

Further inspection of the 1987 data revealed the persistence of several psychological results described as noteworthy in the Baseline and 1985 followup studies. On the SCL-90-R, Ranch Hands demonstrated a statistically greater level of depression than Comparisons and also manifested more physical complaints (somatization) and health-related anxiety. Ranch Hands also recorded higher scores on those MCMI scales thought to reflect antisocial and passive-aggressive traits and psychotic delusional tendencies. However, careful analysis of the MCMI differences determined that these maladaptive traits and symptoms were more probably related to the emergence of psychometric artifacts than the appearance of some new symptoms complex that had not been observed in the previous studies.

The continuing manifestations of depression and health-related complaints and anxiety by members of the Ranch Hand cohort were not surprising. A similar persistence of

entrenched self-reported symptoms had been demonstrated by other populations receiving exposure to known or suspected toxins. Enlisted groundcrew members who reported high levels of herbicide exposure were thought to be particularly vulnerable to repeated public suggestions that negative psychological and physical consequences could be suffered secondary to their exposure. Ranch Hands with psychological make-ups predisposing them to higher levels of anxiety, psychophysiological disturbances and related somatic concerns would predictably demonstrate a self-perpetuating pattern of either static or escalating physical and psychological symptoms. The probability of such a reaction was based in part on previous studies of chronic physical illness. These studies revealed that a significant percentage (5% to 10%) of any medical population is likely to possess a psychological make-up that predisposes them to the development of psychophysiological disturbances and symptom-reactive anxiety that tend to develop in an escalating manner. These same individuals often tend to perceive themselves as unsuccessfully treated and potentially disabled persons. Therefore, they may harbor significant feelings of resentment and hostility that contribute to significantly higher scores on scales reflecting antisocial and passive-aggressive personality traits. On the other hand, moderately elevated scores on such scales and related tendencies toward higher level alcohol consumption could be associated with the presence of "swashbuckling" personality traits that might be perceived as adaptive when viewed in relation to the volunteer and perilous nature of the Ranch Hands' mission in SEA.

As the 1987 examination data was reported in 1990, it was recognized that factors other than dioxin exposure may have contributed to Ranch Hand dependent variable outliers. However, previous studies in clinical medicine suggested that caution was indicated. Studies of medical patients originally diagnosed as suffering from hysteria, hypochondriasis or other "functional disorders" later revealed that these patients were in fact suffering from neurological disease, endocrine dysfunction or other medical disorders approximately 60 percent of the time. Objective monitoring of the study participant's health status over the ensuing years was therefore clearly indicated.

Between 1990 and 1992, objectively determined dioxin body burden levels became available, which allowed extrapolation of initial levels of exposure as well as documentation of current levels. When dependent variables were re-examined in relation to extrapolated initial dioxin levels, a number of statistically significant results emerged for the verified questionnaire, sleep disorder, and SCL-90-R variables. However, when adjusted for effective covariate factors (i.e., age, education, alcohol use, and race), none of these results remained significant. On the other hand, 9 of the 20 MCMI scales remained statistically significant. Careful analyses of the MCMI findings revealed the absence of predicted correlation between the MCMI results and other dependent variable data including verified questionnaire and SCL-90-R results. Furthermore, exploration of MCMI test construction intricacies also suggested the probability of a spurious statistical relationship between MCMI scale results and initial dioxin analyses.

Examination of current dioxin and time since tour analyses for the verified questionnaire and sleep disorder variables generally were found to be nonsignificant. Comparable analysis of the SCL-90-R variables revealed two statistically significant results including a positive relationship between anxiety scale elevation and current dioxin levels for Ranch Hands with

greater than 18.6 years of service. However, additional inspection of verified questionnaire data failed to reveal corroborating evidence.

When adjusted analyses of the MCMI variables were examined in relation to the high current dioxin category, only two statistically significant results emerged (i.e., schizoid and schizo-typal scales). Previously discussed factors relating to test structure and absence of any corroborating verified questionnaire data combined to reduce the likelihood that these results were associated with a dose-response effect. By the time the objectively determined dioxin analyses could be completed, the 1992 followup study psychological instruments were essentially in place. Dependent variable measures remained unchanged and included the five verified questionnaire categories, the sleep disorder questionnaire, the SCL-90-R, the MCMI. As reported above, covariate factors were expanded by the inclusion of five new factors including combat service. Statistical models also were modified as indicated above in order to allow a more sophisticated within group analysis of both initial and current TCDD levels in the Ranch Hand group.

As analysis of the 1992 followup data proceeded, the addition of new covariates resulted in an expanded number of previously unexplored and potentially significant relationships. The SCL-90-R was retained for statistical analysis because of its effectiveness as a co-measure of variables included in the verified questionnaire. Given its historical relationship to the MCMI, the SCL-90-R also was retained to maintain psychometric continuity across the four phases of the AFHS completed to date.

As revealed in the summary tables of the 1992 followup study, the Model 1 analysis contrasted Ranch Hands and Comparisons across all occupations and within each occupation. With the exception of the other neuroses variable, all significant differences were found by combining and contrasting all Ranch Hand and Comparison occupations in both the unadjusted and adjusted analyses. On the unadjusted analysis statistically significant results were observed on the SCL-90-R hostility, paranoid ideation, and somatization scales with tendencies toward significance demonstrated on the anxiety, obsessive-compulsive behavior, and global severity index scales. Adjusted Model 1 data revealed marginally significant elevations for enlisted groundcrew or enlisted flyers on the anxiety, hostility, paranoid ideation, and somatization SCL-90-R scales as well as a continued significant elevation on the other neuroses variable. When all occupation categories were combined, the number of statistically significant scale elevations increased. Significant results were obtained on the other neuroses indicator as well as the anxiety, obsessive-compulsive behavior, paranoid ideation, somatization, and global severity index subscales of the SCL-90-R.

The persistence of elevated indicators of psychological distress for the adjusted Model 1 data is probably best understood when viewed in relation to dependent variable data obtained from Models 3, 4, 5, and 6. Like Model 1, Model 3 contrasted Ranch Hand versus Comparison dependent variable data calculated in relation to categorized dioxin levels. Ranch Hands demonstrating high levels of dioxin obtained SCL-90-R scaled scores that were statistically higher than those obtained by Comparisons on a consistent basis. Essentially, all but two of the SCL-90-R scales reached the level of statistical significance (see Table 12-22). In addition, significant scores were obtained on the anxiety and other neuroses scales obtained from the verified questionnaire data. Adjusted analyses revealed a dramatic change

as only the anxiety scale of the SCL-90-R remained statistically significant and three additional scales remained marginally significant.

The above results highlight the important impact of covariate factors such as occupation and lifetime alcohol history upon dependent variable outcomes. For example, examination of SCL-90-R anxiety scale results across models reveals statistically significant unadjusted and/or adjusted scale elevations on essentially all models. Inspection of dependent variable-covariate associations for psychological assessment appearing in Appendix Table H-l-l demonstrate the extent to which these anxiety scale elevations were influenced by occupational status. An average of 9.1 percent of enlisted groundcrew and enlisted flyers obtained significant scores on this scale, while only 2.9 percent of the officers obtained comparable results. This is not to say that all dependent variable-covariate associations were significant. For example, combat service was not significantly associated with any dependent variable outcome.

The current dioxin level analyses for Ranch Hands offer a unique opportunity to clearly assess dose-response relationships essentially in the absence of potentially confounding covariate factors. The unadjusted psychological data for Models 4, 5, and 6 again revealed statistically significant outcomes on six of the SCL-90-R scales and the other neuroses and anxiety verified questionnaire scales. These results are highly similar to those obtained on the Model 3 analysis where symptoms of anxiety, tension, hostility, somatization and generalized psychological distress were endorsed with significant frequency. Marginally significant elevations also were found on the somatization, phobic anxiety, and positive symptom distress index of Models 4 and 5. The Model 6 analyses found generally fewer significant results. Adjusted analyses of Models 4, 5, and 6 were nonsignificant with one minor exception. The essential absence of statistically significant adjusted test results observed in Models 4, 5, and 6 suggest that the statistically significant adjusted test results observed in Models 1 and 3 can be explained on the basis of factors other than a causal relationship with TCDD body burdens. Notably, the residual presence of statistically significant Ranch Hand psychological test scores is reminiscent of the results obtained on the 1982 and followup 1985 and 1987 studies.

As reported in the previous studies, a significant portion of the enlisted men continued to endorse test items reflecting higher levels of anxiety and somatic complaints with persistent health-related apprehension. Concern about their current symptoms and future life has probably been heightened by self-estimated or substantiated exposure to dioxin. Some of these Ranch Hands have evidently developed both conscious or unconscious forms of anticipatory anxiety with a related tendency to associate almost any psychological or physical symptom they might experience with their self-perceived dioxin exposure. While some of their fears regarding negative future outcomes may have abated over the years, residual apprehension, and perhaps resentment and hostility, remain. Conscious and unconscious feelings of this type tend to be maximal while undergoing followup medical and psychological evaluation. Anxiety and related psychophysiological disturbances probably also have been heightened by sometimes negative and sensationalized media reports concerning possible outcomes associated with dioxin exposure. As noted in the introduction of this chapter, a previously completed Veteran's Administration study (22) found that those veterans reporting "high level" exposure to Agent Orange are most likely to demonstrate

poor morale, anxiety, organic symptoms, hostility or fear of possible injury or losing control. Notably, those veterans reporting high levels of exposure and related levels of psychological distress failed to differ from low exposure veterans on objective measures of psychological status or cognitive function. Similarly, those Ranch Hands who obtained statistically significant symptom scale elevations on the adjusted results, failed to demonstrate clear-cut evidence of verified psychological disorders.

In conclusion, these data further suggest that factors other than dioxin exposure continue to contribute to a relatively small but notable number of Ranch Hand test score abnormalities. However, previous studies in clinical medicine continue to indicate the need for caution when interpreting the outcome of large group statistical studies, While such undertakings increase the probability of obtaining reliable and valid results, the possibility that a small subset of physically or psychologically vulnerable Ranch Hands may have suffered psychological injury in the context of their exposure to dioxin cannot be unequivocally ruled out at this time.

SUMMARY

Verified psychological conditions and the SCL-90-R inventory of nine primary symptom dimensions and three global indices of distress were examined in the psychological assessment. Each endpoint was tested for any relationship with group (Model 1), initial dioxin (Model 2), categorized dioxin (Model 3), current lipid-adjusted dioxin (Model 4), current whole-weight dioxin (Model 5), and current whole-weight dioxin adjusted for total lipids (Model 6). Results are summarized and presented in Tables 12-20 through 12-23. A summary of group-by-covariate and dioxin-by-covariate interactions is found in Table 12-24.

Model 1: Group Analysis

The Model 1 analysis contrasted Ranch Hands and Comparisons across all occupations and within each occupation. With the exception of the other neuroses variable, all significant differences found were from the contrasts combining all occupations in both the unadjusted and adjusted analyses. The other neuroses variable displayed significant differences for both enlisted groundcrew contrasts as well as the adjusted contrast for all participants. Also, all significant results revealed more Ranch Hands than Comparisons either had a higher percentage of histories of other neuroses or a greater prevalence of high SCL-90-R T-scores. Variables revealing significant or marginally significant differences were other neuroses, SCL-90-R anxiety, SCL-90-R hostility, SCL-90-R obsessive-compulsive behavior, SCL-90-R paranoid ideation, SCL-90-R somatization, and SCL-90-R global severity index. Unadjusted significant or marginally significant results were either from the contrasts combining all occupations or the enlisted groundcrew contrasts. The enlisted flyer contrasts of the adjusted analysis also revealed marginally significant differences.

Model 2: Initial Dioxin Analysis

Significant results in the unadjusted tests of association between the psychological endpoints and initial dioxin tests occurred only for the SCL-90-R phobic anxiety symptom dimension. The results indicate a positive association between initial dioxin and high SCG 90-R phobic anxiety T-scores. The adjusted analysis of SCL-90-R phobic anxiety was

Table 12-20.
Summary of Group Analyses (Model 1) for Psychology Variables
(Ranch Hands vs. Comparisons)

	UNADJUSTED			
Variable	**All**	**Officer**	**Enlisted Flyer**	**Enlisted Groundcrew**
Verified Medical Records				
Psychoses	ns	ns	NS	ns
Alcohol Dependence	NS	ns	NS	NS
Drug Dependence	ns	--	--	ns
Anxiety	NS	NS	NS	NS
Other Neuroses	NS	ns	NS	+0.040
Psychological Examination				
SCL-90-R Anxiety	NS*	NS	NS	NS
SCL-90-R Depression	NS	NS	NS	NS
SCL-90-R Hostility	+0.044	ns	NS	NS*
SCL-90-R Interpersonal Sensitivity	NS	ns	NS	NS
SCL-90-R Obsessive-Compulsive Behavior	NS*	NS	NS	NS
SCL-90-R Paranoid Ideation	+0.022	NS	NS	NS*
SCL-90-R Phobic Anxiety	NS	US	NS	NS
SCL-90-R Psychoticism	NS	NS	NS	NS
SCL-90-R Somatixation	+0.048	NS	NS	NS
SCL-90-R Global Severity Index	NS*	NS	NS	NS
SCL-90-R Positive Symptom Total	NS	ns	NS	NS
SCL-90-R Positive Symptom Distress Index	NS	NS	ns	NS

+: Relative risk ≥ 1.00.
--: Analysis not performed due to sparse number of abnormalities.
NS or ns: Not significant ($p > 0.10$).
NS*: Marginally significant ($0.05 < p \leq 0.10$).
Note: P-value given if $p \leq 0.05$.
A capital "NS" denotes a relative risk 1.00 or greater; a lower case "ns" denotes relative risk less than 1.00.

Table 12-20. (Continued)
Summary of Group Analyses (Model 1) for Psychology Variables
(Ranch Hands vs. Comparisons)

Variable	ADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
Verified Medical Records				
Psychoses	NS	NS	NS	ns
Alcohol Dependence	**(NS)	**(ns)	**(NS)	**(NS)
Drug Dependence	ns	--	--	ns
Anxiety	NS	NS	NS	NS
Other Neuroses	**(+0.034)	**(NS)	**(NS)	**(+0.017)
Psychological Examination				
SCL-90-R Anxiety	+0.039	NS	NS*	NS
SCL-90-R Depression	NS	NS	NS	NS
SCL-90-R Hostility	**(NS*)	**(ns)	**(NS*)	**(NS)
SCL-90-R Interpersonal Sensitivity	NS	NS	NS	NS
SCL-90-R Obsessive-Compulsive Behavior	+0.047	NS	NS	NS
SCL-90-R Paranoid Ideation	**(+0.010)	**(NS)	**(NS*)	**(NS*)
SCL-90-R Phobic Anxiety	NS	ns	NS	NS
SCL-90-R Psychoticism	NS	NS	NS	NS
SCL-90-R Somatixation	+0.018	NS	NS	NS*
SCL-90-R Global Severity Index	+0.044	NS	NS	NS
SCL-90-R Positive Symptom Total	NS	NS	NS	NS
SCL-90-R Positive Symptom Distress Index	NS	NS	ns	NS

+: Relative risk ≥ 1.00.
--: Analysis not performed due to sparse number of abnormalities.
NS or ns: Not significant ($p > 0.10$).
NS*: Marginally significant ($0.05 < p \leq 0.10$).
**(NS) or **(ns): Group-by-covariate interaction (p 50.05); not significant when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
**(NS*): Group-by-covariate interaction ($p \leq 0.05$); marginally significant when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
**(...): Group-by-covariate interaction (p 10.05); significant when interaction is deleted and p-value is given in parentheses; refer to Appendix H-2 for further analysis of this interaction.

Note: A capital "NS" denotes a relative risk 1.00 or greater; a lower case "ns" denotes relative risk less than 1.00.

Table 12-21.
Summary of Initial Dioxin Analyses (Model 2) for Psychology Variables (Ranch Hands Only)

Variable	Unadjusted	Adjusted
Verified Medical Records		
Psychoses	ns	ns
Alcohol Dependence	NS	N S
Drug Dependence	--	--
Anxiety	NS	**(ns)
Other Neuroses	NS	NS
Psychological Examination		
SCL-90-R Anxiety	NS	**(NS)
SCL-90-R Depression	NS	**(NS)
SCL-90-R Hostility	NS*	NS
SCL-90-R Interpersonal Sensitivity	NS	**(NS)
SCL-90-R Obsessive-Compulsive Behavior	NS	**(NS)
SCL-90-R Paranoid Ideation	NS	ns
SCL-90-R Phobic Anxiety	+0.036	NS*
SCL-90-R Psychoticism	NS	NS
SCL-90-R Somatization	NS	NS*
SCL-90-R Global Severity Index	NS	**(NS)
SCL-90-R Positive Symptom Total	NS	**(NS)
SCL-90-R Positive Symptom Distress Index	NS	NS

+: Relative risk $\geq$ 1.00.
--: Analysis not performed due to sparse number of abnormalities.
NS or ns: Not significant ($p > 0.10$).
NS*: Marginally significant ($0.05 < p \leq 0.10$).
**(NS) or **(ns): Log_2 (initial dioxin)-by-covariate interaction ($p \leq 0.05$); not significant when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
Note: P-value given if $p \leq 0.05$.
A capital "NS" denotes a relative risk of 1.00 or greater; lower case "ns" denotes relative risk less than 1.00.

Table 12-22.
Summary of Categorized Dioxin Analyses (Model 3) for Psychology Variables (Ranch Hands vs. Comparisons)

Variable	UNADJUSTED			
	Background Ranch Hands vs. Comparisons	Low Ranch Hands vs. Comparisons	High Ranch Hands vs. Comparisons	Low plus High Ranch Hands vs. Comparisons
Verified Medical Records				
Psychoses	ns	NS	NS	NS
Alcohol Dependence	NS	NS	NS	NS
Drug Dependence	ns	--	–	–
Anxiety	ns	ns	+0.044	NS
Other Neuroses	ns	NS*	+0.037	+0.010
Psychological Examination				
SCL-90-R Anxiety	ns	NS	+0.002	+0.009
SCL-90-R Depression	NS	ns	+0.031	NS
SCL-90-R Hostility	NS	NS	+0.008	+0.032
SCL-90-R Interpersonal Sensitivity	ns	NS	+0.024	NS*
SCL-90-R Obsessive-Compulsive Behavior	NS	NS	t-o.049	NS
SCL-90-R Paranoid Ideation	NS	NS	+0.010	+0.029
SCL-90-R Phobic Anxiety	ns	ns	NS*	NS
SCL-90-R Psychoticism	NS	ns	NS	NS
SCL-90-R Somatixation	NS	NS	+0.011	+0.024
SCL-90-R Global Severity Index	NS	NS	+0.006	+0.035
SCL-90-R Positive Symptom Total	ns	NS	+0.033	NS
SCL-90-R Positive Symptom Distress Index	ns	NS	NS	NS

+: Relative risk ≥ 1.00.
--: Analysis not performed due to sparse number of abnormalities.
NS or ns: Not significant ($p > 0.10$).
NS*: Marginally significant ($0.05 < p \leq 0.10$).
Note: P-value given if p 10.05.
A capital "NS" denotes a relative risk 1.00 or greater; a lower case "ns" denotes relative risk less than 1.00.

Table 12-22. (Continued)
Summary of Categorized Dioxin Analyses (Model 3) for Psychology Variables
(Ranch Hands vs. Comparisons)

Variable	ADJUSTED			
	Background Ranch Hands vs. Comparisons	Low Ranch Hands vs. Comparisons	High Ranch Hands vs. Comparisons	Low plus High Ranch Hands vs. Comparisons
Verified Medical Records				
Psychoses	ns	NS	ns	NS
Alcohol Dependence	NS	NS	NS	NS
Drug Dependence	NS	--	--	--
Anxiety	NS	ns	NS	ns
Other Neuroses	**(NS)	**(NS)	**(NS)	**(NS)
Psychological Examination				
SCL-90-R Anxiety	NS	NS	+0.041	NS*
SCL-90-R Depression	NS	ns	NS	NS
SCL-90-R Hostility	NS	NS	NS*	NS
SCL-90-R Interpersonal Sensitivity	NS	NS	NS	NS
SCL-90-R Obsessive-Compulsive Behavior	+0.007	ns	NS	NS
SCL-90-R Paranoid Ideation	**(+0.007)	**(NS)	**(NS*)	**(NS)
SCL-90-R Phobic Anxiety	NS*	ns	NS	ns
SCL-90-R Psychoticism	**(NS)	**(ns)	**(NS)	**(NS)
SCL-90-R Somatixation	+0.031	NS	NS	NS
SCL-90-R Global Severity Index	NS	NS	NS*	NS
SCL-90-R Positive Symptom Total	NS	NS	NS	NS
SCL-90-R Positive Symptom Distress Index	NS	NS	NS	NS

+: Relative risk $\geq$ 1 .00.
--: Analysis not performed due to sparse number of abnormalities.
NS or ns: Not significant ($p > 0.10$).
NS*: Marginally significant ($0.05 < p \leq 0.10$).
**(NS) or **(ns): Categorized dioxin-by-covariate interaction (p 50.05); not significant when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
**(NS*): Categorized dioxin-by-covariate interaction ($p \leq 0.05$); marginally significant when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
**(+0.007): Categorized dioxin-by-covariate interaction ($p \leq 0.05$); significant ($p = 0.007$) when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
Note: P-value given if $p \leq 0.05$.
A capital "NS" denotes a relative risk 1 .00 or greater; a lower case "ns" denotes relative risk less than 1.00.

Table 12-23.
Summary of Current Dioxin Analyses (Models 4, 5, and 6) for Psychology Variables (Ranch Hands Only)

Variable	UNADJUSTED		
	Model 4: Lipid-Adjusted Current Dioxin	Model 5: Whole-Weight Current Dioxin	Model 6: Whole-Weight Current Dioxin Adjusted for Total Lipids
Verified Medical Records			
Psychoses	NS	NS	NS
Alcohol Dependence	lls	ns	ns
Drug Dependence	ns	ns	ns
Anxiety	NS*	+0.041	NS
Other Neuroses	+0.013	+0.005	NS
Psychological Examination			
SCL-90-R Anxiety	+0.005	+0.002	+0.013
SCL-90-R Depression	NS	NS	NS
SCL-90-R Hostility	+0.008	+0.004	+0.019
SCL-90-R Interpersonal Sensitivity	i-o.022	+0.012	NS*
SCL-90-R Obsessive-Compulsive Behavior	NS	NS	ns
SCL-90-R Paranoid Ideation	NS	NS	NS
SCL-90-R Phobic Anxiety	NS*	NS*	NS
SCL-90-R Psychoticism	NS	NS	NS
SCL-90-R Somatization	NS*	+0.023	NS
SCL-90-R Global Severity Index	+0.024	+0.014	NS
SCL-90-R Positive Symptom Total	+0.027	+0.013	NS
SCL-90-R Positive Symptom Distress Index	NS	NS*	NS

+: Relative risk ≥ 1.00.
NS or ns: Not significant ($p > 0.10$).
NS*: Marginally significant ($0.05 < p$ 10.10).
Note: P-value given if $p \leq 0.05$.
A capital "NS" denotes a relative risk of 1.00 or greater; a lower case "ns" denotes relative risk less than 1.00.

Table 12-23. (Continued)
Summary of Current Dioxin Analyses (Models 4, 5, and 6) for Psychology Variables (Ranch Hands Only)

Variable	ADJUSTED		
	Model 4: Lipid-Adjusted Current Dioxin	Model 5: Whole-Weight Current Dioxin	Model 6: Whole-Weight Current Dioxin Adjusted for Total Lipids
Verified Medical Records			
Psychoses	NS	NS	ns
Alcohol Dependence	ns*	ns	-0.036
Drug Dependence	--	--	--
Anxiety	ns	ns	ns
Other Neuroses	**(ns)	**(NS)	**(ns)
Psychological Examination			
SCL-90-R Anxiety	**(NS)	**(NS*)	**(NS)
SCL-90-R Depression	**(NS)	**(NS)	**(ns)
SCL-90-R Hostility	NS	NS	NS
SCL-90-R Interpersonal Sensitivity	NS	NS	NS
SCL-90-R Obsessive-Compulsive Behavior	**(ns)	**(ns)	**(ns)
SCL-90-R Paranoid Ideation	**(ns)	**(ns)	**(ns)
SCL-90-R Phobic Anxiety	ns	ns	ns
SCL-90-R Psychoticism	**(ns)	ns	ns
SCL-90-R Somatization	**(NS)	**(NS)	**(NS)
SCL-90-R Global Severity index	**(NS)	**(NS)	**(NS)
SCL-90-R Positive Symptom Total	NS	NS	NS
SCL-90-R Positive Symptom Distress Index	NS	NS	NS

-: Relative risk < 1.00.
--: Analysis not performed due to sparse number of abnormalities.
NS or ns: Not significant ($p > 0.10$).
ns*: Marginally significant ($0.05 < p \leq 0.10$).
**(NS) or **(ns): Log_2 (current dioxin + 1)-by-covariate interaction (p 50.05); not significant when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
**(NS*): Log_2 (current dioxin + I)-by-covariate interaction (p 10.05); marginally significant when interaction is deleted; refer to Appendix H-2 for further analysis of this interaction.
Note: P-value given if p 10.05.
A capital "NS" denotes a relative risk of 1 .OO or greater; a' lower case "ns" denotes relative risk less than 1.00.

Table 12-24.
Summary of Group-by-Covariate and Dioxin-by-Covariate Interactions from Adjusted Analyses of Psychology Variables

Model	Variable	Covariate
1[a]	Alcohol Dependence	Current Marital Status
	Other Neuroses	Education, Current Total Household Income
	SCL-90-R Hostility	Current Alcohol Use, Education
	SCL-90-R Paranoid Ideation	Race
2[b]	Anxiety	Occupation
	SCL-90-R Anxiety	Occupation, Current Alcohol Use
	XL-90-R Depression	Lifetime Alcohol History
	SCL-90-R Interpersonal Sensitivity	Occupation, Lifetime Alcohol History
	SCL-90-R Obsessive-Compulsive Behavior	Occupation, Current Total Household Income
	SCL-90-R Global Severity Index	Current Alcohol Use
	SCL-90-R Positive Symptom Total	Occupation, Current Total Household Income
3[c]	Other Neuroses	Lifetime Alcohol History, Education, Current Total Household Income, Combat Service
	SCL-90-R Paranoid Ideation	Current Marital Status
	SCL-90-R Psychoticism	Current Alcohol Use
4[d]	Other Neuroses	Lifetime Alcohol History
	SCL-90-R Anxiety	Current Alcohol Use
	SCL-90-R Depression	Current Total Household Income
	SCL-90-R Obsessive-Compulsive Behavior	Current Alcohol Use, Current Total Household Income
	SCL-90-R Paranoid Ideation	Education, Current Marital Status, Combat Service
	SCL-90-R Psychoticism	Current Alcohol Use
	SCL-90-R Somatixation	Current Alcohol Use, Education
	SCL-90-R Global Severity Index	Current Alcohol Use
5[e]	Other Neuroses	Lifetime Alcohol History
	SCL-90-R Anxiety	Current Alcohol Use
	SCL-90-R Depression	Race, Current Total Household Income
	SCL-90-R Obsessive-Compulsive Behavior	Current Alcohol Use, Current Total Household Income
	SCL-90-R Paranoid Ideation	Education, Current Marital Status, Combat Service
	SCL-90-R Somatixation	Current Alcohol Use
	SCL-90-R Global Severity Index	Current Alcohol Use, Current Total Household Income

Table 12-24. (Continued)
Summary of Group-by-Covariate and Dioxin-by-Covariate Interactions from Adjusted Analyses of Psychology Variables

Model	Variable	Covariate
6[f]	Other Neuroses	Lifetime Alcohol History
	SCL-90-R Anxiety	Current Alcohol Use
	SCL-90-R Depression	Race, Current Total Household Income
	SCL-90-R Obsessive-Compulsive Behavior	Current Alcohol Use, Current Total Household Income
	SCL-90-R Paranoid Ideation	Education, Current Marital Status, Combat Service
	SCL-90-R Somatixation	Current Alcohol Use, Education
	SCL-90-R Global Severity Index	Current Alcohol Use, Current Total Household Income

[a] Group Analysis (Ranch Hands vs. Comparison).
[b] Ranch Hands-Log, (Initial Dioxin).
[c] Categorized Dioxin.
[d] Ranch Hands-Log, (Current Lipid-Adjusted Dioxin + 1).
[e] Ranch Hands-Logs (Current Whole-Weight Dioxin + 1).
[f] Ranch Hands-Logs (Current Whole-Weight Dioxin + 1), Adjusted for Total Lipids.

marginally significant. Other marginally significant analyses were XL-90-R hostility (unadjusted) and SCL-90-R somatization (adjusted).

Model 3: Categorized Dioxin Analysis

Unadjusted Model 3 analyses revealed many significant differences between high Ranch Hands and Comparisons and between low plus high Ranch Hands and Comparisons. Other neuroses, SCL-90-R anxiety, SCL-90-R hostility, SCL-90-R paranoid ideation, SCL-90-R somatization, and SCL-90-R global severity index were each significant for both contrasts. Anxiety, SCL-90-R depression, SCL-90-R interpersonal sensitivity, SCL-90-R obsessive-compulsive behavior, and SCL-90-R positive symptom total each demonstrated significant differences for the high Ranch Hand contrast only. Marginally significant results were found from the low Ranch Hand contrast examining other neuroses, the high Ranch Hand contrast examining SCL-90-R phobic anxiety, and the low plus high contrast examining SCL-90-R interpersonal sensitivity. Each significant and marginally significant resulting contrast revealed Ranch Hands exhibited the greater history of verified psychological conditions or a greater percentage of high T-scores for the SCL-90-R inventory variables.

Adjusted analyses of Model 3 varied greatly from the unadjusted analyses. Most of the significant results were from the background Ranch Hands contrasts and resulted from the analyses of SCL-90-R obsessive-compulsive behavior, SCL-90-R paranoid ideation, and SCL-90-R somatization. The SCL-90-R phobic anxiety result was marginally significant for the background Ranch Hand contrast. Differences between high Ranch Hands and Comparisons were significant only for the SCL-90-R anxiety analysis. Marginally significant differences were revealed from the high Ranch Hands versus Comparisons contrast for SCL-90-R hostility, SCL-90-R paranoid ideation, and SCL-90-R global severity index. Marginally significant differences were uncovered from the low plus high Ranch Hand versus Comparison contrast for SCL-90-R anxiety. Similar to the unadjusted analyses, all significant and marginally significant contrasts revealed that Ranch Hands had the larger percentage of high SCL-90-R T-scores.

Models 4, 5, and 6: Current Dioxin Analyses

Unadjusted analysis results of Models 4 and 5 closely resembled each other, but Model 6 analyses found fewer significant results. Models 4 and 5 each displayed significant current dioxin associations with other neuroses, SCL-90-R anxiety, SCL-90-R hostility, SCL-90-R interpersonal sensitivity, SCL-90-R global severity index, and SCL-90-R positive symptom total in the unadjusted analyses. Unadjusted analyses of anxiety and SCL-90-R somatization displayed marginally significant results in Model 4 and significant results in Model 5. SCL-90-R phobic anxiety was marginally significant in Models 4 and 5. The SCL-90-R positive symptom distress index was marginally significant for Model 5 only. Only SCL-90-R anxiety and SCL-90-R hostility showed significant current dioxin associations from Model 6 unadjusted analyses, and SCL-90-R interpersonal sensitivity displayed a marginally significant association with current dioxin from Model 6. All significant and marginally significant results revealed that the history of a verified psychological condition or the prevalence of high T-scores for the SCL-90-R inventory variables increased as current dioxin levels increased.

In contrast to the unadjusted analyses of Models 4, 5, and 6, most associations from the adjusted analyses were nonsignificant. Only one current dioxin association, which was from the Model 6 analysis of alcohol dependence, was significant. Model 4 results were marginally significant for alcohol dependence only. Both analyses revealed an inverse association where the history of alcohol dependence decreased as the current dioxin level increased. A marginally significant positive association also was found from the Model 5 adjusted analysis of SCL-90-R anxiety.

CONCLUSION

Most Model 1 significant results were from contrasts combining all occupations and among the SCL-90-R inventory variables. All significant differences from Model 1 contrasts found that Ranch Hands exhibited higher psychological distress than Comparisons.

No significant differences were observed based on the Model 2 initial dioxin adjusted analyses, and only two of the SCL-90-R measures were marginally significant. Significant results from Model 3 unadjusted analysis were found exclusively within the high or low plus high Ranch Hand versus Comparisons contrasts. Adjusted Model 3 analysis revealed only three significant SCL-90-R endpoints and were found within the background Ranch Hand versus Comparisons contrasts. All significant differences from Model 3 contrasts found that Ranch Hands exhibited higher psychological distress than Comparisons.

Notable among analyses of Models 4, 5, and 6 were the similarities among Models 4 and 5 and their differences with Model 6 results. Unadjusted analysis of Models 4 and 5 displayed several positive significant associations between psychological distress and current dioxin levels while the Model 6 unadjusted analysis exhibited only two significant results. However, after adjustment for covariates, no positive significant associations were found from the adjusted analyses of Models 4, 5, and 6.

Each model analyses produced a smaller number of significant results from the adjusted analyses than from the unadjusted analyses due to the adjustment for important confounding effects such as education and occupation.

In conclusion, the differences in the Ranch Hand and Comparison groups, but the lack of an effect attributable to dioxin, suggest that factors other than dioxin exposure continue to contribute to a relatively, small but notable number of Ranch Hand test score abnormalities. Ranch Hands with psychological make-ups predisposing them to higher levels of anxiety, psychophysiological disturbances, and related somatic concerns, resulting from repeated public suggestion of physical and psychological consequences of dioxin exposure, would predictably demonstrate a self-perpetuating pattern of either static or escalating physical and psychological symptoms. Previous studies in clinical medicine continue to indicate the need for caution when interpreting the outcome of large statistical studies. The possibility that a small subset of physically or psychologically vulnerable Ranch Hands may have suffered psychological injury in the context of their exposure to dioxin cannot be definitively ruled out at this time.

CHAPTER 12
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